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# **An Intelligent Agent for Adapting and Delivering Electronic Course Materials to Mobile Learners**

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## **Abstract**

The concept of mobile learning is often defined as learning that takes place with the help of mobile devices to access course materials; however, these devices operate in different ways and have different capabilities. To make course materials available on these mobile devices as well as on desktop systems, a software program is required to allow course material to be delivered in heterogeneous computing platforms. Because of these heterogeneous computing platforms, some course materials may not be in a format that different mobile devices would accept. This project developed an intelligent software agent capable of adapting to the heterogeneous mobile computing environment. The agent can search for a conversion tool according to the desired format and convert the course materials automatically. The agent is able to understand mobile clients' capabilities. In order for the server to know what type of course material the client wishes to receive, the client needs to feed information on the software and hardware capabilities of the device to the server. However, devices do not normally carry any information about their capabilities. We have chosen the Resource Description Framework (RDF) represented Composite Capabilities/Preferences Profile (CC/PP) promoted by the W3C to describe the device capabilities and user preferences.

*Keywords: Mobile Learning, Intelligent Agent, M-learning, Mobile Devices*

## **1. Introduction**

With the proliferation of mobile technology in society and business, many individuals and organizations are seriously looking at using mobile devices for learning and training. As a result, educators must develop new courses and re-purpose existing courses for mobile learning. The concept of mobile learning (M-learning) is often defined as learning that takes place with the help of mobile devices. Ally (2004) defined M-learning as the delivery of electronic learning materials on mobile computing devices to allow access from anywhere and at anytime. However, different mobile devices operate in different manner and have different capabilities. The design for mobile devices has to be flexible to allow electronic learning (E-learning) materials to be delivered in heterogeneous computing platforms. Because of these heterogeneous platforms, some course materials may not be in a format that mobile devices would accept. The objective of this research is therefore to develop an intelligent software agent capable of adapting to the heterogeneous mobile computing environment. The agent should be able to search for a conversion tool according to the desired format and convert the course materials automatically through understanding the mobile clients' software capabilities and hardware limitations.

In order for the server to know what type of E-learning material the client wishes to receive, the client needs to provide the software and hardware capability of the device to the server. However, a device initially does not carry any information about the capability. This project experimented with the Resource Description Framework (RDF) represented Composite Capabilities/Preferences Profile (CC/PP), which is promoted by the W3C (2005) to describe the device capabilities and user preferences. Jena as an RDF parser was used to obtain the device information, providing a query language called Resource Description Query Language (RDQL, 2005) to query for device information. Sun's Wireless Toolkit and PalmOS Emulator were used as the testing environment. Also, an open and service-oriented architecture was used to develop the agent and open application interfaces to enable interaction and integration seamlessly between learning objects repository, course repository, and learning services.

## 2. Related work

Gaedke et al. (2005) proposed an approach to automate Web content conversion. Similarly, Castellanos and Sanchez (2003) have designed a framework to allow small devices (e.g. PDA and cellular phones) to download digital library (DL) resources. Gross (2001) has developed a prototype system PRAVTA to monitor the presence of users. The aim of the prototype was "to develop a system that provides users with adequate awareness information anytime and anyplace." The presence of a user can be found by sensors and reported by indicators. The entire "awareness" process is automated. The information is updated on a Web server and can be queried through a Web service. This automated information update principle has been used in this project. Lum and Lau (2002) proposed a content adaptation system that decides the optimal content version for presentation and the best strategy for deriving that version. They developed a prototype PDF documentation adaptation system.

## 3. Architecture Design and Methodology

### 3.1 Design Considerations

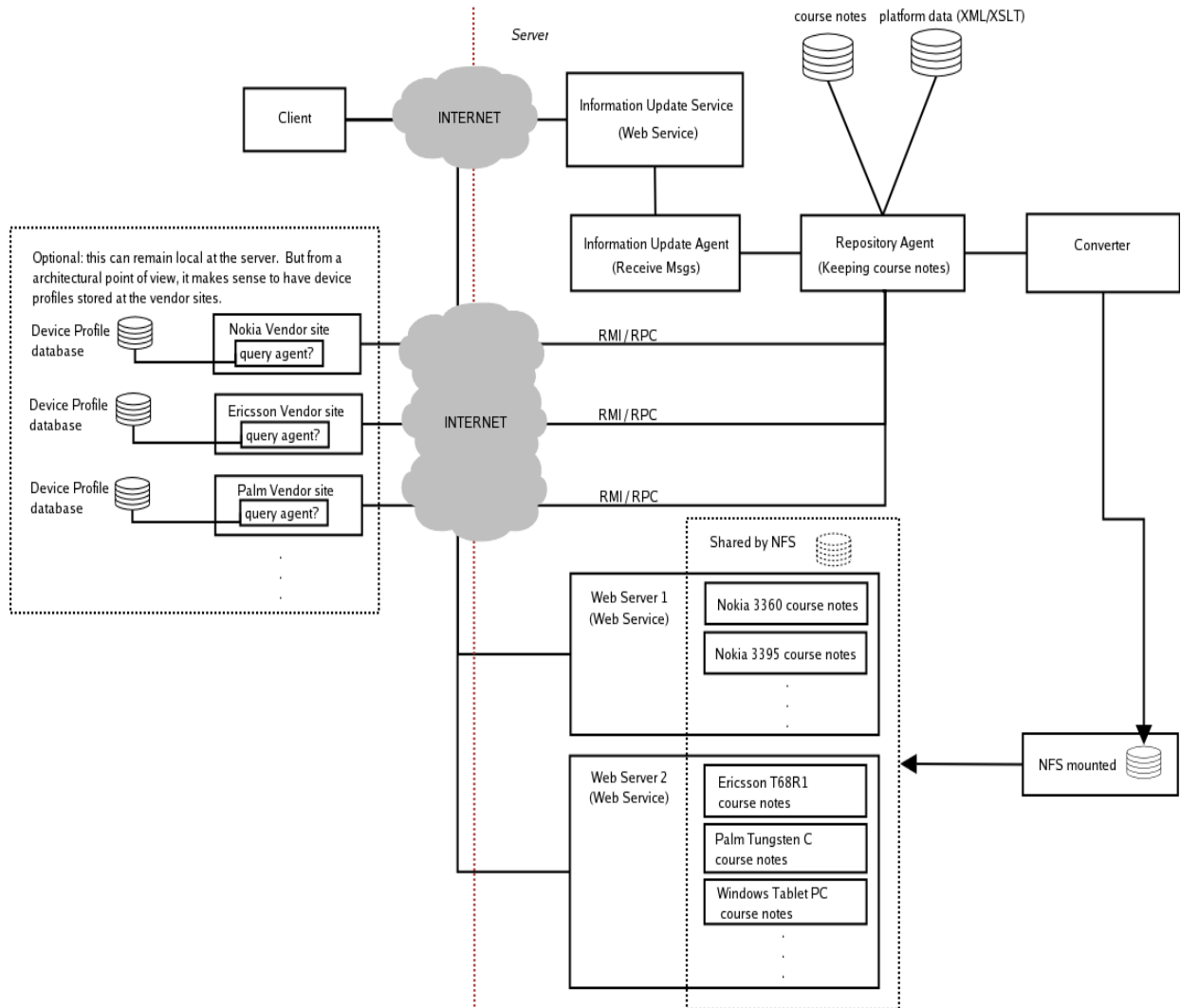
This project considered the following issues in heterogeneous devices.

- *Software Portability.* A Java-based cross-platform software framework is one of the most important features in this project.
- *Limited Computing Power and Memory Consumption.* We designed computing intensive tasks to execute on the server side. The portable computing devices act as a thin client. The thin client design model precludes the need for having large executable files and user libraries stored on the client mobile device.
- *Display Properties.* The system provides support for different devices by separating the presentation layer from the data content. A number of different devices can be supported without the need of modifying programming logic and data content.
- *Development Costs.* This project targets Athabasca University (AU). Therefore, the software should be designed to integrate seamlessly into AU's existing infrastructure.
- *Design Flexibility and Scalability.* The system is designed in a distributed architecture that prevents a single point of failure, improves structural scalability and performance. Besides the distributed architecture, a Web service is deployed on the server to allow thin clients to access the backend data. Web services are platform independent; therefore, virtually any type of client can construct a Remote Procedure Call (RPC) to execute code at the server side.
- *Caching to Save on Limited Resources.* With the support of the caching design, users can read the cached course notes on the device to avoid additional downloads.
- *Software Agent Support.* Software agents can be used to facilitate automated routine tasks, residing in both the client device and the server environment.

### 3.2 Architectural Design

The architecture can be divided into two main areas: Client and Server (Figure 1). The client shown in Figure 1 connects to the University server through the Internet, running the Information Update Client Agent. Figure 2 shows how a client negotiates with the server to retrieve updated course notes. There are two main activities in this Client-Server Communication: Device Recognition Negotiation and Negotiation for Updated Course Notes Files.

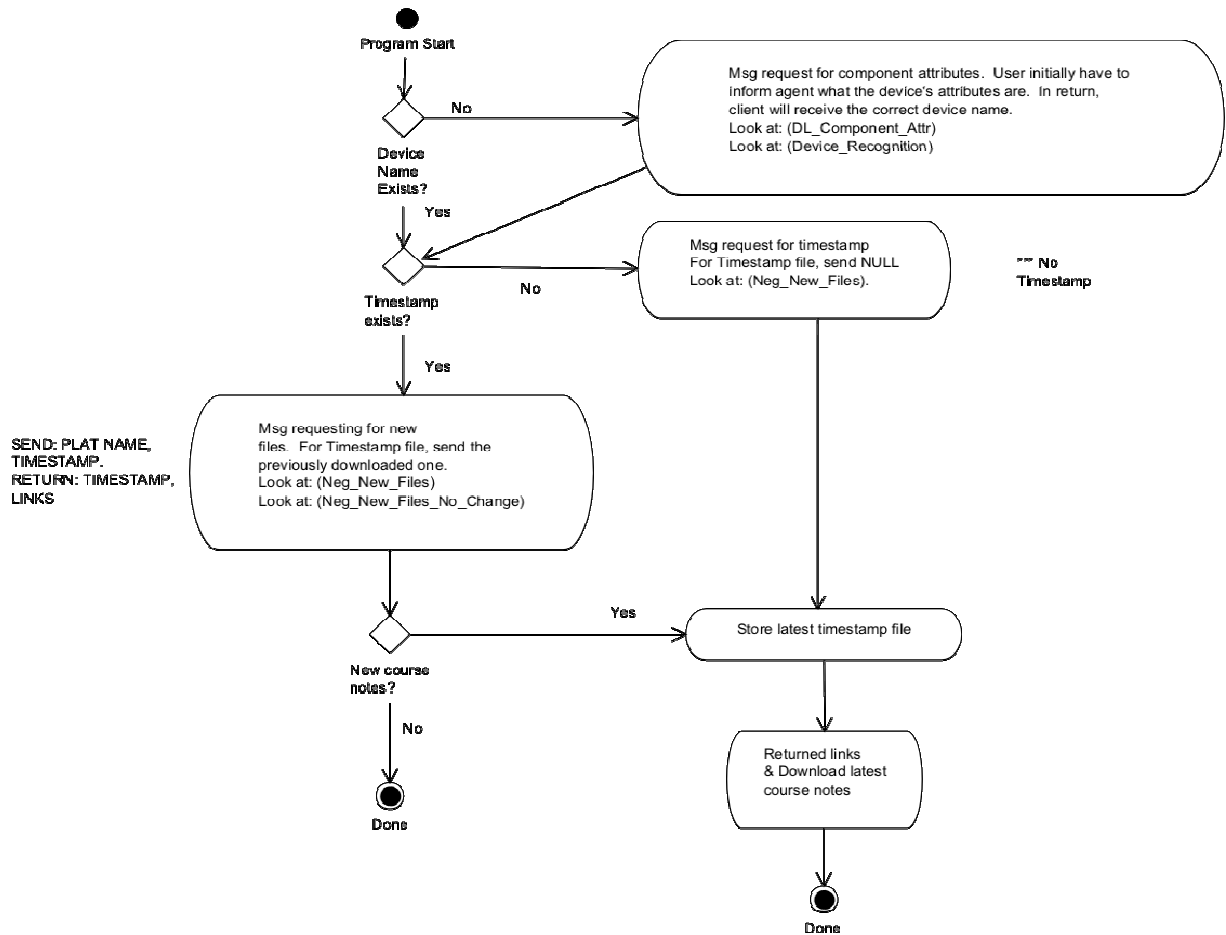
Figure 1. The overall architectural diagram.



*Device Recognition Negotiation.* The reason for having device recognition is that the server needs to know what type of course notes content the client wishes to receive. In order for the server to achieve this, the client needs to provide the information on its software and hardware capabilities to the server. Unfortunately, a device initially does not carry any information about its supported hardware and software capability. Our solution to obtaining this device capability information is to utilize Composite Capabilities/Preferences Profile (CC/PP) promoted by the W3C (2005). CC/PP has been written in Resource Description Framework (RDF) which is represented in Extensible Markup Language (XML). We used Jena (2005) as an RDF parser to obtain device information. Jena provides a query language called Resource Description Query Language (RDQL) to query for device information. RDQL is similar to SQL used in relational databases. CC/PP contains a list of component attributes.



Figure 2: Activity Diagram: Client Server Negotiation.



The attributes contain information about the processor type, amount of memory, operating system version and sound and image capability. The client starts with a request to the server for a set of component attribute criteria, which include a series of questions the user has to answer. Using the answers from the user, the server can recognize the device by matching these criteria. When there are more devices added to the database in the future, additional component attributes might be added to the schema. It is an advantage that component attribute criteria can be re-fetched instead of stored on the device permanently. In other words, the server can easily manage the addition and deletion of component attributes and the client will adapt to the changes immediately. By default, there are four downloadable component attribute criteria in the configuration file. The criteria are a series of questions listed in Table 1.

Table 1: the questions for the component attribute criteria

Attribute Criteria / Question	Sample Answer / Settings
1. Vendor Name?	E.g. Ericsson
2. Model Number?	E.g. T68R1
3. Is this device image capable?	E.g. Yes/No
4. Can this device display color?	E.g. Yes/No
5. Can your device output sound?	E.g. Yes/No
6. Can your device accept downloadable software?	E.g. Yes/No

Some component attributes, for example “HTML version supported”, will not be downloaded because not all users will understand the meaning of this attribute. Only the simple attribute criteria questions that a normal user can understand, such as “Can your device output sound?” will be downloaded. The component attribute criteria are stored in XML format. The criteria can be changed during a software runtime and the new attribute criteria will be downloaded to the client. The client will send a message to the InformationUpdateAgent which then acquires the RepositoryAgent. The RepositoryAgent will invoke the ComponentAttrReader class to retrieve the component attribute criteria. This information will be delivered back to the client. Upon receiving the component attribute criteria, the human user has to provide some information about the device for device recognition. The component attribute settings the user specified will be sent to the InformationUpdateAgent to search for the appropriate device name. The RepositoryAgent will fetch all available device profiles with the DeviceProfileReader class. RDQL will be used to query for the device name and the correct device name will be sent to the client.

There are two steps in the device recognition process. In the first step, the server agent will try to recognize the device by its vendor and device names. If the server agent cannot find that device directly from the database, it will try to recognize the device by the component attributes. The advantage of this strategy is that, if the user already knows the device model, this can be entered into the device. This strategy saves the extra computing time on the server to perform device recognition. If this information is not recognized, the server agent will have to match the device component attributes for the correct device name.

Component attribute settings can also be overridden to suit the users' preferences. For example, some users cannot tolerate a slow network speed and therefore, they prefer to download Web pages without images. The “image capability” attribute flag can be turned off even if the device has the ability of displaying images. After the user has entered the component attributes, the client agent can communicate with the server agent to perform device recognition.

There are three main components on the server side: Information Update Service, Information Update Server Agent, and Repository Agent. First, the Information Update Service provides a Web service for the client to connect and request for a specific service to execute. The Web service is provided by a Java Servlet which is run on the Apache Tomcat Web server. The Web service provides a light version of SOAP, called KSOAP (2005), as the communication protocol. Second, the Information-Updating Service automatically marshals and un-marshals KSOAP objects, which are delivered to the appropriate destinations. When the servlet has successfully received a message from the client, the message will be synchronously delivered to the Information Update Server Agent. The Information Update Server Agent executes method calls according to the message types. In addition, the Information Update Server Agent will communicate with the Repository Agent in fetching data from the repository. Third, there are two main functions for the Repository Agent: File Conversion and Fetching updated files for the remote client.

**File Conversion:** Each platform requires a transformation file (XSLT) for data conversion. Transformation files are made device specific and contain layout and formatting information. A transformation file transforms a generic data file to a file in a specific format.

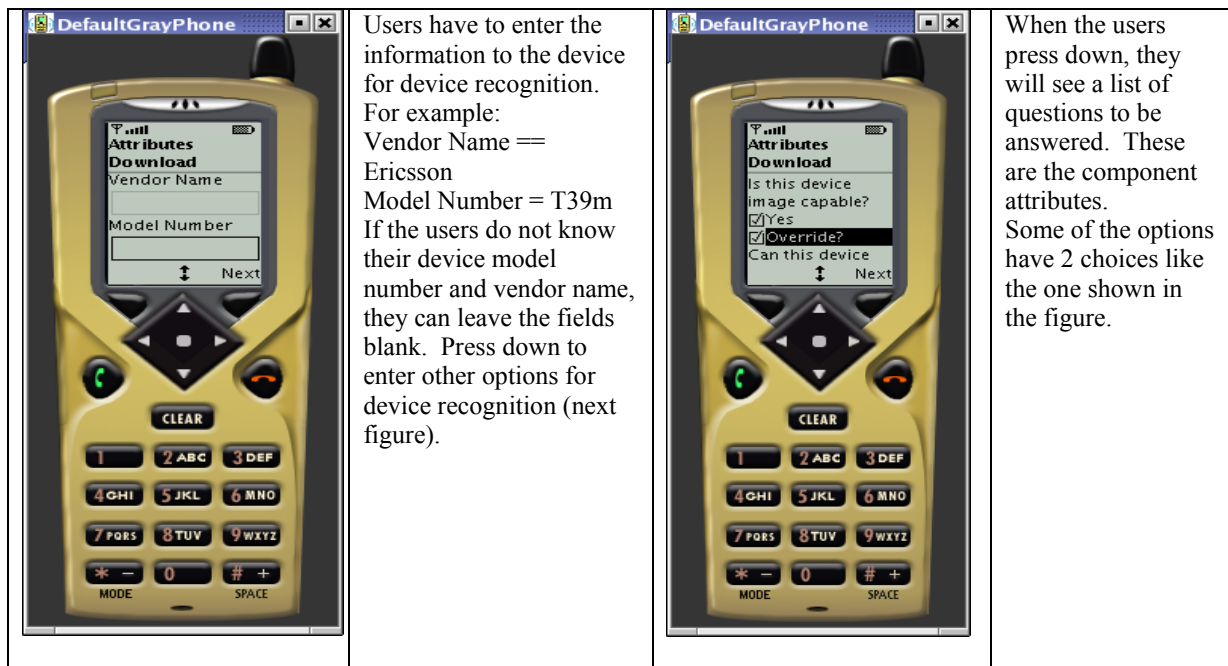
**Negotiation for Updated Course Materials Files.** This functionality is used where the client has to communicate with the Repository Agent to determine what files have been updated. InformationUpdateClient sends a message to the InformationUpdateAgent which redirects the request to the RepositoryAgent for requesting new course materials. The message includes the platform name and the timestamp last obtained from the server. The timestamp file contains timestamps of the entire list of course files currently stored on the client device. The RepositoryAgent first

retrieves all timestamp data from the timestamp file on the server. The retrieved data will be compared against the timestamp data passed in from the client. The agent can obtain a list of updated files with a timestamp comparison. With the same mechanism, the files deleted on the server will also be detected. Next, the RepositoryAgent will try to find the location of the updated files based on the platform name obtained from the client. In return, the RepositoryTimeUtil class will fetch and return the links to the RepositoryAgent. The RepositoryAgent will also request the latest timestamp file in byte array from the RepositoryTimeStampReader class. Then three items returned to the client: links to download latest course materials, deleted files, and the latest timestamp file. If there are no files being updated or deleted, a message will be returned to the client indicating there has been no file change.

### 3.3 Testing Environment

There are two pieces of software used in this project to save testing time: Sun's Wireless Toolkit (WTK) and PalmOS Emulator. The wireless toolkit provides an easier way to build a software package for a Java compatible device. The toolkit also offers package integrity checking to ensure the package and other files are generated correctly from Java class files. This toolkit also provides emulation of a few Java-enabled cell phones. The compiled package can run on these emulated cell phones (Figure 3). The PalmOS Emulator provides the ability to run the J2ME package on the emulated PalmOS environment. With these testing tools, the testing image is not required to run on-target; instead it can be run in an emulated environment.

Figure 3: Screen Shots



## 4. Results

There are a number of advantages of distributing course materials using the agent over the current method. Table 1 shows the total time an average person would need to create course notes.

	First Page		Second Page	
	With Automatic Software Updater	Conventional method of distribution	With Automatic Software Updater	Conventional method of distribution
<b>Compose course notes (1 page)</b>				
- <i>Windows</i>	N/A	30 mins	N/A	30 mins
- <i>Linux</i>	N/A	30 mins	N/A	30 mins
- <i>PDA's</i>	N/A	30 mins	N/A	30 mins
- <i>Cell phones</i>	N/A	30 mins	N/A	30 mins
- <i>Platform-in specific</i>	30 mins	N/A	30 mins	N/A
<b>XML Transformation StyleSheet</b>				
- <i>Windows</i>	30 mins	N/A	0 mins	N/A
- <i>Linux</i>	30 mins	N/A	0 mins	N/A
- <i>PDA's</i>	30 mins	N/A	0 mins	N/A
- <i>Cell phones</i>	30 mins	N/A	0 mins	N/A
<i>Packaging</i>	N/A	10 mins	N/A	10 mins
<b>Total:</b>	150 mins	130 mins	30 mins	130 mins

**Table 1. Time needed for instructor to create Page 1 and Page 2.**

With the agent, there might be a slight learning curve at the beginning. However, using the agent provides the time savings in the long run. The second and third columns of Table 1 show a scenario where the person needs to create the first page of the course notes. The fourth and fifth columns of Table 1 show a scenario where the same instructor needs to create a second page of course notes.

With the help of the updater, an instructor only requires creating another file, which contains the course materials data; that is, there is no page formatting included in the file. The same transformation stylesheets previously created can be reused. The stylesheets also allow the instructor to provide a consistent look and feel across all the pages. Note that there is a significant amount of time which can be saved especially when more platforms are added. Transformation is performed before deployment to avoid the lagging file access time introduced by Just-in-time transformation. Therefore, the entire pages ready to serve on the Web servers should already have been converted, then the users' wait time being reduced tremendously. Without the help of the agent, Web pages will have to be transformed at least once (by caching the transformed pages) during runtime.

The updater also helps instructors save time from packaging and deployment. Instead of packaging and deploying each set of files manually, the updater will copy the files to the appropriate platform folders for deployment. The updater also ensures that students will get the latest files on the server. Therefore, if there is an addition, deletion, or update for the course files, instructors will not need to send out any notifications to their students.

## 5. Conclusion

Because of the increasing use of mobile devices in society and businesses, they will be increasing emphasis on the

use of mobile learning in training and education. As a result, new courses have to be developed or existing courses have to be revised for delivery on mobile devices. The project described in this paper developed and introduced the Automatic Software Updater. The results gathered from using the Automatic Software Updater proves that the Automatic Software Updater provides a substantial timesaving in a heterogeneous platforms environment. Not only the time for developing course notes but also the time for packaging and deployment has been shortened. The Automatic Software Updater generates a substantial timesaving when there are a number of device platforms to support. Organizations that have a large user base should consider adopting this technology for their future benefits.

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# Using Personal Digital Assistants (PDAs) with Internet Access to Support Initial Teacher Training in the UK

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## Abstract:

Fourteen initial teacher training students studying to become science teachers have been given internet enabled PDAs in a pilot study to assess whether PDAs have the potential to support them in their own teaching and learning, and in their role as trainee teachers.

Initial use of the devices was high, we recorded many positive impressions and the devices were well used. Several applications, in particular the use of the calendar, task list, email and internet search facilities were found to be supportive by the teacher trainees to both their teaching and learning. Other successes were bespoke software programs to record attendance, grades and behaviour, to perform scientific calculations and to provide information from the periodic table of elements. At this point in the course the trainees were moving regularly between school - for observation and teaching practice and university - for subject teaching and reflective discussion sessions.

However, for nearly all the teacher trainees, use of their PDAs dropped during the main 12 week block of teaching practice when they are placed in schools full-time. Some trainees reported that under pressure of time and workload they reverted to use of paper and pen to organise themselves and plan their teaching. Also some schools are unsupportive of the need to synchronize PDAs with a desktop PC to copy trainees' presentations and worksheets to the school network.

In this paper the authors will highlight sociocultural issues arising from the role of the initial teacher trainee and their school context and discuss how their situation impacts upon their freedom to explore how a PDA can support them as they develop as a teacher.

## Introduction:

The increasing use of PDAs by legal and medical students in the US (Manhattan Research, 2002) suggests that where professional training requires access to sizeable quantities of information, a PDA can deliver information directly to the individual as and when required.

The one year science teacher training course in the UK, the Postgraduate Certificate of Education (PGCE) is particularly information heavy. It also requires the students to spend 24 of the 36 weeks of the course in a partner school rather than in the University making access to conventional information sources for students such as the library difficult. In particular, initial teacher training (ITT) students need access to the documentation of the various UK statutory requirements for schools including the National Curriculum and Qualifications and Curriculum Authority (QCA) Schemes of Work and information to supplement their subject knowledge such as science data and teaching resources. Then there is the documentation associated with being on a PGCE course such as timetables, assessment guidance, pupil mark books, lesson observation and lesson plan proformas. Our students are currently supported via a virtual learning environment (VLE) with discussion groups, PGCE documents and links to teaching resources that can be accessed on any computer linked to the internet. However, finding a computer in the teaching practice school, getting logged on and finding media on which to store downloaded information makes regular use of this system very difficult.

Previous research such as the Becta Project, PDAs in schools, (Becta, 2003) reported a recognition of the real value of handheld computing devices for teachers in English schools. Their most positive indicator showed that PDAs offer considerable potential to make teachers' management and presentation of information more efficient. One Science teacher noted "I would never willingly go without one now; it is my instantly accessible

encyclopaedia, thesaurus, periodic table, diary, register/mark book, world map and even star chart!'. A US teacher is on record as noting that PDAs are particularly useful for managing grading (<http://teachers.net/mentors/software/topic989/1.21.04.13.35.50.html>) confirmed by a UK teacher at [http://www.handheldlearning.co.uk/index.php?option=com\\_content&task=view&id=12&Itemid=1](http://www.handheldlearning.co.uk/index.php?option=com_content&task=view&id=12&Itemid=1). Additionally, an evaluation study carried out with undergraduates at the University of Bristol (Ramsden, 2003) found that web content including course documentation, course announcements, email and discussion boards were all accessed successfully from the University's VLE, Blackboard, via an internet-capable PDA.

Thus it appears that there is likely to be considerable potential benefit to a PGCE Science student from having personal access to a PDA, allowing them to access information wherever and whenever they need it. Whilst technical issues such as battery life, reformatting documents for a small screen and synchronisation of the PDA with a base station can make life difficult for the PDA owner, their potential as an electronic book, as a source of dedicated science software, as an interface to the World Wide Web especially via a course linked VLE, as a store of previously recorded pupil data and as a communications device for emailing peers and tutors stands out. The communications capability of the PDA is the key feature in this context.

In order to identify where and to what extent these potential benefits can be realised with the current generation of PDAs and what factors have to be in place in order to realise that potential, fourteen PGCE science students on the teacher training course at the University of Bristol were given handheld computers with mobile phone connectivity and cameras to take with them on teaching practice. As one aspect of the study was to prepare for variety in individual ownership of PDAs amongst students arriving at the university a range of handheld computers was supplied. The project itself was funded jointly by the Teacher Training Agency (TTA) for England and the Graduate School of Education at the University of Bristol.

## Method

The 14 PGCE Science students were given either a Windows Pocket PC or a Palm OS based handheld and four hours of training in its use. During this training they were informed that the PDAs have the potential to support them in:

- accessing the VLE (Blackboard) discussion groups and email;
- accessing course documentation (on PDA or via Blackboard or via synching);
- just in time acquisition of knowledge from the web;
- acquisition of science information from e-books and encyclopaedias;
- delivering accurate figures for scientific constants and formulae;
- organising commitments, lesson plans and timetables;
- recording and analysing lab results;
- recording pupil attendance and grades;
- photographing experiments for display and reinforcing pupil knowledge;
- maintaining a reflective web log (blog) that will allow them to record lesson evaluations and other reflections on their teaching.

The students were chosen from volunteers from the PGCE cohort of 55, all of whom had a home PC, by selecting randomly from a stratified sample in order to create a mixed group: 4 biologists, 5 chemists and 5 physicists including 6 males and 8 females. Their teaching practice schools were sited over a wide area from South Wales to Somerset and included private as well as government maintained schools.

Students received PDAs chosen from the range then available in the UK that could deliver web browsing via the internet, email, SMS texting, word processing, spreadsheet management and picture messaging. The researchers wished to compare platforms so these comprised 4 Tungsten Ws running Palm OS 4 and 2 Treo 600s running Palm OS 5 and 5 Qtek 2020s and 3 i-mates (both the latter are SIM free XDA II clones running Pocket PC 2003). Mobile phone connectivity via GPRS was supplied by Vodafone as it had proved a reliable service provider in a pilot test. The PDAs were supplied with aluminium protective cases and screen protectors. Separate collapsible keyboards were also originally provided for all the Pocket PC PDAs as they have only the pop-up on screen keyboard and then later for the Treo 600s as the students found their keys too small to write with. Add on cameras were later obtained for the Tungsten Ws as they were the only PDAs without integral cameras.

The students were participant researchers in the project; they reported in via a weekly online survey and additionally were encouraged to reflect on their experiences via a diary of use in the form of a web log or 'blog'. There was also a dedicated discussion area on Blackboard, the VLE, for them to exchange information and ideas about the PDA project. Additionally a focus group of all PDA users was organised for the end of each of their two blocks of teaching practice in order to collect impressions and share potential uses face to face. Lastly there was an exit interview on finishing the project.

## Results

At the point that the students had just completed their first four week teaching practice, the results of the weekly online survey indicated that they recognised that there is great value in having the PDA for both their practical teaching in the field and in their learning about teaching and the underpinning pedagogy. 41 entries were made over the 4 week period giving a return rate of 73%. Later in the academic year, towards the end of the main 12 week teaching practice PDA use had tailed off with three students dropping out of the study, however, 26 entries were still made in the online survey making the return rate for this teaching practice 74%. Not all of these entries were complete though and 8 referred only to reasons for not using the PDA.

For the students using the PDAs the pattern of applications used remained similar throughout the academic year. Their most commonly used applications were the diary scheduler, the web browser and the email client whether Palm or Windows based. Table 1. shows the results when participants were asked at intervals throughout the year to name their three most frequently used software applications.

<b>Table 1. Most frequently used software</b>			
<b>First teaching practice</b>		<b>Main teaching practice</b>	
<b>Software application</b>	<b>Percentage of mentions (total=118)</b>		<b>Percentage of mentions (total=46)</b>
Calendar/Diary	19.5	Calendar/Diary	17.4
Email	19.5	Web Browser	15.2
Web Browser	14.4	Email	13.0
Word	12.7	Word	13.0
Tasks/To Do list	8.5	Spreadsheet	8.7
Spreadsheet	6.8	SMS	6.5
Memo/Notes	5.9	Games	4.3
Games	3.4	Memo/Notes	4.3
SMS	2.5	Periodic Table	4.3
Tiny Red Book (mark book)	1.7	Camera	4.3

Spreadsheets for recording attendance and grades and SMS texting gained slightly in popularity during the study as participating students shared their ideas and templates and the To Do or Task list lost popularity – the students largely swapped to using the calendar to record tasks as they could set reminders for deadlines.

When considering what software was most supportive for actual teaching of lessons the PDA's own calendar or diary software and task lists were mentioned often. One student explains why, "The calendar and task functionality has been extremely useful. My timetable is surprisingly fluid, with various planning and review meetings being scheduled and re-scheduled - any paper diary would be unreadable and unusable. The task list helps me effectively track and manage the many different tasks that need to be done to survive as a student teacher." Interesting discoveries amongst downloadable software were Tiny Red Book (at <http://www.tiny-red-book.com>) and a variety of periodic tables including one associated with Calc98 (at <http://www.flosim.com/fsi/download.htm>). Tiny Red Book (for Palm OS) incorporates a customisable mark book, attendance tracking and a place to record student behaviour. One student particularly benefited from using the attendance tracking to prove a child was absent from their lesson. Other students used Excel for this purpose.



Another success story was the use of the internet, especially the search engine Google, to look up answers to students' (and staff's) questions and get an almost immediate response. Examples cited include "Where do red robins go in summer?", "How do starfish reproduce?", searching for up to date information on cloning and finding the telephone number for the local hands-on science centre. One of the students reported that "Instant access to the internet has been particularly useful. For example, during one lesson I was able to quickly look up the answer to a pupil's question - this really helped to keep them engaged and interested in the subject matter (in addition to promoting ICT to them)". Table 2 shows the results when PGCE students were asked at intervals in the teaching practices to identify the software that was most helpful to their teaching. Applications in bold were mentioned throughout the year as being helpful to teaching.

<b>Table 2. Software that was most helpful to actual teaching.</b>	<b>First Teaching Practice</b>	<b>Main Teaching Practice</b>
<b>Application</b>	<b>Frequency (n=41)</b>	<b>Frequency (n=13)</b>
<b>Using the Internet as a resource (Google)</b>	8	2
<b>Calendar/date book/diary for schedule/timetable</b>	7	3
To do / Task list	6	
<b>Attendance Register/mark book/test scorer</b>	5	2
<b>Recording/writing up lesson evaluations</b>	4	1
Writing/noting ideas for lesson plans	3	
Note-taking	2	
<b>Calculator</b>	2	1
MSN chat with an expert	1	
Reviewing a powerpoint presentation	1	
Physical constant look up program	1	
<b>Periodic table program</b>	1	1
Email		2
Showing presentations		1

Showing presentations was only mentioned by one student as the hardware (Margi Presenter to Go) only arrived very late on in the study but the concept of being able to plug the PDA directly into the data projector was very popular amongst all the students.

The use of the internet was also the most popular when, as shown in Table 3, the students were asked to identify the software that was most helpful to their learning on the course. Also popular though was the use of a word-processor or note-recorder either of which were used to jot down or tape information at the point of reception for later processing into assignments or lesson plans. The effectiveness of this activity 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 (i.e. file) in a way that allows me to access it easily."

<b>Table 3. Software that was most helpful to your learning.</b>	<b>First Teaching Practice</b>	<b>Main Teaching Practice</b>
<b>Application</b>	<b>Frequency (n=41)</b>	<b>Frequency (n=14)</b>
<b>Using the Internet as a resource (Google)</b>	10	4
To do / Task list	7	
Notes for note-taking in meetings and lesson observations	7	
<b>Notes or Word for lesson evaluations and essays</b>	6	2
Calculator	3	1
<b>Calendar/ Diary scheduler</b>	2	2
Spreadsheet of audit for QTS standards	2	
Reading electronic journals	1	
Periodic table	1	
<b>Email</b>	1	2
Physical constant look up	1	
Recorder for lesson evaluations		1
Showing presentations		1
Taking pictures		1

However, when asked what software was the most use to them, as an individual, the students, as shown in Table 4 reverted to citing the information management functions of the PDA such as the Task or To Do list, the diary scheduler and the use of email. Another student puts in plain words “I formed a comprehensive To Do list and prioritised well - really useful with everything mounting up.”.

<b>Table 4. Software that was most helpful to you as an individual.</b>	<b>First Teaching Practice</b>	<b>Main Teaching Practice</b>
<b>Application</b>	<b>Frequency (n=41)</b>	<b>Frequency (n=17)</b>
To do / Task list	10	
<b>Email</b>	8	4
<b>SMS/Texting</b>	6	2
<b>Calendar/date book/diary for schedule/timetable</b>	5	2
<b>Taking photos</b>	2	1
Contact info/Address book	2	
<b>Word for recording lesson evaluations/making notes</b>	2	1
Spreadsheet audit of QTS standards	2	
Syncing via Bluetooth	1	
MSN chat with expert	1	
Spreadsheet for registers		1
<b>Internet for personal use – recipes, maps, shopping</b>	2	4
Recorder for lesson evaluations		1
Games		1

As well as Tiny Red Book, three downloadable software applications were recommended by the students: OmniRemote which allows the PDA to remote control the television and other devices in the home, PhysConst and an interactive periodic table containing physical constants and element data respectively. Two students in the first week of teaching practice reported using the periodic table software successfully to give pupils accurate data almost instantly. Another student downloads e-books. “Using the e-book meant that I could catch a few pages at convenient times, I don't think it can ever take the place of reading books, but it certainly cuts down carrying (my bag is so full of school things that I just couldn't carry around any more books)”.

One of the most useful aspects of the PDA is the ability to use it wherever you happen to be, and the carry over into elements of student life beyond the course underlines this. Whilst most use, as shown in Table 5, takes place at home or in the school staff areas, activities such as keeping up to date or even ahead of others in school

by accessing the latest educational news on the way in to school and taking photos of local events were reported extremely positively by the students.

<b>Table 5. Places where you have used your PDA in the past week.</b>	<b>First Teaching Practice</b>	<b>Main Teaching Practice</b>
<b>Place</b>	<b>Percentage of respondents (n=41)</b>	<b>Percentage of respondents (n=18)</b>
Home	95.1	83.3
School staffroom	85.4	55.6
School classroom/lab	58.5	27.8
Public Transport	29.3	11.1
Café/Restaurant/Bar	24.4	5.6
University teaching room	17.1	5.6
Elsewhere on campus	12.2	16.7
Car	7.3	27.8
During shopping	2.4	0.0
Carnival	2.4	0.0
Other people's homes	0.0	5.6

Table 5 also shows the decline in student' use of the PDAs which is most marked in public areas including the classroom. Students reported feeling uncomfortable about being the only one in the school with a PDA, that it was a distraction in the classroom and, in one case, fear of damage or loss.

The PDAs were used immediately by half the students for keeping in touch with the University tutor whilst they were away from campus on teaching practice in school. Table 6 shows how many times the students used the PDA to communicate with their tutors and peers during the first teaching practice.

<b>Table 6. Who have you communicated with via the PDA this week and how.</b>			
	email on PDA	SMS* on PDA	VLE discussion group (via PDA)
University tutor	15	0	5
School based mentor	2	0	0
Other PGCE students	18	8	5

\*Short Messaging Service (texting).

The pattern of using email to contact the university tutor and SMS and occasional email to contact other students continued into the main teaching practice but more sporadically. The VLE discussion group was also less well used despite the students spending a longer period separate from each other in partner schools. One student used MSN on a regular basis and even 'chatted' with medical student colleagues during a biology class to gain answers to pupils' questions.

Documents on the VLE were used via PDA but only eight students downloaded from the choice of background reading, presenter's slides or course documentation from Blackboard during the first teaching practice and six of these also downloaded materials during the second, main teaching practice. These students appear to be fairly well aware of the different ways they could transfer documents from the VLE to their PDA and made sensible choices linked to file sizes about whether to download directly to the PDA or whether to download to their desktop PC and transfer the new files across to the PDA via its USB connection 'cradle'.

Web based logs, known as blogs, for recording teaching reflections were even less popular with only one student contributing to one regularly though a second kept a blog of PDA use for a short while. However, the students reported that having the word-processor or note recorder on their handheld was actually serving the purpose of recording reflections on teaching and storing them for later use in written assignments or in tutorials with their school based mentor or university tutor. There appeared to be little desire to put up a blog publicly online for tutors to read and add to.

For the students that gave up on using the PDA the following reasons were identified during exit interviews.

- Loss of data when not recharged for a lengthy period – this happened to at least 3 individuals during vacations and was very disheartening.
- Lack of time to continue to explore the use of the PDA under the pressure of teaching, planning for teaching and researching for and writing up university assignments. One student reports “I just don't have the time to be playing with it - I am simply trying to get to grips with teaching!!” and another says “with all the planning, essays etc. I haven't had the time to set up other uses for it.” This was the most commonly cited reason.
- Lack of available hardware or access to suitable computers within school to synchronise the PDA so that students' files could be made available on the school network or for data projection. One student describes his situation “I like the idea but as no computers at school are available to synchronise it with then it's easier to just use a memory stick.”
- Embarrassment at the attention the PDA caused – difficult to handle when still learning how to handle a class.
- Worry about taking the PDA into school where mobile phones are regularly stolen.
- Having purchased a laptop and preferring to use that.

## Discussion

It is clear that the PDA and its information management and communications functions have great potential to support students in initial teacher training. The most popular applications throughout the year were the calendar or diary used mainly for appointments but occasionally for timetabling, email to maintain contact with other students and the university tutor, the web browser to access information both in class and for personal reasons, the word processor to make notes from meetings, on lesson observations for essays and to record lesson evaluations and the spreadsheet management system to record pupils' attendance and grades. However, only three of the 14 students used the PDAs on a regular basis throughout the year, most used theirs intermittently and another three gave theirs up.

The level of use appeared to be governed by four main factors:

- the socio-cultural context of the school environment;
- the pressure of work on a PGCE course;
- other hardware availability and
- certain 'killer applications'.

A central aspect of socio-cultural theory (Vygotsky, 1978, Wertsch, 1998) is the claim that all human action is mediated by tools which may be technologies and artefacts such as the PDA or desktop computer, semiotic systems such as language including diagrams, social interactions such as those between student and class or student and class teacher and institutional structures such as school ICT policy. Within this context the idea of 'person-acting-with-mediational-means' (Wertsch, 1991) both implies expanded capability for the student teacher through having the PDA and also suggests that their situated and mediated actions will be constrained by the social and cultural context.

For instance, 8 of the students, who used the PDAs intermittently throughout the year were most affected by the sociocultural context of being a student in a school. Whilst recognising that having Internet access on the PDA extended their capability to answer questions and plan lessons and having Word enhanced their recording of their observations for later assignments, they tended to feel uncomfortable about using the PDA in class or about asking the school to resolve hardware issues. For these students personal use of the PDA appeared to support their intermittent use of it for the PGCE, where students could see that the PDA applications were personally relevant they continued to use the Internet and Word in particular to support their teaching and learning. They were also more likely to view the PDA as creating work rather than saving it. Killer personal applications included using the PDA as an alarm clock, as a remote control, for SMS (text) messaging and MSN, taking pictures of significant events, online shopping, checking bank balances and having information such as recipes and maps on hand when needed.

The three students that maintained regular use of the PDAs were all men who used Excel or Spreadsheet to Go everyday to keep tabs on their classes. One of these students also regularly used the voice recorder to record lesson evaluations for later transcription. They acknowledged the distraction factor of the PDA cited by other students but pointed out that as they used it everyday the novelty had worn off for their classes. Also these students were at schools where staff were less concerned about viruses and malicious software and allowed the PGCE students to link to school computers. They also made a variety of personal uses of the PDA including, for two of the three, games.

Of the three students who withdrew from the study and handed back their PDA, two gave frustration at the PDA's apparent inability to operate in the way they wished it to as their main reason, in particular a Treo incited one student to uncharacteristic hatred, and the third cited a preference under the pressure of increased teaching in the main teaching practice to work with pen and paper rather than to use the PDA which she viewed as more time consuming.

## Conclusions

There appear to be three applications on the PDAs that are proving key to managing students' learning of how to teach in the field. These are the calendar or diary scheduler for organising yourself, the spreadsheet of attendance or mark book for organising your pupils and the use of a word processor to make notes on information and events immediately they are encountered. This information which often contained reflections on the teaching process can then be incorporated quickly and easily into the assessed components of the PGCE course.

However, the communications capability of the PDA was also essential to its success. Having the internet available as a portable resource was very welcome, it was the software application that the PGCE students considered to be most helpful to both teaching and learning. It is our conclusion that, having the Internet literally 'in your hand' enables the PDA to act as a distributed memory system. The wealth of information on the internet means you can use it to answer virtually any question and whilst the GPRS signal was not as fast as a broadband connection the delay was acceptable both to the PGCE students and their pupils. It was discovered that you can even use a PDA surreptitiously in a lesson or meeting to look up the topic under discussion or to 'chat' with experts without overtly appearing absent minded or particularly unintelligent. Pea (1993) described these activities well in his concept of 'Person Plus', which is the concept of cognition being distributed between the person and their environment, and associated artefacts. Finally, email for keeping in touch with the university tutor, other students, family and friends is well used and provides a valued support for students who are working in school away from the rest of their peers.

Whilst all the PDAs have similar functionality it was clear that the students with the Pocket PC based systems got further more quickly in the training sessions and have reported fewer difficulties to the project team. Though student familiarity with Windows based products is obviously a factor, web pages and documents did not initially appear as readable on the Palm based systems as they did on the Pocket PC based ones. Nor is the internet connection 100% reliable for either system with 6 of the students reporting occasional difficulties getting online. Two of the three students who gave up on their PDAs cited the difficulty they had in using a Palm based device.

Other factors to be considered include the socio-cultural context of PDA use, currently PDAs are rare in schools. One student found the interest it generated amongst the pupils detracted from her teaching and a number of them have reported a feeling of no-one to share their mlearning practice with in the classroom. Also an ITT course is an extremely busy time – the students that gave up on the PDAs described the course demands as preventing them from devoting time to necessary exploration of the PDA functionality. One issue that prevented more students taking pictures to use in their teaching was concern about the number and level of permissions required to photograph children.

However, looking to the future, as PDA prices are already coming down it is clear that personal ownership of internet enabled PDAs whether wireless or mobile phone is on the increase. The personal computer and mobile phone are merging with the PDA on one side and the Smartphone on the other. Where universities are aiming to deliver course based content to students such as teacher, nurse, veterinary and medical trainees in the field or supporting students on sandwich courses during their industrial placement this small scale study shows there is great potential for enhancing student learning by making the course content accessible via any or all of these

handheld devices. It is anticipated that many students coming on such courses within the next 5 years will already have PDAs or equivalent devices so that many of the teething and resourcing problems encountered in this study will be alleviated.

In particular, recommendations for future development of PDA use by teachers and trainee teachers include:

- ensuring 'always on' internet access;
- investing in a larger community of practice;
- enabling connection with the classroom data projectors;
- designing bespoke software that allows both timetabling and personal appointments;
- allowing synchronisation with the school network computers;
- more use of images;
- encouraging personal use and
- focussing on making students comfortable with 'killer applications' such as attendance registers, markbooks and maintaining an online audit of Qualified Teacher Status standards.

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Field Code Changed

# Content Exposure of Slide Show Presentations for Selective Download and Annotation via Mobile Devices

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## ABSTRACT

Presentation software, such as Microsoft PowerPoint, has gained popularity as a method of lecture delivery, and the built-in web publishing features make it easy to convert such slide shows to HTML format. The increase in the availability and functionality of handheld devices has provided new opportunities for using mobile technology in education. We propose the novel integration of these technologies for use in a teaching environment that allows users to selectively download and annotate parts of the slide show using mobile devices. A web application has been developed for use in a lecture theatre or classroom environment that allows students to access content from a slide show during a presentation. An HTML version of a PowerPoint slide show is made available via a wireless access point. A server-side application parses the slides contents to create an image representation of the various content groups. A mobile web application displays these content groups as different coloured blocks which correspond to the content on the main lecture display screen. Each coloured block provides a link to selectively download the desired content group, which the server application then extracts from the slide's contents. In addition, the mobile application allows for the annotation (lecture notes) and storage of the downloaded data. Students can then view the downloaded data and annotations at a later stage for study purposes.

*Keywords: Digital Slide Show, Content Exposure Annotated Content, Spatial Representation.*

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## 1. INTRODUCTION

Rapid advances in mobile device technology have resulted in an increased adoption of these devices in the corporate sector and, more recently, in the educational sector (Finn and Vandenharm, 2004). In addition, mobile technology has opened up new opportunities to create novel learning experiences (Rogers *et al.*, 2004). While traditional computer laboratories offer occasional exposure to learning technology, mobile devices now provide the opportunity for frequent exposure making them an integral part of the learning process (Roschelle, 2003). Mobile devices have also been shown to significantly increase students' ability to manage their learning environment and to collect information (Zurita and Nussbaum, 2004).

Formal lecture sessions continue to be a popular method of presenting information to university students, and, over the last ten years, digital slide show presentations have become the standard medium of delivery (Bartsch and Cobern, 2003). Students are often encouraged to make study notes during lectures. They then may or may not have access to the original presentation slides after the lecture. Common presentation software packages, such as Microsoft PowerPoint, have built-in web publishing features which make it easy to convert slide shows to HTML format. This, together with numerous content extraction approaches for web content (Alam and Rahman, 2003; Buyukkokten *et al.*, 2001; Chen *et al.*, 2003; Han *et al.*, 2000; Kunze and Rosner, 2001; Gupta *et al.*, 2003; Gupta *et al.*, 2004), and ubiquitous mobile computing has provided an opportunity for the novel integration of these technologies for use in the teaching environment.

We present a system that applies content extraction techniques to digital slide show presentations, and provides a mechanism for annotating selected content and for storing these notes. This system illustrates the use of mobile devices as a support tool in traditional learning environments. The main role of the system is therefore to augment learning, and not to deliver instructional content.

## 2. SLIDE SHOW CONTENT EXPOSURE

The standard architecture for delivering lecture presentations incorporates a large display screen, whereby the displayed content is controlled by a desktop or laptop computer (Figure 1a). Our content exposure system extends this approach by introducing a server coupled with a wireless access point (AP) (Figure 1b). The server hosts the content exposure system, implemented as a mobile web application, and the actual presentation content in HTML format. Mobile device users connect to the server through the wireless AP and are provided access to the lecture content through the exposure system (Figure 1b).

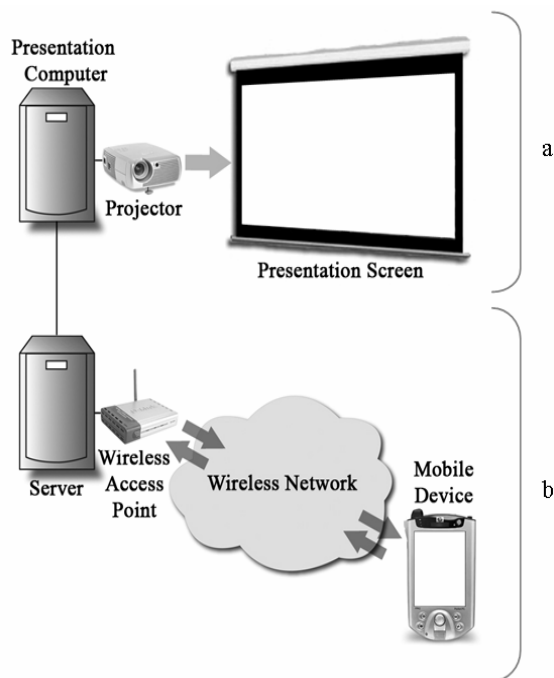


Figure 1. High-level architectural view of the slideshow content exposure system. (a) The standard lecture presentation architecture. (b) An extension to the standard architecture providing the content extraction system and wireless mobile device access.

In order to apply standard content extraction techniques it is necessary to convert slide show files into a markup language. Slide show presentation software, such as Open Office, converts each slide into a single image which is then displayed in an HTML document. This makes identifying content within a slide complex since it would be necessary to analyze the image. However, other presentation software, such as Microsoft PowerPoint, maintains the content from the original slide during the conversion process and represents each content object separately, thus making content extraction a simpler process. In addition, PowerPoint is supplied with an abstract programming interface (API) for use with the .NET framework, which exposes certain functionality and allows certain processes to be automated. PowerPoint was therefore the presentation software selected as a base format for creating and storing digital slide show presentations for use with the content exposure system.

### 2.1. PowerPoint Conversion

Conversion from PowerPoint file format to HTML is automated by utilizing the PowerPoint API in a C# windows application. Conversion is carried out in code by loading the desired PowerPoint file, then executing the "Save As" command and specifying HTML version 3 as the output type. The C# application will search a specified directory for previously unconverted PowerPoint files at a set time interval, and automatically convert any appropriate files discovered. After conversion the necessary content extraction techniques are applied to the generated HTML file.

### 2.2. Content Extraction

Content extraction comprises a collection of techniques that have previously been used in an attempt to display normal web content on small screen devices such as PDAs. Documents are therefore manipulated to be more suited for display on handheld devices.

One of the techniques, referred to as text summarization, improves the network access times of handheld device users and reduces the number of required pen actions while browsing the internet (Buyukkokten *et al.*, 2001). This approach displays web pages in text, and allows sections of the pages to be hidden, partially displayed, summarised or displayed in full.

Text summarization has been extended to include a solution for handling graphics by Chen *et al.* (2003). A web page is arranged into a two-tier hierarchy. The first tier provides an overview of the web page in the form of a graphical table of contents, which is displayed as a thumbnail image (Figure 2a). Content is grouped according to semantic relation, and these groupings are then displayed on the thumbnail in different colours. In order to view content the user selects a colour block, which has been formatted for display on a small screen (Figure 2b). There are two main processes used to identify content blocks: page analysis and page splitting or auto positioning. The web page is first parsed into a Document Object Model (DOM) tree to allow for manipulation. Page analysis attempts to extract the semantic structure of the web page, grouping content by inferring the content layout. This is derived from high-level content blocks, such as headers, footers and sidebars, and visual separators such as white space.



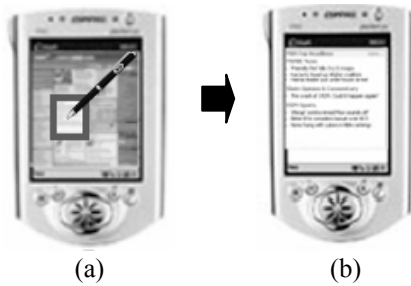


Figure 2. Text summarization extended to include graphics (Buyukkokten *et al.*, 2001). (a) A web page represented as a thumbnail image. (b) The content corresponding to the block selected.

Single-subject splitting divides the page into several smaller pages which are connected by hyperlinks. This technique is used for pages with a particular topic. Multi-subject splitting divides the page into smaller pages, and generates an index page which is used for navigation. This approach has been used to split an entire web site. Auto-positioning is suggested as an alternative to page splitting. The process is similar in that a thumbnail view of the page is generated, displaying the content blocks in different colours. However, when a particular block is selected, instead of splitting the page it is automatically positioned correctly to display the selected content. Certain implementations of this technique have extended this approach to split pages and deliver the sections to different devices (Han *et al.*, 2000).

We have developed a spatial representation algorithm, based on the work of Chen *et al.* (2003), which converts digital slides into a graphical representation. The process creates an image representation of each slide, where each content group is displayed as a differently coloured block. In order to achieve this, the HTML is converted into a document object model (DOM) tree. This tree is then rendered using the ICEBrowser SDK, which is a Java web browser library (ICESoft, 2005). Once rendered, bound box coordinates for each content block can then be extracted. A spatial representation image is then generated (Figure 3b), representing each content block from the original slide (Figure 3a), by using the bound box coordinates previously obtained.

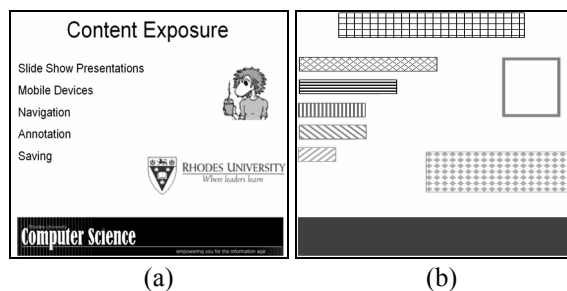


Figure 3. Results of the spatial representation process. Coloured blocks have been represented here as various hatch fills for clarity. (a) The original slide. (b) The resulting spatial representation image.

### 2.3. Text Summarization of Slides

An XML file is also created during the spatial representation process, and this is used to store a detailed description of each slide in the presentation, including: bound box coordinates for each content block, the names and locations of all images and the actual HTML content for each block. The bound box coordinates are necessary to create the image map using the image generated during the spatial representation process. When a user clicks on an area of the image the screen coordinates are captured and are matched against the bound box coordinates stored in the XML file, locating the corresponding content block.

### 2.4. Front-end Application – ASP.NET Mobile Web Application

The client-side interface was implemented as a Microsoft ASP.NET mobile web application, which has the benefit of requiring no smart client application, only a web browser. A further advantage is that the majority of the application processing is carried out on the server-side, reducing the load for the limited processing power of the mobile device (Hadjisotiriou *et al.*, 2004).

The initial application screen provides the user with mechanisms to navigate through the slideshow or to navigate within a single slide (Figure 4). The “Next” and “Previous” buttons allow for navigation to the desired slide. A label indicates the index of the current slide, and corresponds to the actual slide being shown on the large display screen (which also bears an index number). This assists users to follow the slide show presentation and to navigate to the currently displayed slide. Information that is desired can be selected, and the content is displayed in the annotation screen (Figure 5). Annotations can be added using the textbox. The “Add” button temporarily stores annotations and the corresponding content on the server before returning the user to the previous screen. The “Cancel” button will return the user to the active slide without storing annotations or content. Generally, selecting a content block from the spatial representation image map of the slide will navigate the user to the annotation screen (Figure 6a). However, it is also possible to view and annotate multiple content blocks by checking the “Multiple” checkbox. This prevents navigation to the annotation screen until the user selects the “Annotate Selected” button (Figure 6b). The “Save” button (Figure 4) prompts the user to save all annotations and selected content. Notes are saved as a Rich Text Format (RTF) file. RTF was developed as a format that would be readable by all common word processing applications, and can be viewed on most operating

systems. RTF is capable of storing images and basic formatting information. Macros can not be inserted into RTF files, and the format is thus not susceptible to macro viruses. RTF files require less memory than other word processing formats, making the format useful for web downloads and desirable for mobile devices owing to their relatively small memory capacity (Senior Corps Tech Centre, 2005).

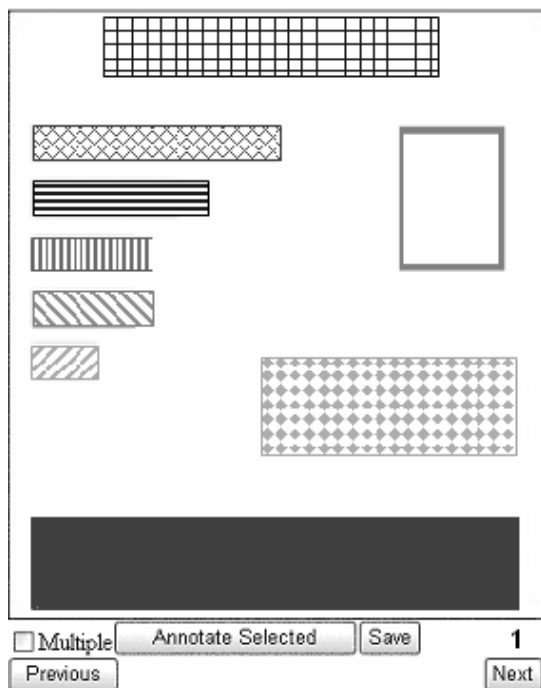


Figure 4. The web application user interface.

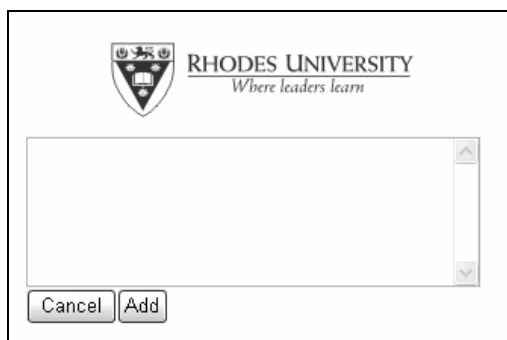


Figure 5. The annotation screen of the web application, showing an image to be annotated.



Figure 6. Using the image map to display selected content. The representation corresponds to the slide shown in Figure 3a. (a) The results of selecting a single content block. (b) The results of using multiple select to select numerous content blocks.

### 3. IMPLEMENTATION TESTING

#### 3.1. Complexity

PowerPoint slideshows, and indeed individual slides, can vary greatly in their levels of complexity. In order to determine the robustness of our system and to observe how the system would handle slide presentations of varying complexity, we categorized slides into two groups: simple and complex. Simple slides contain only static objects, and are limited to certain types of objects such as text boxes, images and tables. Alternatively, complex slides contain animated objects and can consist of an unlimited variety of objects. A complex slide was tested using the spatial representation system. On conversion from PowerPoint format to HTML, it was discovered that PowerPoint automatically removes any imbedded custom animations thus removing the possibility of creating any artifacts. Figure 7 (a - d) illustrates example custom animations, where an image is added after each mouse click. Converting this slide to HTML will produce only the view shown in Figure 7d. Thus conversion removes underlying slide complexities, eliminating the need for modifications to the spatial representation algorithm. The resulting representation is shown in

Figure 7e. Hence, the system is capable of handling complex slide shows without reducing the accuracy of the representations.

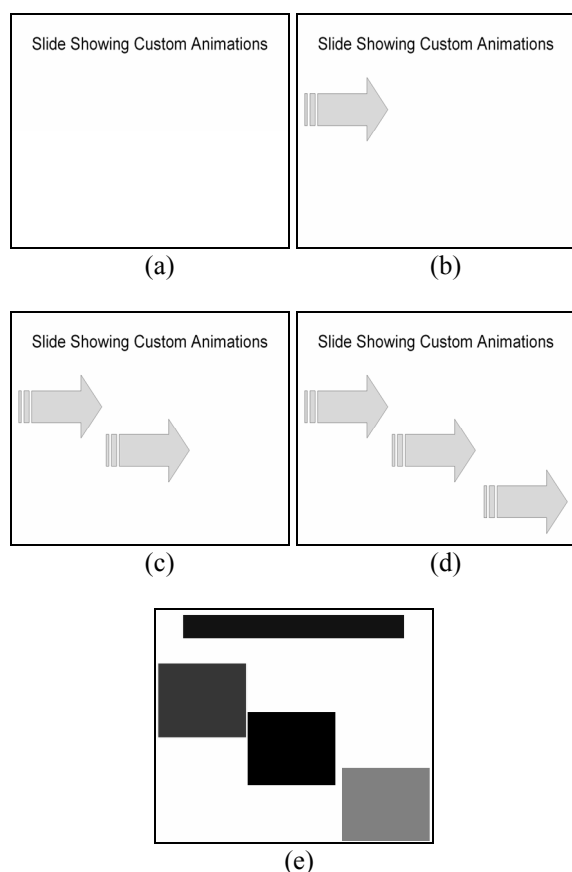


Figure 7. Slide with complex features. In this case custom animations. (a) Initial view. (b) First animation, an image is added. (c) Second animation, another image is added. (d) Third animation, the final image is added. This view is also the result of converting this slide to HTML format. (e) The resulting spatial representation image.

### 3.2. Adaptation to Screen Size

Mobile devices have varying screen dimensions. The front end system provides the ability to adapt to this difference in device specification by using the device filtering approach implemented in ASP.NET (Homer *et al.*, 2005). Device filtering allows criteria to be set depending on the requesting device. We implement a filter which delivers the appropriately sized spatial representation image depending on the device screen size, allowing the system to remove the need for users to scroll on the navigation page.

### 3.3. Load Testing

Since the system is designed for use in classroom and lecture situations, it was imperative to evaluate the maximum number of possible users that the system can accommodate. Testing was carried out in a controlled environment using the testing facilities provided by Microsoft Visual Studio. The server used was a Pentium 4, 2.80GHz CPU with 1.00GB of RAM, running Microsoft Windows Server 2003

Standard Edition. A web test was created that simulated a web session where a user accessed a presentation using the mobile web application. Actions included navigation, annotation of content, and saving the selected content. A load test was then created to evaluate the load handling capabilities of the web application. The load test began with 1 user, and increased the number of users by 10 every 10 seconds until server errors were encountered. Each simulated user carried out the web test created previously. The amount of available bandwidth was limited to an even distribution between 1.5 Megabits per second (Mbps) and 6Mbps in order to simulate an environment similar to that of a wireless network with minimal bandwidth (Varshney, 2003). The test browser was Pocket Internet Explorer 3.02. User “think times” were centered on a normal distribution using the user think time from the web test. Results from the load test indicate that the web application is capable of handling approximately 118 simultaneous connections transmitting about 35 requests per second. As user load (---, Figure 8) increases, the number of requests per second increases until the maximum is reached and test cases begin to fail (---, Figure 8). The average time to last byte (TTLB) (Figure 9) gives an indication of user wait time. After the first few connections have been processed, the TTLB stabilizes at approximately 0.025 seconds. This illustrates how ASP.NET caches data, benefiting users by reducing the response time of the system. The number of requests per second from the test case (35) is much higher than would be expected in a lecture environment where requests per second for each student would be significantly lower. Thus we predict that the system would be capable of handling a large student class size.

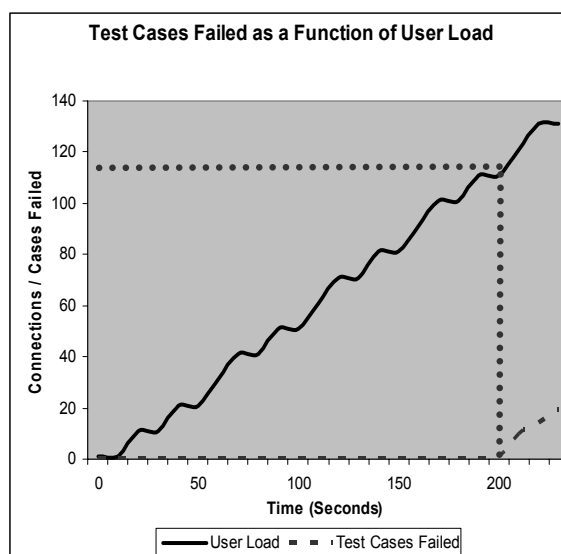


Figure 8. Results of a load test carried out on the mobile web application showing the user load and the number of failed test cases.

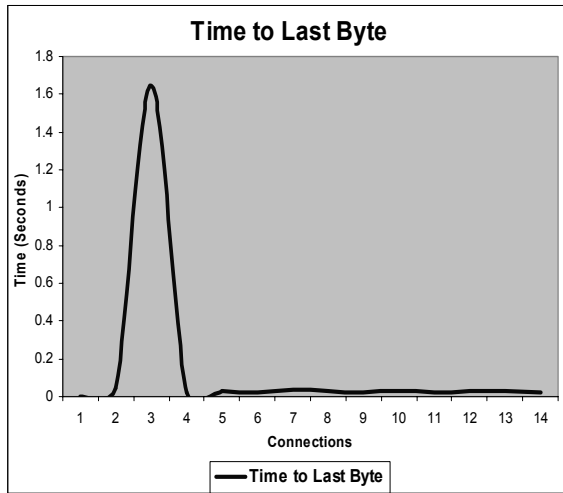


Figure 9. Results of a load test carried out on the mobile web application showing the average Time to Last Byte.

### 3.4. Field Trials

A trial presentation was conducted in order to test the system in a real-world environment. Seven users, who had not previously used the system, were equipped with a variety of mobile device (2 laptops and 5 PDA's) and utilized the system during a simulated lecture session lasting approximately 20 minutes. All aspects of the system were tested including navigation, annotation and saving. It is important to note that the system functionality was evaluated, and not the influence of the system on the learning process. Each user was required to complete a questionnaire at the end of the session. Results from this preliminary investigation into user acceptance of the system were favorable (Table 1). The mobile web application functioned correctly on both laptops and PDAs. The system is simple, allowing users to quickly learn how to use it. Users were able to use the system effectively during a presentation. Users found the spatial representation intuitive, and it allowed them to effectively select the correct content. Overall, users were positive about the system and considered it to be a productive tool.

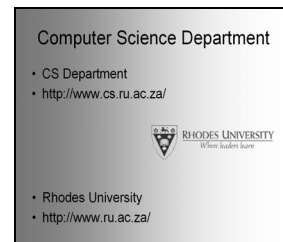
Questions	
1. Overall, I am satisfied with how easy it is to use this system	1 2 3 4 5 6 7
2. I can effectively complete my work using this system	1 2 3 4 5 6 7
3. It was easy to learn how to use the system	1 2 3 4 5 6 7
4. I believe I became productive quickly using this system	1 2 3 4 5 6 7
5. This system has all the functions and capabilities I expect it to have	1 2 3 4 5 6 7
6. I found the spatial representation of the slides	1 2 3 4 5 6 7

to be intuitive	7. I could easily keep up with the presenter	1 2 3 4 5 6 7
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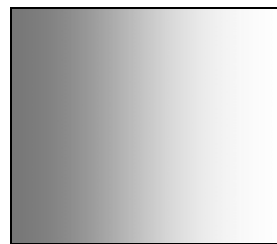
Table 1. Average results of a field trial evaluation of the content extraction system (1 corresponds to a strong disagreement, while 7 corresponds to a strong agreement).

## 4. LIMITATIONS

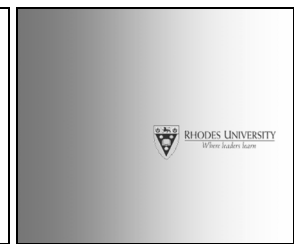
Although the spatial representation algorithm accurately analyses slides, the conversion process from PowerPoint files to HTML may produce some inaccuracies. For instance, the slide shown in Figure 10a consists of various content objects and a background image (Figure 10b). Converting the slide in Figure 10a to HTML resulted in one of the image objects being incorporated into the background image (Figure 10c). This new background image is potentially misleading as one would expect the representation shown in Figure 10d, where the users should be capable of selecting the image object. However, the user is presented with a misleading spatial representation (Figure 10e) as a result of this artifact. In the same way, the slide author's choice of layout could influence the effectiveness of the representation.



(a)



(b)



(c)



(d)



(e)

Figure 10. Limitations introduced by Microsoft PowerPoint. (a) The original slide. (b) The original background image. (c) The resulting background image after the conversion from PowerPoint to HTML where one image has been merged with the background image. (d) The expected spatial representation of the slide. (e) The actual, misleading representation.

## 5. CONCLUSIONS AND FUTURE RESEARCH

A proof-of-concept, content exposure and extraction system has been implemented for use with Microsoft PowerPoint slides shows that allows mobile device users to selectively annotate and download desired content. PowerPoint slideshows are automatically converted to HTML. The system then implements a spatial representation algorithm that has been shown to accurately represent individual slides irrespective of slide complexity. However, the algorithm is reliant on the author's chosen slide layout in order to produce an intuitive representation. A mobile web application allows users to navigate, annotate and save slideshow content. This application adapts to mobile device screen size, reducing the size of the spatial representation image in order to fit the application page into a single screen thus removing the need for scrolling. Testing has shown that the system can accommodate a maximum of approximately 118 simultaneous users transmitting approximately 35 requests per second. However, since the number of requests per second is expected to be much lower in a typical lecture environment, it is likely that the system can accommodate a larger number of users. Results from a user study indicated that users are able to learn how to use the system quickly, and consider the application to be a productive tool.

Future investigation will employ a more comprehensive user study in order to determine possible positive influences of the system on student learning. Third-party PowerPoint to HTML conversion tools exist and utilizing these tools may produce more accurate spatial representations. .NET Remoting provides the opportunity to further integrate the presentation system with the mobile web application by providing functionality for the applications to communicate. New releases of the Microsoft Office package, or other presentation software packages, may introduce further opportunities such as direct XML representation of slide shows.

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# MOBILE LEARNING IN THE NETHERLANDS: POSSIBILITIES OF USE OF REAL-TIME DATABASE ACCESS IN AN EDUCATIONAL FIELDWORK SETTING

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## Abstract

Mobile technology offers new possibilities to support students during fieldwork. With handheld devices or Pocket PC's students can take their learning materials everywhere they go. When a Pocket PC Phone edition or a bluetooth connection is used, connectivity to networks is added. Browsing the web, sending and retrieving information and various modes of communication become possible.

In our project we search for ways to use two new tools to support mobile learning:

- ❑ Blackboard<sup>unplugged</sup> is a very recently delivered 'building block' extension of Blackboard to support the use of learning materials on small mobile devices. This extension allows Blackboard users to download subsets of Blackboard webcontent on their pocket PC or to access content entirely through a wireless connection. Attention is paid to the readability of the materials when displayed on the small Pocket PC screens. Our experiences with the use of Blackboard<sup>unplugged</sup> in a fieldwork situation will be addressed in the presentation.
- ❑ ArcPad and CropViewer, resp. GIS software and a crop registration tool used by professional fieldworkers offers the possibility of storing location based fieldwork data . In our project, we look for ways to send these data to a remote server using GPRS-technology. When a functionality is added that gives the opportunity to view previously recorded data, in our view a rich fieldwork learning environment is available that will give fieldworkers the same information and instant feedback that office workers have while using a LAN.

In this presentation, mainly the educational implications and some technical implications of the use of CropViewer in combination with GPS, GIS and GPRS in fieldwork will be addressed.

This work is part of the Manolo project, a two-year collaborative project between the Vrije Universiteit Amsterdam and Wageningen Universiteit.

## Keywords:

*Mobile learning, fieldwork, handheld devices, Blackboard<sup>unplugged</sup>*

## Introduction

In our previous project (GIPSY) it was suggested that the use of Pocket PC's might be of most educational value during fieldwork. Various experiments showed that fieldwork students value the small size of a Pocket PC in combination with its broad functionality. With a connected GPS and the GIS-software ArcPad, students are able to locate their position and insert field measurements of that position. These measurements can then be synchronized with a desktop computer for further analysis.

In this situation, incorrect measurements as a result of a wrong execution of a measurement procedure, are not identified until the student returns to the campus. In this case, just as in classroom education, it is preferable to give immediate feedback to the student.

### **The software**

CropViewer is a GIS application thus far mainly used for agricultural applications, that allows fieldworkers to visualize a high-resolution satellite map of the fieldwork area on a handheld device. The area displayed on the device is centred on the position of the user, determined by GPS. The user can insert a point on the map and associate animal or plant species information to it, such as type, family etc. The information collected on the PDA are transferred to a permanent station at the university campus by using cradles and cables, thus giving all students access to all data gathered. The students are pleased with the fact that they no longer need to make drawings on paper of the point and later transferring these data to a computer.

### **Transforming to a true mobile environment**

The collection and use of vegetation information can be extended when a wireless (GPRS) connection is added. Through this wireless (GPRS) connection, each newly added crop point and associated point information is sent to a central server in real-time. In this case the information is stored both locally and sent remotely. It gives the possibility of exchanging data remotely between different field teams and the office. This allows monitoring of the whole field campaign and allows the introduction of process optimizations.

Since fieldwork locations are often remote and involve significant travel time, it is clear that the time spent on-site should be used effectively. For example, CropViewer enables students to immediately compare current results with previous findings. Students may be engaged in an exercise to learn the skills to test the water quality. They are provided with instructions to do water tests and are asked to report on their results. In a normal situation, students do the tests, return to the university, and discover that their results are either correct or incorrect. If the results are incorrect, they have to return to the spot and conduct the tests again. In a mobile fieldwork situation, students can do their tests, send the information to a remote server, and compare their results with the information available at this server. They will now see immediately if their results are correct or incorrect, and if necessary can redo the experiment on-the-spot. In this way the fast feedback will provide a better way of learning, as from a pedagogical standpoint it is advised that the correction of a mistake should take place as soon as possible.

Thus far, small scale experiments show that GPRS can provide a reliable connection, that can be useful in the field. Connections are slower than normal LAN, but will increase hopefully when EDGE becomes more widely available.

### **The insertion of graphics/figures/diagrams:**

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### **Citations and references:**

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# CONCEPTION AND DEVELOPMENT OF REUSABLE AND MODULAR MOBILE CONTENT

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Keywords: *M-Learning standards, E-Learning standards, learning design, metadata*

## Abstract

The goal of this paper is to show the use of learning technology standards for mobile scenarios, identifying potentials and requirements for the next generation of standards.

Within the conception and development process of M-Learning scenarios, learning technology standards are often neglected because they do not take new M-Learning opportunities into account. E-Learning Standards support -among other areas- learning resources description (e.g. LOM), didactics (e.g. Learning Design) and actor description (e.g. LIP). Whereas E-Learning can actually be based on a technical platform like a web browser and related technology, this is not the case with M-Learning.

We describe our understanding of good M-Learning metadata usage focussing on the necessary extensions to standards. We focus on the didactic conception of learning scenarios. IMS Learning Design provides a standardized way of describing the learning-process and associates the learning process with adequate resources and services.

Finally, we summarize how the resulting metadata for the M-Learning scenarios can be used to enhance learning experiences for all actors within an M-Learning scenario.

## 1 Introduction

Within the E-Learning community, standards gain importance and help to design interchangeable content. This is achieved by providing standards to describe the content and specify a software interface to Learning Management Systems (LMS). Thus, two main problems with E-Learning content are addressed: The descriptive metadata enables indexation, retrieval, and thus reuse. Content packaging makes it possible to integrate the same content package into different LMS. Content packages describe the resources included in it along with a representation of the structure of included documents. See Pawlowski (2001) and Ellis (2005) on using standards in E-Learning.

Namely, there are two wide spread standards, which deal with content packaging: IMS Learning Design (IMS LD) (IMS 2003) and the Shareable Content Object Reference Model (SCORM) (ADL 2004). The main difference between SCORM and IMS LD is that IMS LD uses a generic language to capture the specifics of the underlying pedagogies of the content. SCORM on the other hand just captures the structure of the described content package from the metadata, without taking into account the pedagogic conception behind the content.

Content Packaging is being used increasingly in the E-Learning community and helps to make E-Learning more efficient and successful. This will –as we suggest in this paper- also happen for M-Learning. M-Learning

itself needs to be integrated with traditional and E-Learning scenarios. This cannot be done without metadata and not without an established infrastructure. To actually use the infrastructure available, M-Learning not only has to adhere to established standards. More over the next generation of these standards need to include M-Learning specifics to more efficiently integrate mobility into learning processes.

### 1.1 *M-Learning redefined*

In the following, we will use a specific *definition of M-Learning*. First of all, *M-Learning is not restricted to a specific hardware*. M-Learning is –as we understand it– a form of learning in which the learner can use the learning resources in different locations and can organize his learning schedule himself. (Bryan 2004) discusses this definition of M-Learning in more detail with a focus on a *nomadic learning style*. As such, M-Learning needs a transparent pedagogical conception to enable the learner to successfully learn with the given resources. For instance, if a learning resource requires the learner to be in a specific location or in contact with other learners, the mobile learner has to know this and see if this fits to the situation he is in during his learning process. This also is the case, if the mobile device used by the learner just has not the capability to work with the given resources.

As an example, we illustrate the use of a learning resource on an integrated development environment for c++. At some point the learner is required to write and

compile a program. While learning using a smart phone, there is no access to such an environment. The learner would not have used the resource in the first place, if he had known that he is required to write a program at this stage in his learning process. Instead, he would have continued another learning process, which supported his situation -learning with a smart phone- better.

As a second case, the learner is required to take photos with his cellular phone camera to learn how to document a car accident for insurance purposes. Thus, this learning resource would be much more useful if accessed directly from the cellular phone instead of using a desktop computer in the learner's office.

To our understanding, this also means, that M-Learning must be carefully integrated into E-Learning and traditional teaching to make it successful. To deal with the requirements derived from these assumptions, IMS Learning Design (IMS LD) is the most promising vehicle to meet the requirements. Thus, we suggest using IMS LD for content packaging for M-Learning resources.

## 1.2 M-Learning and E-Learning

Basically, the success of standards in E-Learning was achieved by using a widespread technical platform, which abstracts to hardware specifics: the internet browser, like Mozilla.org's Firefox (mozilla.org 2005), Microsoft's Internet Explorer (Microsoft 2005) or Netscape's Navigator (Netscape 2005) for instance. Thus, it was possible in E-Learning to more or less ignore the technical details of the learner's device. Only plug-ins are required which can easily be installed on the learners device. Looking at available devices to M-Learning, it becomes clear that this assumption does not meet the requirements of M-Learning. While notebooks and also tablet PCs actually could cope with normal E-Learning content, PDAs, smartphones and cellular phones are different. Smaller devices for instance have much smaller display-resolution and make it much harder to navigate through large documents. Thus, it is clear that we have to take into account which devices our learners want to use.

Another difference is how experienced they are with learning with mobile devices. Through the years, as the World Wide Web became a commercial success, even terms as "Internet Literacy" become well known (on Internet Literacy see Wing 2004). Computer literates became the main target group for E-Learning solutions. Cell phones and PDAs are nowadays primary used for personal communication, so learners can not be expected to know all functions of their devices. Especially the network connection, which most desktop computer now have, cannot be required from mobile learners, as network connection is much more expensive and even availability is not always self-evident. So "Mobile Literacy" is not as advanced as "Internet Literacy".

This has a big influence on the current M-Learning

solutions. The learner has to know how to handle his mobile device and has to be willing to learn with it. It is very important that advantages of M-Learning are communicated to the learner to enable him to efficiently decide when to learn mobile and when not.

## 2 M-Learning scenarios and standards

In the following, we will analyse the most important standards in E-Learning and identify requirements and extensions to M-Learning. As a premise, metadata itself needs to be of high quality to be useful (Currier 2004). Firstly, we give a short description of the standards used in this article and then identify extension requirements and potential solutions.

### 2.1 IEEE Learning Object Metadata (LOM)

*Learning Object Metadata* (LOM) describe a minimal set of attributes needed to manage, locate, and evaluate learning objects. Typical attributes include the *type of the learning object, author, owner, terms of distribution and format of the learning object*. Additional support for pedagogical attributes is provided, like interaction style, grade level, mastery level or prerequisites. To accommodate specific needs, the standard does support local extensions to the basic fields. Multiple LOM sets are possible for any given Learning Object (IEEE 2005).

LOM does not provide any information about the implementation of the described learning object, other than the format of the learning object. LOM provides metadata for retrieving and indexing learning objects, but does not help to integrate learning object in LMS or explain how learning objects are integrated in the learning process. Chan (2003) discusses a more elaborate right management, which can enhance informal learning by enabling automated rights validation. Additionally, M-Learning need more information on the nature of the materials to enable LMSs to evaluate which content can be delivered to a specific end user device. This should also be added to LOM metadata as an M-Learning extension.

### 2.2 IMS Content Packaging

"The objective of the IMS CP Information Model is to define a standardized set of structures that can be used to exchange content." (IMS 2004a).

The IMS Content Packaging (IMS CP) standard consists of two components: the *Information Model* (IMS 2004b) and its corresponding *binding* (IMS 2004c). The *IMS CP Information model* describes the data structure of IMS CP, which ensures the interoperability between LMS and authoring tools. The *IMS CP XML Binding Specification* describes the representation of the data structure using XML (W3C 2005).

While the *information model* describes the data used to

make IMS Content Packages interoperable, the XML Binding offers a technical solution to extract the data from each package. This is realized by adding one metadata file to each IMS Content Package which structures includes the metadata. This file is called *manifest* and added to the top level of the package which also includes all content files of the package.

The *manifest file* is structured in four categories: *Metadata*, *Organization*, *Resources*, and *Sub-Manifest*, which will be described in the following paragraphs.

The *General* section specifies an identification key, the version and the relative offset for included content files of the package.

The *Metadata* section can contain the metadata describing the package as a whole. IMS suggests the IEEE Learning Object Metadata (LOM) (IEEE 2005) to describe the package.

The *Organization* section is the key part for interoperability. It describes the structure of learning resources. A learning resource specifies either a structure of other learning resources or refers to a set of resources in the resource section. Each learning resource can be used on its own and thus represents reusable content. The hierarchical structure of the organization section is used to rebuild the default structure within applications using these packages. As an example, LMS are enabled to access the structure of IMS Content Packages and include the structure in the navigation. Each learning resource can include either inline metadata or refer to a file within the package which includes its metadata. IMS CP suggests IEEE LOM (see above) as metadata, but other metadata standards (such as Dublin Core, see Dublin Core Metadata Initiative, 2003) can also be included.

In the *Resource* section, resources refer to files or group of files within the package which are needed for learning resources specified in the organization section.

In the *Sub Manifest* section, different organizations can be specified and application using the package can provide learners with a variety of alternative navigations for the content.

Figure 1 shows how IMS CPs are integrated into the content management processes within a learning platform. The aim was to design a standardized way to specify LMS independent E-Learning content. IMS CP focuses on import and export functionalities for compliant LMSs and thus does not need to provide a full-fledged view on the content. It is tailored to help authors to produce E-Learning content which can be imported in and extracted from LMS easily. Other than that, the LMS has to cope with the content of the package on its own, as IMS CP does not support learning activities directly.

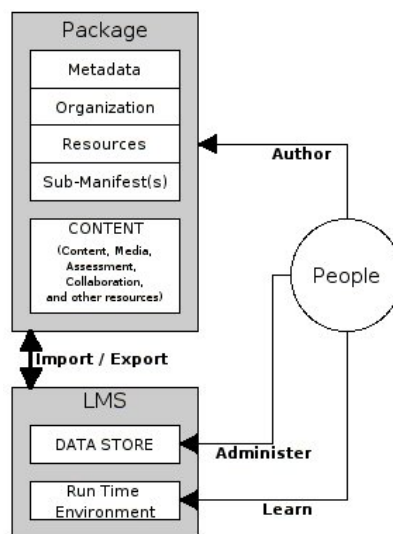


Figure 1: IMS CP framework

Content packaging in E-Learning is usually used to enable authors to reuse their work in different LMSs (Santally et al. 2004). In M-Learning even more as in E-Learning the need for learner individual content packages is more imminent, as learners cannot easily stay connected to the internet while changing their location. M-Learning packages have to address this to make full use of its potentials.

### 2.3 IMS Learner Information Package (IMS LIP)

The IMS Learner Information Package (IMS LIP) describes characteristics of a learner needed for a number of purposes involved in the learning process. It is designed to *record and manage learning-related history, goals and accomplishments* (IMS 2001).

The specification supports the exchange of learner information among a variety of systems, such as learning management systems, human resource systems, student information systems, enterprise e-learning systems, knowledge management systems, or resume repositories. The IMS Learner Information Package specification does not provide or suggest solutions for handling requests for learner information or other profile exchange mechanisms.

IMS LIP is divided in eleven categories to describe the learner. The following list, which is based on (IMS 2001) gives a short overview about these categories.

1. *Identification*: This category describes the biographic and demographic data relevant to learning.
2. *Goal*: Here the learner learning related objectives are described.
3. *Qualifications, Certifications and Licenses (qcl)*: The learner's qualifications, certifications and licenses granted by

- recognized authorities are described here.
4. *Activity*: Here the learner can add any learning-related activity in any state of completion to his profile.
  5. *Transcript*: A record that is used to provide an institutionally-based summary of academic achievement.
  6. *Interest*: Additional information about the learner is described here, for instance his hobbies and recreational activities.
  7. *Competency*: Skills, knowledge, and abilities the learner acquired in the cognitive, affective, and/or psychomotor domains are described here.
  8. *Affiliation*: Membership of the learner in for example professional organizations can be added here.
  9. *Accessibility*: General accessibility to the learner information.
  10. *Security key*: The set of passwords and security keys assigned to the learner for transactions with learner information systems and services.
  11. *Relationship*: The set of relationships between the core components.

In addition to the learner information described above, Chan et al. (2004) suggest adding a more dynamic structure for addressing learning activities and competencies to IMS LIP to cope with informal learning. These data should also include location data of the learner, technical options (such as available mobile devices) and specifically information on the environment, like for example learning in a noisy environment.

#### 2.4 IMS Learning Design (IMS LD)

IMS Learning Design is a specification describing *pedagogical concepts* and promoting the exchange and interoperability of E-Learning activities. To cope with specifics of *pedagogical concepts*, a generic and flexible language is used (IMS 2003).

IMS LD uses IMS CP to describe resources used within learning activities and effectively replaces the manifest section with its own representation of learning processes. As this paper is intended to introduce IMS LD, we abstract from details IMS LD and use a simplified version, as shown below in Figure 2.

A *pedagogical concept* is represented using by an IMS LD *Method*, which in turn consists of *Plays* and *Acts*. The whole learning process will be represented by such *Methods* and each *Act* will be detailed by describing intended *Actors*, their *Roles* and their planned *Activities*. The *Activities* are connected to the actual content and use the *Role* of the respective *Actor* to decide how the content has to be accessed.

Of particular interest to M-Learning are the *Services* of

an *Environment*, which specify the software and other services like tutoring available within a specific *Environment*.

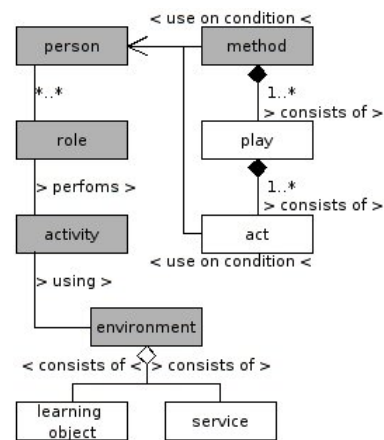


Figure 2: IMS LD structure

The above example shows how *Activities* in a *pedagogical concept* for a learning process can be represented by IMS LD. Paramythi et al. (2004) elaborate on this on behalf of adaptive learning environments. Further features of IMS LD include the description of prerequisites and intended outcomes to each *Act*. This represents the requirements to successfully use the described learning process. Additionally, intended Actors can be described by using IMS LIP and thus actual learner profiles can be matched with described learning process to see if a learner can actually use a learning resource. This is generally a difficult task, as there is no common taxonomy for knowledge's or learning objectives. For instance, corporate educational profiles can be used to build such taxonomy for a specific context. But even without such a predefined taxonomy the prerequisites make the learning process much more transparent for learners.

### 3 Successful conception of M-Learning scenarios

To illustrate the required changes and extensions to standards, we describe a sample M-Learning scenario. For this section, we deliberately took an example which is integrated in traditional learning and has a formal setting. The example is based on the "Mobile Lessons: concept and applications for 'on-the-field' georeferenced lessons" (Pintus et al. 2004).

#### 3.1 Mobile Lessons - a short example of a M-Learning scenario

(Pintus et al. 2004) have developed a concept to carry the lessons directly on-the-field to enable all actors – including teacher, students and tutors- to move in a certain geologic regions and receive and add documents to GPS positions in the region. In tabular 1, the general concept of such a lesson is depicted. (Pintus et al. 2004)

describe how the Mobile Lesson should be designed and what devices are needed. As a base software for the devices, the “augmented” browser as described in (Carboni et al, 2004) is used. Additionally, a Website which interprets the GPS data send by the browser is necessary.

Design of mobile lesson	Introduction of technology and topic	In the field	Discussion of solutions
Teacher develops idea	Teacher introduces pupils to their assignments	Pupils solve their assignments	Pupils and teacher discuss their experience
Didactic conception: Exercise Oriented Learning, Investigation			

Tabular 1: Conception of “Mobile Lessons”

As an example, we show a *geologic Mobile Lesson*, in which the teacher wants his students do take samples of soil for a certain region, which will be used to produce a geologic map of the region. Each of the conception sections shown in figure 3 can be described by *IMS LD Plays*. The conception as a whole can be represented in IMS LD as a *Method called “Mobile Lesson”*.

In the first Play, the teacher goes into the field and adds information to specific regions using his augmented browser. In the second Play, the teacher explains his students the technology used in the field trip and also introduces their assignments for the field trip. The students start to plan their trip in the classroom and decided on tasks to do in the field and who will be assigned to each task. Then in the next Play the students and the teacher actually go on the field trip and solve the assignment. Later back in the class room, they conclude the field trip with the last Play, in which the results of the assignment are discussed.

In the following, we focus on the “*In the field*” Play, as this represents the mobile part of the students learning process.

### 3.2 Conception of the play “In the field”

In figure 3.1 and 3.2, a part of the IMS LD design for the Play “*In the field*” is shown. The Play includes four Acts, of which the Act “prepare for taking soil” is described in more detail. Both activities also use learning objects and services provided within the context. For instance, E-Learning objects about the tools used in the field are stored on a web server, which is accessible with the provided mobile devices. Additional students can call upon the teacher as an advisor, which in this case represents a service provided for the Activity.

First we need to look at the M-Learning specific of this conception. First of all, the locations the students are currently in have to be taken into account. None of the standards provides the entries for this directly, but it is

important for the scenario, that the tutor and the web server have a way to locate students to fulfil their roles in the learning process. Thus, the location data would be a useful extension to IMS LIP as argued before. The documents delivered to the field by the server have to be useable on the respective end user device. This would either be a service of the web server, which then is supposed to prepare readable documents for different end user devices and thus this would be an M-Learning specific service for IMS LD. As an alternative, the documents themselves can be described in a way that it is clear which devices can actually use them. This would be an extension to LOM. So even in this very small and formalized setting, M-Learning specifics can be identified, which E-Learning standards do not take into account right now.

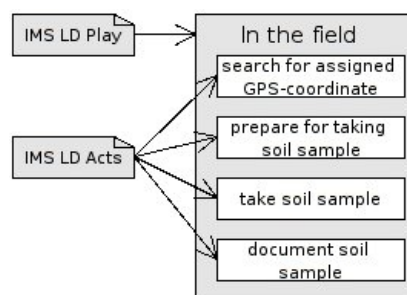


Figure 3.1: IMS LD “In the field” Play

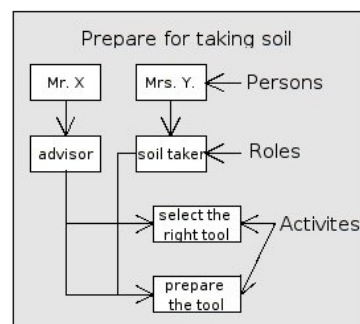


Figure 3.2: IMS LD “Prepare for taking soil” Activity

## 4 Using metadata in M-Learning

In this section, we show how the above described metadata can be tailored to the specific needs of M-Learning. This is done by analysing metadata for the respective users’ point of view.

The section is divided into three subsections to explain how the different actors in a learning process can profit from the extra metadata provided with M-Learning tailored E-Learning standards.

### 4.1 How can authors profit from this conception?

First of all, authors can better analyse their intended target group, if detailed information on the learners is

provided. Thus, IMS LIP, with the above discussed extensions, additionally provides them with information about end user devices and learning locations preferred by the user. This way, authors are enabled to include these preferences in their conceptions and thus react much faster to the need of their learners.

Additionally, using IMS LIP, in combination with the respective evaluation of the learning scenario, will help the author to better recognize the needs of learners. Thus, successful conceptions can be reused with the same intended user group within other scenarios to improve the learning experience as a whole.

Last but not least, as in E-Learning, standards provide the most promising way to reuse M-Learning conceptions and contents in different scenarios.

#### 4.2 How does the learner profit from the metadata?

M-Learning processes are much more transparent to learners and they can better decide, which conception does fit their needs best.

LMS can provide learners with M-Learning enabled resources and as such the learner can much easier identify which resources work in his current learning situation. Thus, he can better plan his learning process and can decide when and where to learn before hand, giving him the needed security that he can achieve the competencies without having to evaluate the whole scenario himself.

By browsing through the evaluation of different learning scenarios (M-Learning and traditional scenarios) and directly compare them, because they are described using the same criteria.

#### 4.3 How can other actors profit from the metadata?

Several more actors are involved in mobile learning processes. We present some suggestions who might also profit from the tailored metadata.

- M-Learning service providers can better select which M-Learning conception and scenarios fit to their target group.
- HR managers can better select M-Learning solutions which fit into their company.
- Tutors can better provide adequate help on how to use the provided resources, if they are aware which device the learner is using.
- Tutors better react to different conceptions used for one learning objective by looking up the respective metadata on the progress of an individual learner.

## 5 Conclusions and future developments

In this article, we have shown how the development of M-Learning scenarios can be supported using E-Learning standards. We have identified weaknesses of existing standards. As an example, recent standards for not take location data into account. Therefore, several basic extensions of standards have yet to be established.

The most urgent extension is *Location Awareness*. The location should be added to learner profiles, documents and conceptions used in M-Learning as this is the key factor of M-Learning.

However, more elaborate functionalities can be build upon this base. For instance, the concept of trusted computing should be transferred to IMS LIP Repositories for “*trusted M-Learning*”. Thus, learners are enabled to work with one profile in different LMS. Additionally, LMSs are enabled to identify the target platform the have to serve documents and services to.

Additionally, the concept of *Content Packaging* for E-Learning resources should be extended to the end user. Thus learner would be able to load these packages to their mobile devices and thus learn without being online. The conception of the package is the key factor, as it has to support this learning process.

These are just a few examples on how M-Learning might be enriched by the integration of standards in the workflows of the conception and use of M-Learning. To explore these opportunities is an important task for the M-Learning community as a whole.

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# Evaluating Mobile Learning: Reflections on Current Practice

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## **Abstract:**

The field of mobile learning is at present characterised by a proliferation of pilots and trials that allow mobile technologies to be tested out in a variety of learning contexts. The sustained deployment of mobile learning will depend on the quality of these pilots and trials, which includes evaluation methodology and reporting. The paper examines current evaluation practice, based on evidence drawn from conference publications, published case studies, and other accounts from the literature. The authors also draw on their work in collecting case studies of mobile learning from a range of recent projects. Issues deserving examination include the apparent objectives of the pilots or trials, the nature of the evaluations, instruments and techniques used, and the analysis and presentation of findings. The paper reflects on the quality of evaluation in mobile learning pilots and trials, in the broader context of evolving practices in the evaluation of educational technologies.

## **Keywords:**

*Evaluation, methodology, literature review, good practice.*

## **1. Introduction**

The last four years have seen a dramatic increase in the number and the variety of pilots and trials involving mobile learning. This increase has been reflected in and supported by submissions to the MLEARN conference series, and by the emergence of smaller and local conferences. The growing pedagogic and technological sophistication of mobile learning pilots and trials is evident, but increased and sustained deployment of mobile learning will depend of the quality of analysis and evaluation of these pilots and trials.

Evaluation and analysis are key to the sustainability of mobile learning because first, they inform the outside world about the effectiveness of pilots and trials, specifically in relation to the objectives they set out to achieve, and second, they provide some insights to funders and champions on the utility and cost-effectiveness of the pilots and trials they support. In some cases, evaluation will determine whether pilot projects become embedded as ongoing provision in institutions.

Historically, the development of evaluation strategies for educational trials and pilots has focused on face-to-face contact with students or learners working in cohorts on courses in classrooms, lecture theatres and laboratories, and perhaps involving other stakeholders. Evaluation has depended on a small stable repertoire of techniques, embracing, usually, observation, interview, focus group and questionnaire. More recently, e-learning evaluation has supplemented these with analysis of system logs and technical data. In other areas of social research, for example policy interventions, and to a lesser extent, in other areas of educational research, evaluation is a complex and mature discipline (Patton 2001).

Now, the changing political, economic and social climate is forcing or encouraging educational institutions

- to address new constituencies of learners, such as ‘access’ students without adequate study skills and full-time students forced to hold down substantial part-time jobs
- to deliver informal and life-long learning, alongside conventional structured courses and programmes
- to engage with industry and commerce by delivering more training
- to teach increasing numbers of students in spite of static financial resources.

This means that developmental and innovative trials and pilots working in these environments, in our case those that use mobile technologies, must question the efficacy of traditional evaluation techniques and must adapt and explore more innovative and varied evaluation approaches. This is in itself



problematic because it raises concerns about the validation of untried evaluation techniques and about the trustworthiness of adapted techniques.

There are no *a priori* attributes of a 'good' evaluation (to say that there would be to take an implicitly realist or essentialist position that not every stakeholder would agree with, and would also confront a widely held view that in fact evaluation is a contingent activity). In an earlier work, we tried to outline some candidate attributes of a 'good' evaluation (Traxler 2002) but we also identified the reasons why evaluation of mobile learning is unusually challenging. Briefly some of these attributes were that a 'good' evaluation should be:

- Rigorous, meaning that conclusions must be trustworthy and transferable
- Efficient, in terms of cost, effort, time
- Ethical, specifically in relation to the nuances of evolving forms of provision
- Proportionate, that is, not more ponderous, onerous or time-consuming than the learning experience or the delivery and implementation of the pilots themselves
- Appropriate to the specific learning technologies, to the learners and to the ethos of the project concerned – ideally *built in*, not *bolted on*
- Consistent with the teaching and learning philosophy and conceptions of teaching and learning of all the participants
- Authentic, in accessing what learners (and perhaps teachers and other stakeholders) *really* mean, *really* feel, and sensitive to the learners' personalities within those media
- Aligned to the chosen medium and technology of learning
- Consistent across:
  - different groups or cohorts of learners in order to provide generality
  - time, that is, the evaluation is reliably repeatable
  - whatever varied devices and technologies are used

The last of these attributes is particularly challenging in mobile learning, since the technologies are changing at an exceptionally fast pace and consequently reaching an understanding of underlying issues is difficult. Some of the others are more subtle. Some issues around ethics have been explored elsewhere recently (Traxler and Bridges 2004): mobile learning continues to evolve however, and any account of the ethics of evaluation would now, for example, have to address the issue of using virtual ethnography to evaluate mobile blogging.

As we have said, there is no *a priori* basis for these attributes and thus no specific philosophical basis for the agenda of this paper, namely reflection on current evaluation practice in mobile learning trials and pilots. However we feel that in light of the current state of evaluation in mobile learning, we can still make a valuable contribution to theory and practice by juxtaposing some current evaluation practice as illuminated by the literature with some discussion of 'good' evaluation.

Bates and Poole (2003) have proposed a model for the effective use of technology for teaching in higher education that suggests eight criteria to be used in determining choice of technology. An investigation of whether the right technology has been selected is arguably an important aspect of a comprehensive evaluation of mobile learning. It would therefore have to take account of these criteria, namely:

- the appropriateness of the technology for students
- ease of use and reliability
- costs
- teaching and learning approaches
- interactivity
- organizational issues
- novelty, as a choice not to use existing technology
- speed, i.e. how quickly materials can be developed

It is interesting to note that this model is an evolution of a previous model developed by Bates (1988, 1995), which had 'access' as one of its key criteria - in the sense of providing flexibility, or reaching students who could not attend conventional classes. This criterion was subsequently de-emphasized and subsumed under 'appropriateness for students'. However, our own analysis of the reasons why teachers are using mobile technologies (reported below) suggests a possible reinstatement of access as a key criterion in relation to these new technologies.

There are a wide variety of other authors offering complementary and perhaps competing criteria for all the various aspects of evaluating mobile learning; one way of addressing this complexity and of

exploiting growing experience and expertise would be to use (online) Delphi techniques to develop more consensual criteria (see for example, Des Marchais 1999), and perhaps to use 'contrived' elicitation techniques (Rugg and McGeorge 1992) to uncover the value systems that underlie experts' evaluation criteria.

We can make some progress on the basis that mobile learning pilots and trials each have their own aims and objectives, and that these have driven evaluation in the sense of defining the outcomes sought by the evaluation and hence driving the selection and development of the techniques, instruments and protocols used in evaluation. The outcomes we are interested in are broadly 'educational'. A different evaluation mindset may apply to a project that sets out to test only technical stability, or to trial a specific interface design without explicitly addressing its impact on an educational activity.

Perhaps the obvious potential objective for any educational pilot or trial is cognitive change, where students have learnt something new. An evaluation may be looking for this or might be looking for meta-cognitive change, where students have learned something about the process of learning. An evaluation may also be looking for affective changes in students, reflecting changed feelings, values or preferences and it may also look for social changes, perhaps in how students relate to or work with each other, or in how groups of students show increased collective interaction, competences or skills.

Mobile learning takes place in a wider social context and evaluation must also recognise this. The wider social and economic benefits of projects may be evaluated through the eyes of learners and other stakeholders, if the pilot or trial has been funded with a social and economic agenda. There is increasing recognition of such benefits but also the difficulty of evaluating them appropriately (Dewson *et al.* 2002). Mobile learning pilots and trials can nowadays receive funding to build capacity within communities and to improve social inclusion; the pan-European *m-learning* project is an obvious example of such an agenda, as are its smaller spin-offs with travellers and the homeless. In these cases, lifelong learning and community education might only be the means to these ends and mobile learning technologies may only be the vehicles to carry them. In such cases, the cognitive gains are likely to be irrelevant – indeed, any kind of learning gains might be irrelevant, nevertheless evaluation must still take place.

## **2. Current Evaluation Practice**

This section reviews current mobile evaluation practice, as described in recent reported case studies, pilots and trials (Kukulska-Hulme and Traxler 2005; Attewell and Savill-Smith 2004). The sample is relatively small and arbitrary, and of course the accounts themselves may be an incomplete or inaccurate reflection of the actuality. The case studies (Kukulska-Hulme and Traxler 2005) were written to a template specifically designed to produce consistent accounts that exposed the relationships between objectives, methods and evaluation; the conference contributions (Attewell and Savill-Smith 2004) were often shorter and less consistent and may often have discussed technologies that were not mature enough for use across a cohort of learners within a formal course for a semester or a term of their studies.

The issues and questions addressed in this section are drawn from a much larger developing evaluation framework being developed by the authors that attempts to build systematically and comprehensively on secure philosophical foundations. A motivation behind the current exercise has been to look at priorities and gaps in this framework, and to create dialogue with practitioners on the issues raised.

In general, examining most accounts of trials and pilots produces only indicative rather than definitive findings but these nevertheless serve to help us develop a more focused and systematic account of evaluation. The following sections briefly highlight how the multiplicity of aims and objectives pose challenges for evaluation; look at some of the evaluation techniques and methods used and at how findings are presented.

### **2.1 Aims and Objectives of Pilots and Trials**

An analysis of 12 international case studies in Kukulska-Hulme & Traxler (2005) reveals that reasons given for using mobile technologies in teaching and learning relate principally to improving access, exploring changes in teaching and learning, and alignment with institutional or business aims, as illustrated by these examples:

Access:

- Improving access to assessment, learning materials and learning resources

- Increasing flexibility of learning for students
  - Compliance with special educational needs and disability legislation
- Changes in teaching and learning:
- Exploring the potential for collaborative learning, for increasing students' appreciation of their own learning process, and for consolidation of learning
  - Guiding students to see a subject differently than they would have done without the use of mobile devices
  - Identifying learners' needs for just-in-time knowledge
  - Exploring whether the time and task management facilities of mobile devices can help students to manage their studies
  - Reducing cultural and communication barriers between staff and students by using channels that students like
  - Wanting to know how wireless/mobile technology alters attitudes, patterns of study, and communication activity among students

Alignment with institutional or business aims:

- Making wireless, mobile, interactive learning available to all students without incurring the expense of costly hardware
- Delivering communications, information and training to large numbers of people regardless of their location
- Blending mobile technologies into e-learning infrastructures to improve interactivity and connectivity for the learner
- Harnessing the existing proliferation of mobile phone services and their many users.

A review of the 27 projects documented in the proceedings of MLEARN 2003 (Attewell and Savill-Smith 2004) shows a similar spread of objectives, with a predominance of objectives identifying or targeting changes in teaching and learning:

Access:

- enabling students to look at course information any time and anywhere
- trying to ensure that every student can access content independently of the channel he or she chooses to use
- the use of a PDA as an assistive technology
- ensuring that classroom-based pupils benefit from the experience of a field trip being undertaken by their peers

Changes in teaching and learning:

- individualisation:
  - to explore the potential for individualised mobile learning - revision material tailored to the needs of the individual
  - to provide learners with a flexible context-awareness system that can react to their needs
- collaborative and active learning:
  - immediate feedback through interactive tests: the user knows in real time if their choice is correct
  - interactive screens encouraging art gallery visitors to respond to the art on view
  - a set of innovative games, materials and activities which will motivate reluctant young learners
  - a user-friendly m-portal that is powerful and empowering, and encourages active participation by its users
  - enhancing interactivity and cooperation while preserving the traditional advantages of face-to-face encounters
- informal learning with multiple media:
  - to investigate how self-produced videos, made with a digital video camera and later viewed on handheld mobile computers, can support informal learning
  - to provide video and still images giving additional context for art gallery works on display, opportunities to listen to an expert talk about details of a work, with the details simultaneously highlighted on the screen
  - enhancing the audio presentation of a multimedia museum guide by using the PDA screen to travel throughout a fresco and identify the various details in it
  - using voice technology to provide rich media content for the user
- cognitive and behavioural change:
  - to explore how context-dependent learners' knowledge concepts are

- to evaluate fragmentation in mobile learning based on students' deep and surface approaches to learning
- to capture learners' thoughts, views and behaviours in a mobile learning setting

Alignment with institutional or business aims:

- to remain at the cutting edge of educational technology by helping to shape a new generation of multimedia tours in art galleries
- to investigate whether an integrated set of learning tools would be useful, which tools would be adopted and the contexts in which the tools would be used
- development of a service model and new component concepts for lifelong mobile learning

In the MLEARN 2003 proceedings we have also identified some aims that address 'the future of mobile learning' more generally:

- to find out in which arenas handhelds are used, how and why they are used, and what role they can play
- what the future take-up of new services and facilities on mobile phones and other technology devices might be
- to find out whether young adults would be willing to use their phones for literacy and numeracy learning
- to understand the range of actions and opportunities open to mobile learners, and seek ways of extending this range to support what learners want to do – even if they themselves do not yet know what that is

The authors of the case studies and papers do not always categorise their own objectives, and they do not prioritise them explicitly. Objectives can usually be identified quite clearly in the abstracts, whilst in the actual papers they may be introduced and discussed at various points in the paper. They are not presented as being linked to evaluation methods in any explicit way, even when the methods are fully explained and justified. Objectives typically consist of the provision of new opportunities, exploration of potential, introduction of new media, or initial exploration of attitudes and patterns of use. The authors may be seeking to encourage or enhance certain ways of learning, but such outcomes may be hard to measure, especially during a relatively short period of technology use.

Given the present state of knowledge in the field of mobile learning, considerable skill is required in formulating objectives. In research projects, the aims may be exploratory and may seek to retain a certain openness to unexpected findings. Clearly, this is problematic for some styles of formal summative evaluation that audit achievements against objectives without recognising that some objectives in exploratory projects may only emerge as projects evolve (whilst it may also become apparent that some initial objectives are disproportionately expensive or impractical to realise). A more fluid, formative and engaged style of evaluation may on the other hand run the risk of losing its perspectives or objectivity.

These are some of the issues that we are addressing in exploring how mobile learning evaluation should engage with project objectives; they are issues with a very direct bearing on the methods and techniques of evaluation.

## 2.2 Types of Evaluation

In looking at our sample, we find that most of the projects can be characterised as 'first-generation' – the technologies used were not always stable, mature or well understood and technical difficulties sometimes hampered the educational delivery and the subsequent evaluation. The sample also seemed to be generally 'first generation' in the sense that most of the trials and pilots were not building on an established base of expertise or equipment. It could be argued that this had consequences for the type of objective that was appropriate, shifting the balance away from answering specific research questions and towards identifying, refining or prioritising such questions (or perhaps demonstrating technological and pedagogic possibilities). Whichever it was, this issue has considerable implications for evaluation, both in the general sense of understanding the technological and pedagogic contexts but also in the specific sense of evaluating the alignment of objectives, methodology and outcomes.

The evaluations in our sample were usually formative (in the sense that changes took place as a consequence). It was not always apparent why they took place when they did. Insofar as we could judge, the evaluations were not usually conducted by external staff or by evaluation specialists.

Very few of the accounts in our sample made direct reference to the literature of evaluation and consequently there was not normally a justification or explanation for the evaluation methods or instruments chosen. There were also few, if any, references to ethics as a potential factor in evaluation in the literature reviewed. The exceptions related to privacy and context-awareness (Lonsdale *et al.*, 2004).

### **2.3 Methods and Techniques**

The vast majority of pilots and trials in our sample had no explicit or apparent educational or epistemological foundations. They may nevertheless have had some tacit foundations that were ‘not-worth-mentioning’ or ‘taken-for-granted’. Where foundations were apparent, they were usually social constructivist and underpinned the pedagogy. There was not usually any statement about the foundations of the evaluation. The fact that foundations were not articulated was problematic because basing a pilot or trial on explicit educational or epistemological foundations implicitly raises the issue of whether the evaluation should be aligned with them.

A crucial element of the evaluation of mobile learning trials and pilots is the elicitation of learners’ attitudes and achievements. In examining elicitation methods and techniques used in each one, the issues can be categorised as:

- Technical: were the methods and techniques used competently and were they appropriate to the specific context of the project?
- Philosophical: what was the relationship between the evaluation elicitation methods and the project in terms of their actual, assumed or implied epistemologies?
- Ethical: were the elicitation methods used with an ethical basis that was consistent with actual, assumed or implied epistemologies?

The technical questions were perhaps the easiest to answer since most authors address them explicitly though not always in much detail. The elicitation techniques used were usually questionnaires, interviews and focus groups, supplemented by observation of the learners or analysis of system data.

In general where these techniques were used, their implementation and delivery was conventional rather than adapted to mobile technologies or mobile learning. If the pilot or trial being evaluated took place in the context of blended learning or classroom delivery this would be appropriate but where the trial or project focussed purely on informal mobile learning, it could be argued to be methodologically flawed and possibly ethically problematic. In fact, most accounts of evaluations did not extend to a discussion of selecting and designing the instruments used.

Questionnaires usually used Likert scale fixed responses and the analysis took the form of bar-charts or histograms. The samples and populations were too small for any form of statistical analysis, though the issue of confidence was usually underplayed and results were frequently translated into percentages or fractions. The fixed response questions were often supplemented by free-text answers. Their analysis took the form of paraphrase.

Interviews, focus groups and observations were used less frequently. Accounts of interviews and focus groups were brief and suggested that the sessions were usually short and probably informal. In a relative small number of cases, evaluation used and combined several of these different techniques.

### **2.3 How findings are being presented**

Apart from the usual academic reporting of findings, an evaluation may result in recommendations. Attewell and Savill-Smith (2004) include a number of papers that make recommendations based on evaluation findings: Mitchell gives recommendations and key challenges for developers; Vainio and Ahonen discuss their work in the MOBIlearn project in terms of providing guidelines for adaptive user interface design; Thomas *et al.* put forward design principles for the development and evaluation of mobile educational games, but emphasize their tentative quality:

“While the principles presented here provide a conceptual overview of what could become ‘good practice’ in relation to the development and evaluation of mobile learning games, only a handful of principles have been illustrated... The aim of this paper has been to highlight the need for comprehensive research and evaluation of usability principles and initiate a dialogue in which usability frameworks can be modified, enhanced and validated by the mobile learning community.”

(Thomas *et al.* in Attewell and Savill-Smith 2004, p.179)

The multiplicity of stakeholders in mobile learning pilots and trials and the fluidity of terminology and technology make the presentation of findings (but also the presentation of evaluation) an important issue. One role for evaluation specialists, especially where external funding or public money is involved, is placing findings, outcomes and achievements in some wider context.

### 3. Conclusions

To draw some of the threads of our discussion together, we have said that developing the concept of a 'good' evaluation is problematic but important. Such a concept should be based on explicit philosophical foundations but our review shows this is not usually the case in mobile learning evaluation at the moment. The evaluations we examined seem to be based on tacit foundations of 'common-sense' or perhaps a tacit consensus amongst mobile learning evaluators. It seems to us that many of the trials and pilots themselves rest on a 'common sense' view of learning. In the case of evaluation, this means that there is not always much theoretical justification or coherence to support the selection or use of any given evaluation techniques or methods. These facts jeopardise the credibility of outcomes reported in mobile learning trials and pilots. Mobile learning challenges evaluators to develop evaluation methods and techniques that are sympathetic to the ethos and technologies of mobile learning but our review shows that these are slow to emerge.

Recommendations for good practice can only convincingly rest on evaluation and consequently recommendations for good evaluation can only rest convincingly on an evaluation of evaluations. We hope we have contributed to that process but recognise the need for continued work on a more systematic and comprehensive framework. Evaluation is problematic but valuable. In the words of one experienced educational evaluator (Somekh 2001):

“Evaluation is a fascinating, socially useful, morally demanding and highly politicised activity. Its future depends on the uses we put it to, and the role it is given by sponsors and politicians.”

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# Moving mobile into the mainstream

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## Abstract

*"The question is no longer whether m-learning works for hard-to-reach learners, but rather how best to fit it into your blend!"*

In the short space of five years, mobile learning (m-learning) has moved from being a theory, explored by academic and technology enthusiasts, into a real and valuable contribution to learning.

In the UK, thousands of mobile handsets have been bought for use as learning tools. User trials have successfully helped a wide range of hard-to-reach learners in many different contexts. The debate has moved on: the issue is not to show that m-learning works for these learners, but to understand the different learning models that best incorporate it, analyse the costs and benefits, and convince the education and corporate sectors to use mobile elements in their learning strategies.

Geoff and his team at CTAD have been key players in much of the experimental work in this field and have learnt many real and relevant lessons about moving m-learning into the mainstream. Their learning resources, pedagogical approaches, support systems and devices have been used with over one thousand learners across a wide spectrum of backgrounds and learning needs.

In this paper we will share some of the lessons learnt during our many user trials, as well as explain the framework we are using for current and future m-learning delivery.

## Keywords:

*mobile learning, user trials, case studies, mediaBoard, MMS, SMS, picture messaging, mobile phone, collaboration, communities of practice, mainstream provision, hard-to-reach learners, work-based learning, P900, XDA2, PDA*



## 1. Background

Cambridge Training and Development Ltd (CTAD) has been an active participant in more than 20 m-learning trials across Europe, mostly in the UK.

Our learning resources, pedagogical approaches, support systems and devices have been used by over 1000 learners at the time of this paper.

The trials have been watched, evaluated and researched by several different institutions:

- Institute of Education (IoE), UK
- Learning and Skills Development Agency (LSDA), UK
- National Research and Development Centre for Adult Literacy and Numeracy (NRDC), UK
- Ultralab, Anglia Polytechnic University, UK

Feedback from the learners, the tutors and the evaluators has fundamentally shaped our approach to m-learning.

## 2. User trials

These trials have covered a wide range of ages, learning needs and contexts, but what all of them have had in common is that the learners were hard to reach, often outside mainstream teaching provision, and that the m-learning was being used as a tool to increase their engagement in learning. Some of the more visible trials are with:

- traveller families across Scotland, many recently housed
- young parents and parents-to-be in inner-city Birmingham; Practical parenting and health information via multiple media
- lorry drivers and their trainers in a large pharmaceutical company
- inner-city refugees and recent immigrants in Stockholm
- several projects in North East England grouped together as a Maths4Life Pathfinder, investigating m-learning to motivate potential numeracy learners
- an NRDC ICT Effective Practice Study, using m-learning with ESOL learners
- work-based promotional materials, raising literacy and numeracy awareness via sector-based phone and SMS quizzes . (15 sectors, 9 Java quizzes, 22 SMS quizzes, 150 000 SMS quiz flyers printed!)
- hard-to-reach learners in targeted workplaces – we have several other ongoing trials into specific work contexts: Care, Cleaning, Construction, Logistics, Sex work
- homeless support charities, working with residential adults
- driving theory test practice questions on your phone; this started as a theme in the original project, but has now become a commercially available product.



### 3. Key lessons

Much debate has focused on the definition of m-learning. Is it about mobile learners? Is it about small personal devices? Is it about communication and collaboration? Is it about context sensitivity? Is it a natural extension to e-learning?

For the purposes of this paper, we will take the lead from the learner, and define m-learning as making use of whichever devices and technologies surround our learners, in an attempt to empower and enrich their learning, wherever and whoever they are.

Across our different trials, we learnt the following lessons:

#### ***It works, and reaches places other learning cannot***

We know that m-learning can empower and engage. We know that the engagement and motivation can continue beyond the initial 'gadget honeymoon'. We know that learners are more comfortable engaging in personal or private subject areas via a mobile device than via traditional methods. (Attewell 2005)

#### ***Best as part of a blend***

Our different trials tried out a number of different approaches to using mobile devices. In some cases we used mobile phones that the learners already had; in other cases we provided them with high-level phones, or even PDAs. In some cases the learning was supplementing activities already underway; in others the learning activities were constructed around the mobile devices.

In almost all of these scenarios, we found that the learning worked best for both the learner and the tutor when it spanned the mobile device, and other media or group activities. Typically it was combined with:

- group activities
- paper-based materials
- other ICTs
- everything else tutors would normally do.

These findings are supported by other studies exploring the different approaches to learning and what opportunities wireless and mobile technologies can offer. The JISC innovative practice guide (Knight 2005) suggests distinguishing between these learning perspectives:

- learning as acquiring competence
- learning as achieving understanding (both individually, and collaboratively)
- learning as social practice

All of these can find a place in our blend.

#### ***It is a collection of pieces to be fitted to a learning need, not a single solution***

When it first became widespread, one of the biggest failings of e-learning was the assumption that it could become everything. Teachers were no longer required. Anything could be taught using it. Success was only about 'broadcasting' good quality learning materials. We now know that this is not true, and that good teachers, communication, collaboration and discovery-activities are essential.

The good news about m-learning is that it is very difficult to make the same mistakes because the devices being used are that much less powerful than PCs. There is clearly no single solution. Screens are smaller. Many have no keyboards. Connection speeds are slower. Processing power is weaker. There is no single

'platform' or set of features that dominates. The learning you can do on an iPod or MP3 player is very different from what you can do with SMS.

In the light of this, we have found it very helpful to describe mobile learning not as a single thing, but rather as a collection of new tools that can be added to a tutor's teaching toolbox, to be assembled as required to achieve specific aims. Some of these tools are:

- SMS (text messaging) as a skills check, or for collecting feedback
- audio-based learning (iPod, MP3 players, podcasting)
- Java quizzes to download to colour screen phones
- focused learning modules on a PDA
- media collection using a camera phone
- online publishing or blogging using SMS, MMS (picture and audio messages), cameras, e-mail and the web.

All of these are explored in much greater depth on the m-learning website ([www.m-learning.org](http://www.m-learning.org)), the Get Mobile CD (CTAD 2005) and previous papers by the author (Stead 2004).

### ***Not just for 'teaching', but for creating, collaborating and communicating***

Given that our target users have often dropped out of school, and were almost always not strong performers when they were at school, being able to exploit different learning styles was a key feature of our work. Luckily for us, the very nature of m-learning ('collection of pieces') made this a fairly natural part of the mobile learning mix. Feedback from learners and tutors was very strongly in favour of this mix of learning styles.

Whenever our learners were a group who already knew each other, they were very keen to make use of the collaborative features of the mobile devices: beaming incomplete pictures and messages to each other so they could each add on their own bit; sending SMS, MMS and e-mails to one another. They figured out how to before we even had the chance to show them! Exploiting this as a learning tool provided us with a rich seam of enthusiasm and contribution from the learners.

Some of these activities made use of existing functions and features of the devices for picture taking and drawing, sound recording, text writing. Other activities used external software systems to combine these. The most useful of these was the mediaBoard ([www.mboard.co.uk](http://www.mboard.co.uk)) which is an online scrapbook that you can send texts and media files to directly from a camera phone or mobile device. (Colley 2005, Colley & Stead 2004, Stead 2004, Mellar & Kambouri 2005)

### ***M-learning can be a bridge into IT***

When working with young people, we expected them to be skilled users of IT, but we were surprised to find that a majority of our socially disadvantaged groups had no confidence in IT at all. In fact many learners actively avoided it. After our trials, several learners initiated steps back into learning, so that they could learn about e-mail, the Internet, word-processing and other IT related skills. For these learners this represents a massive shift in autonomy and motivation. This 'bridge into IT' is a result we saw in several other trials with different age groups as well. (Attewell 2005, Colley & Dixon-Trifonov 2005, Whyley 2005)

### ***Practice makes perfect: just do it!***

The final lesson is a softer one. We found that the best way to understand how to fit mobile learning into your teaching is to take the plunge and try it out. There is a

minimum of technical understanding and skill that tutors need to have before starting, but the majority of the learning, both for tutors and students, can happen on the job.

In some of our trials tutors had extensive training and their own PDA to practise on for more than a month before their learners started, to help them prepare. In other trials they started at the same time as their learners. In both scenarios the tutors felt that they did not have enough time to prepare, but there was no significant difference in the trial outcomes.

Does this result mean that there is no need for training? No. But what it does mean is that students are prepared to go on a learning journey together with their tutor. And that m-learning can still be a powerful tool when the tutor is only half a step ahead.

#### **4. Different learning approaches**

Much of the research and trialling has been carried out to establish whether mobile technology can be used as a motivating force, particularly with those disengaged from traditional education. However, it is becoming increasingly clear that this method of teaching and learning has a far wider application.

Broadly, m-learning seems to have a place at all stages of the accepted learning process:

##### **Engage > Assess > Teach > Practice > Assess**

**Engage:** The original m-learning project focused on the engagement of reluctant learners. The research clearly indicated that m-learning has a motivating appeal was confirmed in the NRDC Maths4Life Pathfinder (Colley & Tomlin 2005). The novelty and status of the devices, as well as the visual and auditory appeal of the materials, seem to be key factors.

**Assess:** Using m-learning to assess skills has several advantages:

- You can use the devices privately and in your own time.
- M-learning assessment is less threatening than paper-based screeners and initial assessments for new learners.
- M-learning is not as intimidating as computer-based assessment, which suits learners who are not comfortable with ICT.

M-learning screeners and assessments could be presented in a comfortable, informal environment and could be in a visually attractive 'health check' mode or in a form which more closely resembles the multiple-choice National Test format.

**Teach:** M-learning uses new, developing technologies. Consequently the appropriate pedagogy is also only beginning to form. It is clear that m-learning has a role in assessment and in practice. Currently, there is some debate as to how effective it can be to instruct or explain. Possibly this connects to deeper worries about ICT 'replacing the teacher', which m-learning certainly does not claim to do. On the other hand, there is some evidence that being able to look at learning as many times as you like, in your own time and at your own pace, might be the ideal way for some learners to understand a concept. As new generations of learners familiar with mobile technology emerge, perhaps this will become clearer.

**Practice:** Having material on your phone or palmtop means that it is always accessible to you. Whenever you have a spare five minutes, you can use it to practise some learning, just as you might choose to play solitaire whilst waiting for a train or bus. Learning materials that are colourful, engaging and stimulating make the learner want to go back and practise many times.

**Assess:** Both formative and summative assessment can be carried out using mobile technology, privately and independently, whenever the learner feels ready. This can be attached to a piece of learning, or larger scale, such as practice tests in literacy and numeracy, in preparation for a formal National Test. Other skills besides literacy or numeracy can also be assessed: for example, knowledge of a particular subject such as driving theory.

## 5. Making it work for you

Driven by the messages in this paper, and unable to match the demand we are encountering for our learning materials, CTAD is busy developing a suite of authoring tools to empower tutors to learn from our lessons, and to create their own, contextualised mobile resources and learning. Below is a preview of some of the current resources available, or in the pipeline:

5.1. **GetMobile CD:** We have collected together almost all the learning materials that have been created for all the projects mentioned above and made them available on a CD, together with a teacher-focused set of resources, instructions, tips and tricks. This was released late 2005 and is available to all.



5.2. **mediaBoard:** One of our most successful tools for collaborative working has been the mediaBoard. It is a flexible, web-based tool which enables tutors to create their own interactive learning tasks and projects. Some fairly typical learning scenarios are

- working as a team to give and receive directions and instructions or negotiate and agree how to solve a problem
- following directions or answering questions to complete a task
- making enquiries, conducting interviews or surveys, and recording speech or other audio
- using photographs and audio
- adding and editing text to create a multimedia web site
- learning about and using the internet and mobile technologies.

Each mediaBoard you set up is a bit like an internet message board that students can send messages, pictures and sounds to from their phones. However, the mediaBoard is a visual image, and the messages, instead of being organised in a linear way or in discussion threads, are collected around different parts of the image, like locations on a map. Users can attach audio, text and images to the zones on their mediaBoard by uploading them from their computer via the



web, by e-mail, or by multimedia message (MMS) from a handheld computer or a mobile phone.

The mediaBoard was first introduced at MLearn2004 in Rome, where all delegates contributed to a live session of capturing and recording media. It is still being used in several projects around the world, and will become commercially available from early 2006.

- 5.3. **SMS Quiz builder:** Many projects across the world have looked at using SMS (text messaging) to deliver learning. Some have succeeded, some have failed. Our most popular and effective approach by far has been to combine different media so that a potential learner is given some initial information not via SMS, but via some other means: a poster, a flier, a book, a projected screen. Included within that information is a short quiz, with a number to text their answers to. A single text message contains all the answers for the entire quiz, and they get a single reply with the results, and follow up information.

This structure has been developed into a standalone web-based authoring tool, first trialled at an all-day authoring workshop at the MLearn2005 conference and available publicly from the start of 2006.

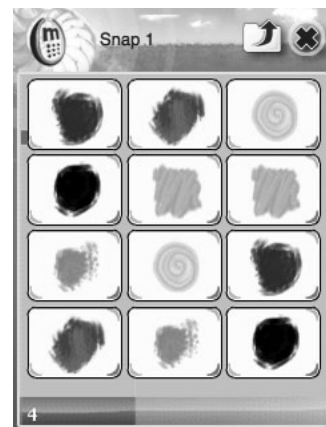
- 5.4. **mobileBuildit:** If you are interested in using larger handheld device like a PDA for your m-learning, it helps to have existing, relevant content to include on it. This is a real challenge because the small, compact nature of all good m-content means that a motivated student can work through lots of it!

We have created over 50 modules of trialled and tested, curriculum mapped content to run on any PocketPC device. Along the way we have developed several templates and frameworks which embed the best practice and learning design that seems most effective.

These templates have been added to a PC-based authoring tool that lets tutors create their own versions, putting in their own content but using our interactivity. The simplest example of this would be a quiz or a PowerPoint-type presentation, though there are several more 'game-like' activities, all of which can now be created by any tutor using our authoring system.

But the content is only the first part. There are three other aspects of creating PDA-ready learning materials that we can help with:

- installing the materials to the device
- helping the student navigate around your materials
- tracking and reporting on use.



All of these are dealt with automatically when you use the authoring tool. When an author creates new materials, at the click of a button these are turned into a full PocketPC installation. When new materials are installed, they get automatically assembled into a shared menu of all other learning materials on that device. And there is the option for different users to keep records of the time they spent on different learning activities.

These three may seem normal for tutors used to e-learning, but they are almost unknown in the offline m-learning world due to rather unwieldy technical

challenges that are beyond even the most technically bold of tutors. With mobileBuildit they are part of the package.

The product is currently being trialled in the UK and Australia, was also used during MLearn2005, and will be available commercially from early 2006.

## 6. Summary

Mobile learning works. We know that it reaches part that other learning does not, which is especially powerful for disadvantaged learners. We are also collecting evidence that the same learning approaches are powerful tools for mainstream learners too. You don't need to be hard to reach to benefit from the empowering effects of being trusted with a mobile device and engaged in creative learning.

We also know that there are many different technology pieces that contribute to the m-learning puzzle. If you are a rural family in Africa, the only technology option available to you is SMS. If you are a refugee in Stockholm you are likely to be able to access the Internet on your phone. Both of these are valid learning tools, but they should be seen and used in different ways.

And finally, a reminder. The first step into m-learning seems to be the most important. In a majority of our trials, the organisations have continued to do their own m-learning long after the trials have finished. The key starting point for them on their m-journeys was taking that first step, and trying it out. Now, many are creating their own learning.

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# Wireless Technologies Bridging the Digital Divide in Education

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## Abstract

*The objective of this paper is to demonstrate how the latest wireless standards and technologies may overcome the digital divide in education in the developed and developing worlds.*

*The concept of the digital divide is discussed in the traditional socio-economic sense and expanded in terms of the learner's location, age, culture and background. It is important that we understand the full extent and complexities of this division if we are to effectively bridge it. Why and how the digital divide may be bridged is examined. Apart from the inherent inequalities that need to be addressed from an ethical perspective, it is very much in the interests of governments and citizens globally that Information and Communications Technology (ICT) is made available to all as quickly and cost-effectively as possible.*

*New forms of wireless protocols are overcoming challenges of terrain, infrastructure and finance. It is proposed that, by leveraging open broadband wireless standards, like Wireless Fidelity (Wi-Fi\*) and Worldwide Interoperability for Microwave Access (WiMAX\*), and implementing Mobile Computing architecture, it is now possible to make dramatic strides in this direction. The paper continues with a general overview of these wireless standards and technologies followed by an in-depth look at Wi-Fi and WiMAX. The paper goes on to give examples of IT Innovation's involvement in delivering solutions and new usage models for eLearning that utilize the latest wireless standards and technologies. The challenges and successes of these projects are outlined and metrics are presented where available.*

*Keywords: digital divide, wireless, WiMAX, Wi-Fi*

## 1. The Digital Divide

The concept of a "Digital Divide" has been around almost as long as ICT has been publicly available. While traditionally it has come to mean a division in society, based on socio-economic factors, this does not "paint the entire picture". Location, age, culture and background also play a significant role in how likely users are to embrace ICT generally and eLearning in particular. There is also concern that some IT-savvy students are not being adequately catered for and a digital gap exists between schools and students. It is important that we understand and bridge the real digital divide going forward.

### **Kofi Annan – Secretary General, United Nations**

**"A digital divide," Mr. Annan said in his Message to the Conference... "threatens to exacerbate already-wide gaps between rich and poor, within and among countries. The stakes are high indeed. **Timely access to news and information can promote trade, education, employment, health and wealth...**"**



*Figure 1. Mr. Kofi Annan on the Digital Divide ["The WiFi (Wireless Fidelity) Opportunity for Developing Nations", The Wireless Internet Institute, 2003]*

By the end of 2004, approximately 700 million people worldwide had access to computing and the Internet. For those people, the effects of digital technology have been profound. However, most of the global population – approximately 6.5 billion people – do not, as yet, have access.

The developing world is particularly affected by the digital divide. For example, as of January 2005, India had 0.4% Internet and 0.2% broadband connection penetration [*Broadband India: Recommendations on Accelerating Growth of Internet and Broadband Penetration*, TRAI Report, 2004]. Obviously, this is extremely low and this country alone accounts for circa 17% of the total global population. However it is ahead on these statistics for Brazil, Russia and China which cumulatively account for a further 25% of the total global population [*2004 World Population Data Sheet*, Population Reference Bureau, 2005].

Often finances are a key issue in accessing ICT, and it is fair to say that the lower socio-economic groups within our communities and those in Less Economically Developed Countries (LEDCs) are often those suffering from ICT deficit.

While the digital divide is commonly classified as a social/political issue referring to the socio-economic gap between communities and countries, it should be remembered that this term also refers to gaps that exist between groups regarding their ability to use ICT effectively. The reasons for this "ability gap" include differing levels of literacy and technical skills, as well as the gap between those groups that have access to relevant, high quality digital content and those that do not.

Cultural issues also play a significant role. Usage models where it is assumed each learner has their own PC, PDA or other mobile device and require Euro/US-styled multimedia content may not be at all suited to the requirements of rural learners in LEDCs who may share ICT equipment and will not identify with the design of the content.

The digital divide extends to sophisticated users who are not adequately catered to in the provision of digital content. This is especially relevant to students at all levels where schools and other educational institutions are not advancing quickly enough to provide content that is relevant to their audience. It is important that educators acknowledge this short-fall and work towards continually improving and enhancing the design and content of ICT components thus driving the "information-wealthy" to new heights.

Finally, social and legal constraints also contribute to this divide. This includes censorship and denial of access. There are a number of countries, including some very populous ones that attempt to strictly control access to the Internet and to Internet resources. The systems used to enforce such constraints, most notably proxy servers, inevitably affect the performance and currency of available data, and inevitably limit the breadth of available information, the range of resources accessed, and the number of people who have access to even that data which has not been proscribed.

## **2. Current Technical Limitations & Advancements**

Practical limitations prevent cable and DSL technologies from reaching many potential broadband customers. Traditional DSL can only reach about three miles from the central office switch while many existing cable networks have not been equipped to provide a return channel. Converting these networks to support high-speed broadband would be expensive. The cost of deploying cable to new areas of low subscriber density would not, in many cases, be commercially feasible and in any case, would take years of disruptive infrastructure installation.

All of these factors are much more acute in developing countries where existing infrastructures are not as advanced and where enormous tracts of economically-deprived land are without infrastructure of any kind.

New forms of wireless protocols are overcoming challenges of terrain, infrastructure and finance. This is especially true in the developing world. By leveraging the Wi-Fi and WiMAX open broadband wireless standards and implementing Mobile Computing architectures, broadband can quickly and cost-effectively be deployed to areas not currently served. This can be done with little or no disruption to existing infrastructures.

### 3. Bridging The Divide

Wireless eLearning is being implemented throughout the developed and developing world. While much good work has been done, there is a sense that much remains to be achieved. While this may be disappointing, it may also be seen as an unprecedented opportunity. Due to technological advances, particularly in the areas of Wi-Fi, WiMAX, Mobile Computing and Voice over IP (VoIP), there are opportunities to reach audiences that heretofore were too remote or for other reasons beyond the digital divide. While technology is now allowing us to access this ever-increasing audience for eLearning, we must ensure that we can reach them in a truly holistic sense. This depends on us understanding the geographic, economic and cultural complexities of those we want to embrace.

**What was once a vast underserved population may be what management guru Dr. CK Prahlad has called “The single biggest market opportunity in the history of commerce.”**

From the social, government and business perspectives, there are many advantages to facilitating those who before now - for whatever reason be it social or geographic - have not been part of the digital revolution. The citizens will benefit from being better informed and included in society thus creating better citizen satisfaction and a more educated populace. The benefits of a larger educated and well-informed workforce will have significant benefits for business and society in general. Bringing streamlined, efficient and effective applications to the technology-savvy user while demystifying technology services for the uninitiated will encourage a dramatic uptake in ICT. Availability of broadband services at affordable price levels will have significant impact on gross domestic product (GDP) and attract new investment, create jobs and a larger more qualified labour pool. In addition, greater availability will increase productivity through infrastructure creation and access to new and improved services.

The Business Case Value Drivers for bridging the digital divide include:

- Lifestyle improvement for citizens regardless of socio-economic status
- High availability of information for all users
- Access to educational resources for a vastly increased user base
- Unprecedented opportunity to exercise entrepreneurial skills regardless of user background

The key question is how the situation can be remedied and what actions will effectively create the digital opportunity? Research at Intel, indicates we are now at an inflection point. This is due to a number of factors:

- The cost of computing is steadily decreasing while growing capacity is being incorporated into a wide variety of form factors at price points within the range of users from a wide variety of socio-economic backgrounds.
- New forms of wireless protocols (Wi-Fi, WiMAX, etc) are overcoming challenges of terrain, infrastructure and finance. This is especially true in the developing world.
- The convergence of computing and communications means that this technology now has the opportunity to facilitate those who traditionally would have been outside its reach due to less developed environments and other demographic factors.

The time is right to focus more explicit and coordinated attention on the issue of Internet access and the attendant educational opportunities.

In parallel to the implementation of technology, digital content developers, designers, subject matter experts (SMEs) and providers need to be mindful of the various levels of ability and sophistication of their audience as well as cultural diversities. We must work to improve the knowledge of the “information-poor”. When providing technologies that attend to the needs of those currently without ICT experience or ICT interest, we must understand that humans will only adopt something for one of two reasons: there is an absolute need for it or they have a personal interest in it. By nature, we don’t like change especially if we feel it is being forced upon us. Cultural diversity must also be taken into account and the “norms” of developed countries must not be automatically assumed to be universal when designing for other cultures. Interestingly, we must also face challenges specific to the “information-wealthy” and continue to be innovative and creative to invent new

exciting products to spur on the appeal of ICT in learning. Our approach to bridging the digital divide must be tactful and information rich.

#### **4. Candidate Wireless Technologies**

By leveraging open broadband wireless standards like Wi-Fi and WiMAX, implementing Mobile Computing (using the Occasionally Connected Computing model) and Intel® Centrino™ mobile technology enabled tools, it is now possible for Governments and Partners to make unprecedented strides towards narrowing the digital divide on a global scale.

Gartner\* predicts that by the year 2008, there will be more than 167 thousand public WLAN hotspots around the globe and over 75 million users worldwide [*"Market Trends Worldwide, 2002-2008"*, Gartner Inc., 2005]. WLAN will provide users with wireless high-speed access while it gives service providers great opportunities to stimulate growth in the wireless data market. Broad coverage and easy access will be critical factors for acceptance and growth of public WLANs.

##### **4.1. Technology Overview**

The proposed open broadband wireless standards are Wi-Fi and WiMAX.

Wi-Fi is a high-speed data networking technology that is being widely deployed in residential, enterprise and public areas worldwide. It brings high-speed Internet access to users of mobile computers and PDAs (and cell phones in the near future) in myriad locations. As a wireless data transmission over radio waves, it broadcasts across the 2.4 and 5GHz bandwidth spectra with speeds of up to 54 Mbps (theoretical) and is designed for coverage from 50 up to 125 meters.

WiMAX is a rapidly maturing broadband delivery technology that provides a wireless backhaul alternative to cable, xDSL and Tx wired options. It is a non-Line-of-Sight (NLoS) point-to-multipoint technology that supports multiple licensed and unlicensed frequencies in the 2-6GHz range. With throughput of up to 75Mbps (theoretical) it has a range of up to 30 miles in ideal conditions although 4-6 miles typically would be the design radius.

Mobile Computing technology is designed to insulate users from network dependencies by making data and applications available when the user is offline. Upon re-connection to the network, information is automatically updated through a data synchronization process. This application architecture enables mobile users to work more productively and conveniently by:

- Adding online/offline functionality which allows users to work anywhere, any time, and to work without disruption, even when network connections are interrupted
- Providing intelligent roaming capabilities when moving from hotspot to hotspot which means users won't waste time reconnecting or lose critical data because of dropped connections
- Enabling the flexibility to access data and applications on various computing devices, whether they are laptops, desktops, handhelds or servers
- Tuning applications to conserve power and maximize performance delivers fast application execution and lets users worry less about running out of battery power

##### **4.2. Technology Options**

The diagram below shows the main network types and the technologies associated with each. Personal Area Networks (PAN), Local Area Networks (LAN), Metropolitan Area Networks (MAN) and Wide Area Networks (WAN) are mapped against ranges and throughputs. We are especially interested in those technologies associated with the LAN, MAN and WAN network architectures.

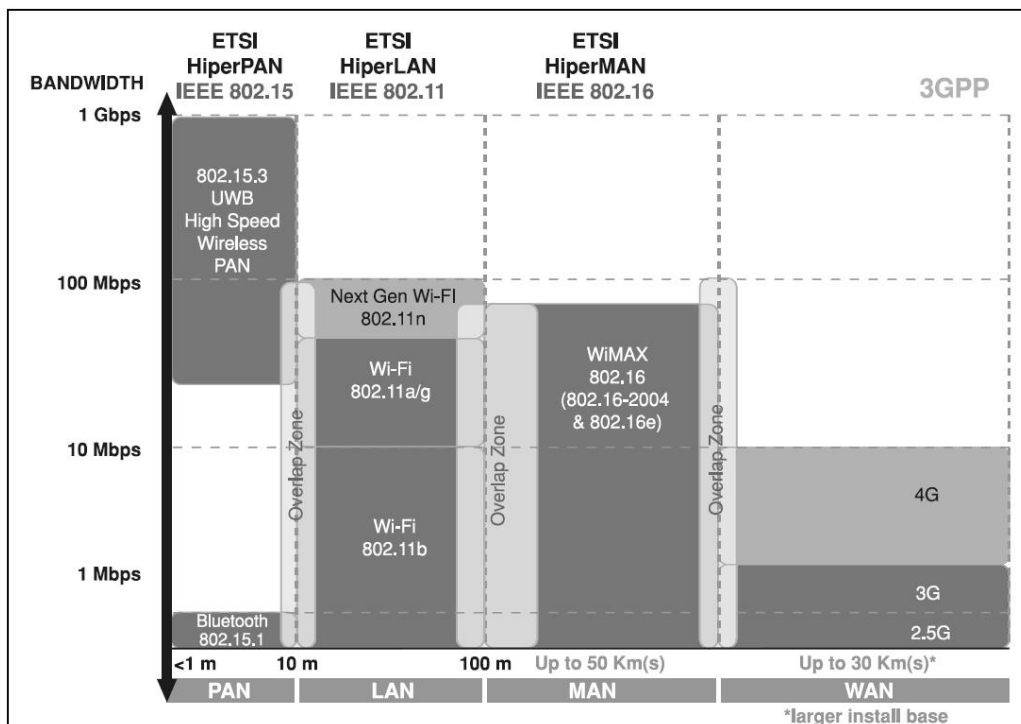


Figure 2. Wireless Technologies: Network Type, Range and Throughput

#### 4.2.1 Wi-Fi

Wi-Fi is a high-speed data networking technology that provides an "over the air" interface between a wireless client and a base station or access point. This technology forms the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard for wireless LANs. The essential subsets of this standard include 802.11a, 802.11b and 802.11g. 802.11a broadcasts in the 5GHz spectrum, is designed for coverage of up to a 50 meter radius and delivers up to 54Mbps. It operates on twelve channels thus minimizing interference. 802.11b and g both broadcast in the 2.4GHz spectrum and are designed for coverage of up to 125 meters. 802.11b delivers up to 11Mbps while 802.11g delivers up to 54Mbps. Both 802.11b and g operate on three channels thus potential sources of interference must be considered at the design stage. Mesh networks (proposed 802.11s standard) are also discussed as a possible architectural implementation of Wi-Fi.

Currently, due to proprietary systems and lack of standardized methods of implementation and security, pre-standard Wi-Fi networks suffer from interoperability issues and connecting can be confusing for users. It should be noted that Intel's goal is to promote a common standards-based approach to address interoperability.

Intel's key Wi-Fi recommendations for operators of public hotspots and service providers include:

- Wi-Fi Protected Access should be adopted as soon as feasible to provide mutual authentication with the Home Provider and session security.
- The framework must accommodate older UAM authentication models while providing coexistence and longer-term migration to more robust schemes based on Wi-Fi Protected Access/802.1X (WPA2).
- Support should be preserved for VPN users to serve the large number of corporate users who use VPN to access their intranet from public networks. In particular, care must be taken to ensure that network address translation (NAT) functionality does not adversely affect VPN.
- If integration of services requires interworking with another network (such as a cellular operator's core data network), Intel recommends a loose coupling between the WLAN hotspot and core network enabled by gateway servers such as EAP-SIM gateways.

- Key distribution between Home Providers and visited networks for wireless link-layer encryption should be secured and cryptographically bound to authentication and session information. Use of IPsec tunnels between RADIUS servers managed by roaming peers is recommended.
- Backhaul requirements should be determined on the basis of actual or expected traffic. However, Intel recommends at minimum a broadband connection (e.g. DSL, cable modem or T1/E1) be present at all hotspots.
- An industry-standard approach to AAA should be adopted to facilitate the establishment of roaming agreements. This allows service providers to extend the availability of WLAN services beyond their own infrastructure and enhance their own footprint with that of roaming partners.

#### 4.2.2 Wireless Mesh Network Solutions

Infrastructure mesh networks combine the characteristics of cellular networks with Wi-Fi technology. The result is a dense mesh architecture capable of cost-effectively and securely delivering broadband data to standard Wi-Fi clients over entire metro-areas. A standard does not currently exist for wireless mesh although work is currently underway towards incorporating a specification under the 802.11 set of standards. The majority of vendors for WLAN equipment have proprietary mesh implementations.

#### 4.2.3 WiMAX

As a rapidly maturing broadband delivery technology, Intel currently supports the ratified 802.16-2004 WiMAX specification for fixed broadband internet access. This specification also provides for an interoperable, carrier-class solution for the "last mile". A wireless alternative to cable modem, xDSL, Tx/Ex, OC-x and similar wireline technologies, WiMAX provides:

- A wireless backhaul alternative
- Point-to-multipoint technology
- Non Line of Sight Connectivity (NLoS)
- Service Area up to 30 miles (typically 4-6 mile radius)
- Up to 280Mbps per base station

IEEE802.16-2004 is the current standard for WiMAX to provide a carrier-class fixed wireless solution. The upcoming IEEE802.16e WiMAX standard will enable support for both fixed and mobile broadband wireless access. Intel recently released its codenamed "Rosedale" WiMAX chip-set, the first of its kind. Currently, communication product manufacturers are incorporating this chipset in their WiMAX products.

WiMAX supports guaranteed service levels and Quality of Service (QoS) and provides built-in security using PKI certificates to authenticate base stations and link level encryption of data (3DES). While WiMAX pre-standard products have been on the market for some time the first 802.16 standard-compliant products are emerging at time of writing.

The 802.16e amendment to the basic specification will enable a base station to support both fixed and mobile broadband wireless access. This aims to fill the gap between high data-rate WLANs and high mobility cellular WANs. This amendment is being ratified in 2005 with products available in 2006.

Robust bandwidth, QoS support and low cost make WiMAX an excellent choice for long distance backhaul applications such as linking Wi-Fi enabled mesh networks and hotspots to the Internet.

### 4.3. The Proposed Solution

By leveraging the Wi-Fi and WiMAX open broadband wireless standards and implementing Mobile Computing architectures, Broadband can quickly and cost-effectively be deployed to areas not currently served. This can be done with little or no disruption to existing infrastructures.

Standards-compliant WLANs and proprietary Wi-Fi Mesh infrastructures are currently being proliferated widely throughout the world. By 2006, standards-compliant WiMAX products will be available to provide NLoS backhaul solutions for these local networks. WiMAX subscriber stations will also be available to provide access to customer premises such as schools and other educational institutions.

Next generation WiMAX and Wi-Fi enabled clients (due in 2007), will be able to directly access legacy proprietary Wi-Fi Mesh networks, newly deployed standards-compliant Wi-Fi Mesh networks and WiMAX networks.

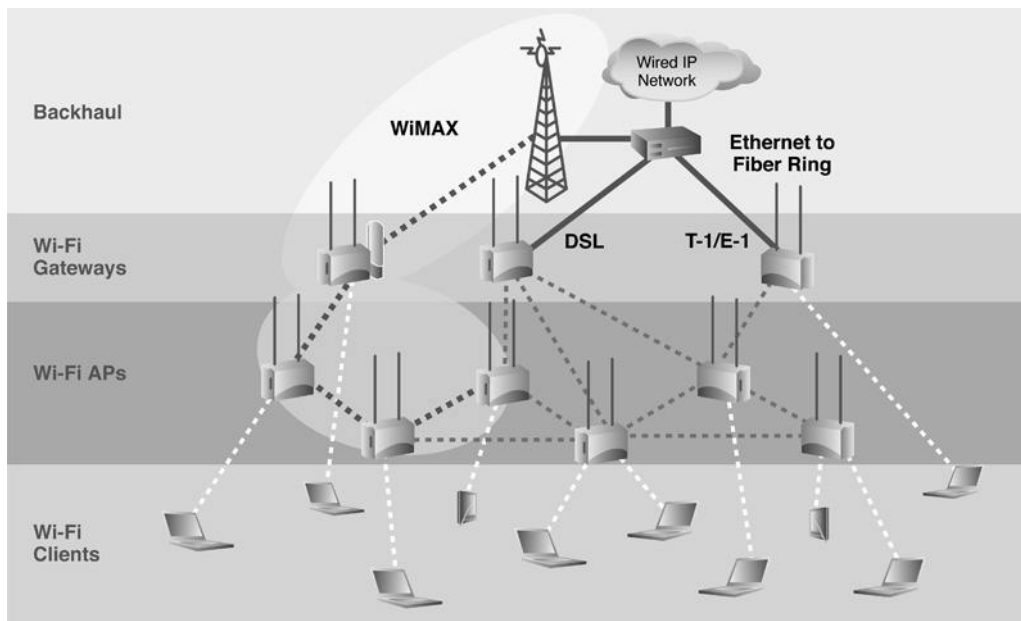


Figure 3. WiMAX and Wi-Fi Integration

This paper proposes that we capitalize on these emerging technologies and standards and work to promote and support their implementation. In doing this, we will surely be laying a solid foundation upon which the digital divide will be bridged.

## 5. eLearning Innovations at Intel

Intel® IT Innovation Centre has been involved in implementing the technologies discussed in several eLearning and wireless projects both domestically and internationally. The following are examples of some of the projects which are at various stages of development.

### 5.1. Digital City Initiative in Developing World

IT Innovation is working with Intel India on presenting a compelling case for the implementation of Digital City initiative in Karnataka, India. Facilitation of education to students and adults, often in remote areas, features strongly in this proposal. The author visited Bangalore and, based on findings, created a comprehensive approach paper. Currently the paper is being assessed by the Government of Karnataka. The Digital City initiative addresses economic vitality, citizen satisfaction and bridging the digital divide.

**"Technology is already transforming lives in India, improving education and fuelling economic growth. We want to support the continuation of these trends," said Intel CEO Craig Barrett.**

### 5.2. Satellite Link for SchoolSat in Ireland

This European Space Agency (ESA\*) project was undertaken in partnership with others and demonstrated the delivery of education-focused Internet services to schools via satellite technologies. The project involved nine post-primary schools in Ireland, in areas poorly served by broadband. At time of writing, research is underway into the implementation of multicast broadband over WiMAX as the next phase to this project.

Although there were no objective measures of learning in this evaluation, all schools reported that they made valid educational uses of the Internet. In some cases, the Internet formed a substantial part of teaching a

particular subject. Teachers' perceptions were that there was real learning benefit, the main one being increased student motivation. Also, in project work, teachers reported an increase in students taking responsibility for their own learning. Teachers using on-line tests reported that these were particularly engaging with weaker students who were anxious to retake tests and increase their scores.

The key barriers reported were:

- Teachers unsure how to use technology especially in a classroom context
- Difficulty in getting access to the computer room
- Worries about time used in working online and relevancy in examination terms

### **5.3. North Rhine-Westphalia (NRW) Challenge**

The North Rhine-Westphalia project is the largest inter-municipal e-government project of its type in Europe. The Zeche Zollverein site was chosen as a pilot program for this project to evaluate the benefits of mobile wireless technology. The solutions are very relevant to educational institutions and include:

- Mobile educational interface for visitors
- Mobile visitor information for administration and visitors
- Mobile security for security guards

### **5.4. WiMAX Broadband Delivery to Schools**

This project is at an early stage at time of writing and, to this author's knowledge, is the first implementation of WiMAX in Ireland in the commercial 3.5GHz range. This project provides wireless broadband to two post-primary and six primary schools within a 7Km radius of the base station. It is not possible to provide any feedback from users on this initiative at this time.

### **5.5. Handheld Device Usage on skool™**

The skool™ learning technology has several live implementations in the UK, Ireland and Sweden.

Work is ongoing in the implementation of online and downloadable learning material for PDA and mobile phone. While Smartphone Learning Objects (LOs) have been successful at the Proof of Concept stage, it is felt that there is not yet a critical mass of students with sophisticated handsets. To date, the pricing of these devices has largely been concentrated on the business community.

Short Message Service (SMS) facilities, e.g. study tips and competitions, have proved very successful with users. Over the course of the school year, a number of SMS campaigns are organised for participating users. To date, exam tips have been the most popular. There is evidence to suggest that SMS / phone delivery type initiatives appeal to students that may be considered border-line performers.

In a recent comprehensive survey of skool™ learning technology in the UK, 67% of KS3 students reported that they had used the SMS service and had used its educational content on PDA while 38% of KS4 students had used the SMS service and 15% had used its content on PDA.

## **6. Conclusion**

Lack of access to ICT leads to a lack of education, wealth and income, in turn leading to lack of access to ICT infrastructure and services and so continues the digital divide. Several socio-economic groups, especially within the developed world, have benefited enormously from the innovative creations of the ICT industry, not least in the arenas of learning and collaboration. By sharing this experience and expanding the key uses of ICT in education to other groups within our own society and in the developing world we can kick-start the beginning of the end for the digital divide.

To date, communications equipment has been expensive and requires good infrastructure to be in place. Rural communities and developing countries often do not have either the necessary infrastructure or the available funding to put such infrastructure in place. With the advent of the new wireless technologies, there is an unprecedented opportunity to remedy this situation at a fraction of the cost, and in a fraction of the time, that would previously have been required.

We are progressing with our initiatives in wireless communications. Going forward we will be developing our existing projects and initiating new ones with specific emphasis on Wi-Fi, WiMAX, Mobile Software Initiative (MSI) and VoIP technologies. In parallel, we will continue to expand the skool™ learning technology to other

geographies worldwide with countries in Africa currently under consideration for deployments of tailored implementations.

Intel® IT Innovation has a unique opportunity to work on both the educational side of eLearning and also the wireless technologies end. It is important that we use our experience and learnings from this to inform and promote the future of eLearning.

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# An Intelligent Mobile Tutoring Tool Enabling Individualisation of Students' Learning Processes

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*Keywords:* mobile learning, tutoring, learning process, agents

## Abstract

*Älykkö is an intelligent mobile tutoring tool for teachers. It enables interaction and tutoring dialogue via mobile devices like mobile phones (SMSs) and PDA's. The tool contains semiautomatic and automatic guidance for learners' learning processes, enabling automatic individualisation of a learning process. In addition, Älykkö contains ready-made-tutoring expressions and a documented tutoring dialogue for teachers' use, in order to reduce the teacher's cognitive load, needed just for memorizing. The tool is created based on the examination of the teachers' pedagogical needs.*

## 1. Introduction

Mobile devices like mobile phones bring new dimensions to vocational education. They extend the learning environment and integrate it with real life environments, where learning can occur in an authentic situation and context (Silander et al. 2004). Existing e-learning products and solutions are mainly technology or content driven and they do not pay enough attention to learners' learning processes and to psychological mechanisms of human's learning. In addition, there is no educational technology designed to work especially as a teacher's tool. New pedagogically advanced software, e.g. cognitive learning tools, learning objects and mobile tutoring applications, and hardware, e.g. mobile educational technology, are needed to support the learners' learning process and to facilitate individual learning based on the needs of contextualised learning.

Our experience shows that pedagogically driven and designed technologies can make difference in the learning settings, if the tools are carefully designed to fit the real users' context and support the individualisation of the students' learning processes. In order to design educational software, the pedagogical foundation is worth of consideration and has to be first defined at some level. The novel step we took in the development process of the Intelligent tutoring tool was to design and create new mPedagogy needed - innovative learning theory and pedagogy suitable for a framework for tutoring students learning in the authentic situation – outside the classrooms or lecture halls.

A pedagogical model for mobile learning should enable adaptation to the various situational contexts of individual's learning, even though on the deepest level, on the level of neuro-cognitive processes, learning can be seen as universal phenomenon. In addition, tutoring of individual's learning process taking place in authentic environments should be based on the design of the learners' individualised learning processes (Koli & Silander 2003).

This paper introduces a mobile intelligent tutoring tool called Älykkö ("egghead"). Älykkö is created based on the examination of the teachers' pedagogical needs for mobile learning, where 52 teachers were peer-interviewed, and based on the pedagogical model developed for mobile learning presented in Chapter 3.

## 2. mPedagogy for Mobile Tutoring and Individualised Learning Processes

There are no widely used pedagogical models or principles of mPedagogy that would give attention to the facilitating of learners learning process by tutoring interventions. When design intentional learning process taking place in real environments new kind of pedagogy are needed especially when developing mobile tutoring practices.

### 2.1. Why mPedagogy is needed in Addition to Methods Used in Web-based Learning

Mobile devices like cellular phones and PDAs bring new dimensions in learning and education. Learning environment extends and integrates to the real environment, when learning can occur in an authentic context. Communication, collaborative knowledge building, observations and finding new innovations describe the student's learning activity in the authentic learning. When using mobile devices, students are able to construct useful knowledge in a real situation.

The past two decades have seen a number of convergences in the field of learning – a convergence that not only applies to the various educational technologies used; but also to the methodologies and the pedagogical principles applied. Educators do not have the same means to influence students in mobile learning as they have in a classroom or even in Web based learning environments. Therefore, it is important to design learning situations from the point of view of the learners rather than from teachers' view.

Learning practices in real environments are influenced by the pedagogical, technical and contextual contexts. Educators have to use different means to foster learning than traditionally have been used. The traditional teaching process does not apply to the mlearning process, because traditional teaching is based on the teacher's teaching process, whereas mobile teaching has to be based on the design of the learner's learning process (Krishnan & Rajamanickam 2005, Koli & Silander 2003, IMS 2003). In mobile learning occurring in authentic environment, situational factors have different influence on the student's learning process than in traditional Web-based distance courses.

## 2.2. AEFIRIP -Pedagogical Model Developed for the Mobile Tutoring

A theoretically constructed pedagogical model called AEFIRIP was developed to be used as a foundation for our development of the intelligent tutoring tool. AEFIRIP is based on the contemporary learning theories and pedagogical models of eLearning, like Progressive Inquiry (Hakkarainen et a. 2001), Activating Instruction (Lonka & Ahola 1995) and Problem Based Learning (see e.g. Albanese & Mitchell 1993), but it is focused on the characteristics of mobile learning. It is meant to be used with different kinds of mobile devices when learning is occurring in authentic situations. In this context, learning is seen as mobile-CSCL (Computer Supported Collaborative Learning, see e.g. Koschmann 1996) that relies on socio-cultural learning theories (Bruner 1985, Vygotsky 1978 and 1986). In addition to the knowledge construction, individual's perception and cognitive processes, like heuristic and logical inference, are heavily emphasized in AEFIRIP.

Although mobile devices can be tools used during the whole knowledge building process, we mainly focus on examining critical elements of tutoring the knowledge building process taking place in the authentic environment. The early phases of knowledge building, like setting up own problems and questions, context creation and externalisation of prior knowledge are heavily emphasized in various pedagogical models. In the AEFIRIP model, mobile technology is seen not just as a mediator of the learning activity or collaboration, but also as a trigger and platform that includes guidance and support for learning methods and the learning process.

AEFIRIP is an acronym for the phases of the pedagogical model design for facilitating mobile tutoring of learning taking place in an authentic environment. AEFIRIP stands for Activation, Externalization, Focusing, Interpretations, Reflection and Information Processing. The following steps of AEFIRIP model, described in Table 1, have been created in order to structure the learning process and tutoring activity needed.

*Table 1. The AEFIRIP pedagogical model for mobile learning and tutoring consists of following phases.*

Phase	Description of activity
<b>1. Activation</b>	<b>Activating student's prior knowledge and cognitive strategies by context creation or e.g. presenting so called activating questions</b>
<b>2. Externalization</b>	<b>Externalization of student's prior knowledge and thinking models. Students become aware of their prior knowledge by making it visible and exposing it to reflection.</b>
<b>3. Focusing</b>	<b>Focusing students perception and cognitive processing in a authentic learning environment according the objectives of the learning situation (e.g. by focusing questions or assignments)</b>
<b>4. Interpretations</b>	<b>Explicit interpretations done by student based on perception and prior knowledge/cognitive strategies as well as situational factors.</b>
<b>5. Reflection</b>	<b>Reflection of own interpretations and situational factors.</b>
<b>6. Information Processing</b>	<b>Information Processing consist of sub learning processes (cognitive processes) such as problem solving, classification, comparison, elaboration etc.</b>

The problems being solved during the mLearning process should be as authentic as possible. The same applies to mobile tutoring and learning assignments that must not be tasks done just for the teacher. Authenticity requires that the culture of professional expertise, i.e., a workplace with authentic tasks, methods, tools, and information sources, should be closely related to tutoring practices. The tutoring and structured learning process makes working in the real environment an intentional and scaffolded learning process needed in order to achieve goals of formal education.

## 3. The Pedagogical Needs and Possibilities of Mobile Learning on Teachers' Perspective

In the conducted study, 52 vocational teachers were peer-interviewed in order to examine, (1.) what kinds of mobile technology applications are needed to promote learning in authentic situations, (2.) what kinds of learning environments or tools would support open and distance learning, as well as (3.), how to facilitate the teachers' work like tutoring and guiding the students' learning processes by advanced mobile technology. The tool Älykkö is created based on the examination of the teachers' pedagogical needs.

### 3.1. Procedure of Teachers' Peer-interview

This pilot study involves 52 teachers who had previous experience in Web-based teaching and were familiar with learning with Web-based open learning environments, like Moodle or WebCT. Teachers were attending to the in-service training organized by the Finnish National Board of Education and they were working with the development projects of Web-based education or learning materials. The majority of the teachers (44) worked in the vocational education institutes of various fields while 8 teachers' backgrounds were a high school teacher or they were developer of elearning on communal level. Regional distribution of participants covered quite widely the whole Finland, both urban and rural areas of the country.

The topic and purpose of the research were first introduced to the teachers and then the peer-interview as the method was introduced to them. The peer-interview is a method where one participant interviews another one and then vice versa. Interview was pre-structured and based on the ready-made questions printed on paper. Participating teachers were given as much time as they needed to complete the interviews, although the average time it took was around 40 minutes.

### 3.2. Results of the Peer-interviews of the Teachers

Our findings are based on the content analysis of the teacher's peer-interviews. The content analysis of the interviews was conducted by using qualitative data analysis software ATLAS.ti. The grounded theory (Glaser & Straus 1967, Straus & Corbin 1994) was used in order to create classes in the analysis process. The answers were classified at the first stage based on the role of the *information and communication technology* (ICT) and students' activity in a learning situation. At the second stage the teachers' answers were examined more closely in order to investigate what kinds of needs and possibilities they would see for using mobile technology in education.

*What kinds of learning environments or tools would support open and distance learning?* Based on the analysis of the interviews, teachers have a noteworthy need for pedagogical software tools (see Table 2) for constructing learning process. There do exist Web-based open learning environments for distance education, but tools for constructing learning process in the Web are deficient. In addition, learning objects and student's learning tools, like mind tools seem to have a significant role in distance education, according to the teachers.

Table 2. Pedagogical applications of information and communication technology needed in order to facilitate distance learning and Web-based education reported by teachers in peer-interviews (25 peer-interviews).

Pedagogical application of ICT needed for distance education	Freq
Software packages for constructing and designing learning process (teacher's tool)	11
Web-based open learning environment	12
Learning objects and learning materials	13
Learning tools for students (cognitive tools and mind tools)	8
Applications for communication, interaction and tutoring	9
Information retrieval / search engines	2

Communication and interaction in learning situations were seen one of the important roles of educational technology as well as tutoring dialogue between teacher and students. There were reported needs for asynchronous and synchronous tools for communication among the students and between a teacher and students.

Teachers participating the interview did not emphasize the role of information retrieval or search on the Web. This might be because of nowadays' Internet search engines (like Google) wide use in Finnish schools. On the other hand, searching the reliable and scientific information from Internet resources, like article databases, is often considered to be too demanding or purposelessness e.g. for the students of vocational educational institutions.

*What kinds of mobile technology and applications are needed to promote learning in authentic situations?* The role of the mobile application and technology in authentic learning situations (learning outside the class room, like learning situations during learning-on-the-job periods) was seen more like using existing computer applications or using mobile devices as a notepad or a recorder (see Table 3). Wireless and mobile devices that have a capability for Internet access were found the most useful.

SMS (Short Message Service) was seen as a good tool for tutoring learning in authentic learning environments. SMS messages could be useful when students have problems or questions to make and messages could also be used for giving instructions to students as well as for writing a learning diary or a learning log book that are stored in the Web environment. The strength of the mobile technology in the authentic learning situations is naturally that it's usable anywhere and at any time.

None of the teachers mentioned a need for learning material accessible via mobile devices like communicators or PDAs, although broadcasting the video image to mobile phones was considered to be useful in authentic learning situations. In

the first place, according the analysis of interviews the pedagogical role of mobile technology and applications in the authentic learning environments is interaction; transmitting instruction to student and tutoring dialogue between a teacher and a student. In addition, there was no indication, that mobile technology and application could be used intelligently in the sense of computer science or that there could be automatic functions or learning tools that would facilitate students learning process.

Table 3. Mobile technology needed to promote learning in the authentic learning situations based on the interviews.

Mobile technology	Freq
Hand-held computers like PDAs or communicators	14
Internet access capable hand-held device	12
Short Message Service capable device (e.g. mobile phone)	8
Capability to store data like own pictures and notes	8
Capability to transmit video image on the hand-held device	5

How to facilitate the teachers' work like tutoring and guiding the students' learning processes by advanced mobile technology? The teachers were also asked how mobile technology would help and facilitate the teachers' work like tutoring and guiding students' learning processes. Answers were focused, not on the technology but on the educational practices that it enables. Implicit assumption was that teachers would have hand-held devices with Internet access and send and receive SMS-messages. The educational practices that mobile technology may be used are shown in Table 4.

Table 4. Mobile technology may be used in following educational practices in order to facilitate teachers' work. Educational practices are classified in 7 classes listed in the left column.

1. Tutoring and guidance of the learning process:	Tutoring by SMSs Blogs Student's inquiries Receiving and answering student's acute questions in problem situations Reaching students rapidly Tutoring by video phone calls Providing help by SMSs if needed Maintaining tutoring dialogue
2. Receiving students products:	Getting students answers to learning tasks / assignments Getting material like pictures and text gather by a student in an authentic environment Easy access to students learning diaries / learning log books Easy access to students observation logs and reports
3. Communication:	Chat One-to-many communication
4. Evaluation / assessment:	Real-time Interaction Student's portfolio Gathering continuous evaluation information on students learning Gathering evaluation information from authentic learning situations
5. Working on open learning environment	
6. Positioning of students (GPS)	
7. Simulations	

Pedagogical needs for using mobile technology in a learning process. On the interviews participants were generally unable to explicitly identified or characterize circumstantial pedagogical needs for use of mobile application and mobile technology, though they had described in the other questions how and what kind of educational mobile technology and educational application should be used in order to promote learning and in order to facilitate teachers' work.

#### 4. Älykkö – An Intelligent Tutoring Tool Enabling Individualised Learning Processes

We have developed an application for tutoring students' individual learning processes, based on the examination of the teachers' pedagogical needs and using AEFIRIP model as a pedagogical framework for the development work and piloting procedures of the system. Älykkö works as a basis for mobile learning and for tutoring dialogue between students and teachers. In addition, it enables the creation of the structure and framework for mobile learning process taking place in authentic environments. Älykkö is a PHP- and MySQL-based application with automatic and semi-automatic tutoring features. It forms an Open Learning Environment (OLE) for both PC and mobile devices. The learning environment is open in the sense that students are able to construct the individual content of learning in the form of the portfolios and communicate with tutors by using the tutoring dialogue log.

#### 4.1. Intelligent Tutoring Agents in Älykkö

Älykkö is primarily a teacher's tool and it provides ready made, pedagogical structure for tutoring processes and scaffolds for learners' learning process. Additionally, it solves many problems related to the teacher's tutoring work making it less time-demanding and focused on pedagogical issues instead of memorizing or document management.

Älykkö provides various features for automatic and semi-automatic tutoring of the learner's learning process. These features are implemented via Tutoring agents that are based on the agent technology utilizing also information got by metasearches done via existing search engines on the Web like Google. Tutoring agents have been pedagogically designed based on the needs analysis done as the peer-interview of the teachers. The features of agents are presented in Table 5.

Table 5. Intelligent agents of Älykkö provide semi-automatic and automatic tutoring.

Agent	Function
<b>1 Triggers</b>	Trigger-agent sends automatic trigger messages to students in order to activate students and bring up new angles. In addition, automatic trigger messages are used to initiate interaction and maintaining dialogue when needed. Triggers are context sensitive.
<b>2 Pre-structured Pedagogical Cycles and Scaffolds</b>	Pre-structured pedagogical cycle scaffolds students learning process. Teachers may define in advance the pedagogical model and/or pedagogical cycle used in automatic tutoring. Agent follows students learning process by observing students dialogue messages and sends automatically tutoring messages according the stage of the pedagogical model. This is used in order to structure students' learning processes and promote students' progress. Tutoring messages are sensitive to individual learning processes. Teachers may use ready-made tutoring expression or define their own messages and pre-structured cycles that works scaffolds for student.
<b>3. On-Demand Tutoring Help</b>	Automatic answers are generated to Students' questions concerning the subject domain and e.g. practical issues of studies by utilizing the information on the FAQ-database and documents defined by the teacher as well as information available via internet search engines. Help, hints and links are provided to a learner on demand. On-demand tutoring agent response to the commands "help me on..." and "give me hint ..." Agent work iteratively in order to ensure appropriate answers for students and simultaneously update FAQ-database. Students rate the relevance of provided answers.
<b>4. Automatic Iterative Tutoring Dialogue / Conversation as Scaffolds</b>	The agent provides focusing and deepening questions to a student based on the student's progress and activity. These questions helps student to get deeper on his/her subject as well as to reflect and develop further his/her conceptual constructions and artifacts. In addition, so called <i>dialogical inquiry questions</i> are sent to students, e.g. "How did you end up to these results?"
<b>5. Tutoring On-Demand Questionnaire</b>	If a student needs more personal tutoring, the agent present questions to the student that the student is supposed to answer. The answers are documented into the database. By answering the questions, students have to consider problem from different angles and try to generate solutions to the problem she/he has. The questions help students to see a larger picture and organize pieces of information he/she has. If the student still needs further tutoring, student's answers are transmitted by an email to the teacher who can reply and advice the student. Student's answers provide to the teacher the necessary information needed in order to give effective tutoring.
<b>6. Indicators of tutoring dialogue and relevance of students answers on learning tasks</b>	The agent provides various indicators of tutoring dialogue related to a student's activity, conceptual density and conceptual centrality of content of dialogue. In addition indicators are used to describe relevance to students answer to learning task or assignments. Indicators are presented as visual symbols, numerical values and textual metaphors.

The gents of Älykkö utilize computational measures *conceptual centrality* and *conceptual density* and *conceptual relevance*. These measure are calculated based on the quantitative results got from metasearches via existing search engines on the Web, either focusing on the result based on the whole Web or the documents assigned by a teacher, or both. Teachers can also specify relevant issues to the subject (e.g. in the form of concept map).

The indicators are provided automatically based on a student's answers by the agent described in Table 5. Indicators have chosen so, that they would facilitate students learning process by providing scaffolds like semantic indicators and questions that support learner to develop her/his constructions further. In this setting agents enable enriched individual learning process supported by automatic tutoring.

#### 4.2. Functionalities of Älykkö

Älykkö consists of a portfolio, a documented tutoring dialogue that could be compared to a shared blog between a learner and a tutor and various aids and tools for teachers in order to enable easy, but still pedagogically effective

tutoring and guidance for the individuals' learning processes. Älykkö provides both a Web interface (Figure 1) and a mobile interface via SMS-messaging and Multimedia messaging enabling tutoring and learning taking place in authentic environments, like working places. Communicators and PDAs with GPRS-data and web-connection naturally may be used with Älykkö. Älykkö is also designed to be used as an extension to a Web-based learning environment like Moodle, but it can be used individually or with various other Web-based open learning environments.

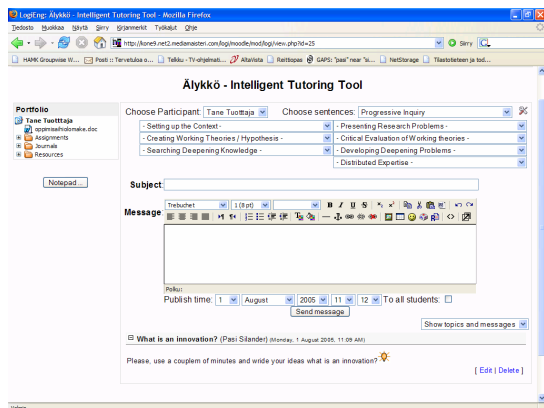


Figure 1. The Web interface for Älykkö.

### 4.3. Technical Implementation of Älykkö

The Älykkö application consists of the PHP module and the Agents module and the database shared with the PHP Scripts and Agents modules (see Figure 2). Sent SMS messages are transmitted to the IP-based SMS gateway by teleoperators. The SMS gateway processes the SMS messages and directs them, based on the command used in the message, to the selected PHP script and executes the script. The PHP module is used to process user commands and to update the learning dialogue and evoke the agents. In addition, the PHP module handles the sending of notification messages to users' mobile phones via the SMS gateway, as well as sending tutoring messages i.e. the messages sent from the Web interface and messages sent from mobile phones.

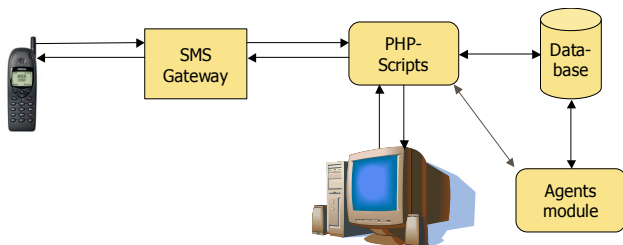


Figure 2. The general technical architecture of Älykkö.

## 5. Conclusions and Further Perspectives

We conclude that mobile technology and applications may have various pedagogical roles in tutoring activity in a learning setting, but the roles are affected by the context of the learning process, like learning tasks and pedagogical methods, not by the mobile technology itself. The results of committed study show that teachers are, in addition the traditional use of ICT in education, willing to use mobile technology in various domain fields enabling various learners' cognitive processes that facilitate learning. Noteworthy is that the mobile devices alone do not give any functional support to the most of these pedagogical roles or to students' cognitive processes: teachers' intensive effort or intelligent mobile tutoring tools are needed in order to provide this support. None of the interviewed teachers mentioned that mobile learning application could have intelligent or automatic properties, even though they described situations and educational practices where automatic and intelligent tutoring would be the solution. Teachers' structured peer-interviews worked as a notable ground for educational software development, but in order to design intelligent educational technology, the expertise of computer scientists plays the significant role.

We have proposed a pedagogical model for mobile learning called AEFIRIP that relies on the contemporary models of elearning and socio-cultural learning theories. AEFIRIP is focus on the mobile tutoring practices that facilitate individual learning processes taking place in authentic environments. The AEFIRIP model has worked as a framework for developing features of intelligent tutoring tool Älykkö. Älykkö consist of intelligent tutoring agents that provides semi-automatic and automatic tutoring as well as indicators based on student's learning process enabling individualised tutoring process for students, even without teacher's virtual present.

Formative research combining both, developing of hard (new educational technology and software) infrastructures and developing soft (new pedagogical and learning methods) infrastructures is most decidedly needed in order to create and implement successful educational technologies. The emphasis should be on the educational technologies that are easy to implement various contexts and conditions of learning and offers pedagogically meaningful added value. The next step probably is to find precisely, which are the most distinctive features of the tutoring learning process occurring in authentic learning environment with Älykkö and how they could be incorporated in the user model.

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## **Towards a Theory of Mobile Learning**

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There is a need to re-conceptualise learning for the mobile age, to recognise the essential role of mobility and communication in the process of learning, and also to indicate the importance of context in establishing meaning, and the transformative effect of digital networks in supporting virtual communities that transcend barriers of age and culture.

In this paper we offer a framework for theorising about mobile learning, to complement theories of infant, classroom, workplace and informal learning. A related aim is to inform the design of new environments and technologies to support mobile learning, since the work described here has been developed through a series of projects to design mobile learning technology.

In the tradition of Activity Theory we analyse learning as a cultural-historical activity system, mediated by tools that both constrain and support the learners in their goals of transforming their knowledge and skills. We separate two perspectives, or layers, of tool-mediated activity. The semiotic layer describes learning as a semiotic system in which the learner's object-oriented actions are mediated by cultural tools and signs. The technological layer represents learning as an engagement with technology, in which tools such as computers and mobile phones function as interactive agents in the process of coming to know.

These layers can be prised apart, to provide either a semiotic framework to promote discussion with educational theorists to analyse learning in the mobile age, or a technological framework for software developers and engineers to propose requirements for the design and evaluation of new mobile learning systems. Or the layers can be superimposed to examine the dynamics and co-evolution of learning and technology.

*Keywords: theory of mobile learning; activity theory; design of mobile learning systems*



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Many theories of learning have been advanced over the 2500 years between Confucius and the present day, but almost all have been predicated on the assumption that learning occurs in a school classroom, mediated by a trained teacher. A few educational thinkers have developed theory-based accounts of learning outside the classroom, including Argyris (Argyris & Schön, 1996), Friere (Freire, 1972), Illich (Illich, 1971), and Knowles (Knowles & Associates, 1984), but none have emphasised the mobility of learners and learning. For example, a search of the extensive and authoritative Encyclopaedia of Informal Learning ([www.infed.co.uk](http://www.infed.co.uk), accessed June 2005) shows no reference to mobile learning.

The objective of this paper is to offer an initial framework for theorising about mobile learning, to complement theories of infant, classroom, workplace and informal learning. A related aim is to inform the design of new environments and technologies to support mobile learning, since the work described here has been developed through a series of projects to design technology for mobile learning, including MOBIlearn ([www.mobilearn.org](http://www.mobilearn.org)), Caerus ([www.caerus.bham.ac.uk](http://www.caerus.bham.ac.uk)), Kleos (Vavoula, 2004) and Interactive Logbook ([www.il.bham.ac.uk](http://www.il.bham.ac.uk)).

A first step in postulating a theory of mobile learning is to distinguish what is special about mobile learning compared to other types of learning activity. An obvious, yet essential, difference is that it starts from the assumption that learners are continually on the move. We learn across space as we take ideas and learning resources gained in one location and apply or develop them in another. We learn across time, by revisiting knowledge that was gained earlier in a different context, and more broadly, through ideas and strategies gained in early years providing a framework for a lifetime of learning. We move from topic to topic, managing a range of personal learning projects, rather than following a single curriculum. We also move in and out of engagement with technology, for example as we enter and leave cellphone coverage.

To portray learning as a labile activity is not to separate it from other forms of educational activity, since some aspects of informal and workplace learning are fundamentally mobile in the ways outlined above. Even learners within a school will move from room to room and shift from topic to topic. Rather, it illuminates existing practices of learning from a new angle. By placing mobility of learning as the object of analysis we may understand better how knowledge and skills can be transferred across contexts such as home and school, how learning can be managed across life transitions, and how new technologies can be designed to support a society in which people on the move increasingly try to cram learning into the interstices of daily life.

Second, a theory of mobile learning must therefore embrace the considerable learning that occurs outside classrooms and lecture halls as people initiate and structure their activities to enable educational processes and outcomes. A study by Vavoula (Vavoula, 2005) of everyday adult learning found that 51% of the reported learning episodes took place at home or in the learner's own office at the workplace, i.e. at the learner's usual environment. The rest occurred in the workplace outside the office (21%), outdoors (5%), in a friend's house (2%), or at places of leisure (6%). Other locations reported (14%) included places of worship, the doctor's

surgery, cafes, hobby stores, and cars. Interestingly, only 1% of the self-reported learning occurred on transport, which suggests both that mobile learning is not necessarily associated with physical movement, and conversely that there may be opportunities to design new technology that supports learning during the growing amounts of time that people spend travelling.

A central concern must be to understand how people artfully engage with their surroundings to create impromptu sites of learning. For example, three children with handheld wireless computers disappear under a school table to create a private learning space. Or (in an example from the diary studies) an adult wants to learn how to connect a computer to a printer and so creates a context for learning out of a computer, a printer and a cable on a table in the house, and a friend with some knowledge of computer hardware.

Third, to be of value, a theory of learning must be based on contemporary accounts of practices that enable successful learning. The US National Research Council produced a synthesis of research into educational effectiveness across ages and subject areas (National Research Council, 1999). It concluded that effective learning is:

- *learner centred*: It builds on the skills and knowledge of students, enabling them to reason from their own experience;
- *knowledge centred*: The curriculum is built from sound foundation of validated knowledge, taught efficiently and with inventive use of concepts and methods;
- *assessment centred*: Assessment is matched to the ability of the learners, offering diagnosis and formative guidance that builds on success;
- *community centred*: Successful learners form a mutually promotive community, sharing knowledge and supporting less able students.

These findings broadly match a social-constructivist approach, which views learning as an active process of building knowledge and skills through practice within a supportive community. It comprises not only a process of continual personal development and enrichment, but also the possibility of rapid and radical conceptual change.

Lastly, a theory of mobile learning must take account of the ubiquitous use of personal and shared technology. In the UK, over 75% of the general population and 90% of young adults own mobile phones (Crabtree, 2003). A survey in 2003 at the University of Birmingham found that 43% of students owned laptop computers. These figures mask the huge disparities in access to technology around the world, but they indicate a trend towards ownership of at least one, and for some people two or three, items of powerful mobile technology including mobile phones, cameras, music players and portable computers. A trend relevant to a theory of learning in the mobile world is that some developing countries, particularly in sub-Saharan Africa, are by-passing the fixed network telephony to install cellphone networks to rural areas. These offer the opportunity for people in rural communities not only to make phone calls, but to gain the advantages of mobile services such as text and multimedia messaging.

We are now seeing a well-publicised convergence of mobile technologies, as companies design and market mobile computer-communicators, combining the functions of phone, camera and multimedia wireless computer. Another equally important convergence is occurring between the new personal and mobile technologies and the new conceptions of lifelong learning (Table 1).

<b>New Learning</b>	<b>New Technology</b>
Personalised	Personal
Learner centred	User centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

*Table 1. Convergence between learning and technology*

Just as learning is being re-conceived as a personalised and learner-centred activity (Leadbetter, 2005), so too are new digital technologies offering personalised services such as music play-lists and digital calendars. Just as learning is now regarded as a situated and collaborative activity (Brown, Collins, & Duguid, 1989), occurring wherever people, individually or collectively, have problems to solve or knowledge to share, so mobile networked technology enables people to communicate regardless of their location. Computer technology, like learning, is ubiquitous: computers are embedded in devices such as photocopiers and televisions that perform human-oriented functions (including basic instruction and user guidance) rather than acting as general-purpose computing devices. They are also becoming more durable, in that although the hardware may last only for two or three years, personal software packages and storage formats (such as PDF) evolve through successive versions, with a large measure of backward compatibility. There are now opportunities for people to preserve and organise digital records of their learning over a lifetime (Banks, 2004).

To summarise, we suggest that a theory of mobile learning must be tested against the following criteria:

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?
- Does it cover both formal and informal learning?
- Does it theorise learning as a constructive and social process?
- Does it analyse learning as a personal and situated activity mediated by technology?

As part of the process of developing a theory of mobile learning, the core members of the MOBIlearn European project held a reflection session during its final plenary meeting in January 2005, to discuss what is distinctive about mobile learning and “what do we know now that we didn’t at the start of the project”. MOBIlearn involved 24 partners from the European Community, Israel, Switzerland, USA and Australia to develop new methods and systems for mobile learning. The list below summarises findings from the final reflection session, representing the collective wisdom of twelve research leaders after 30 months of the project.

*It is the learner that is mobile, rather than the technology:* Initially we had focused on the design of specific portable technologies, but a series of studies for MOBIlearn of everyday

learning indicated that the interactions between learning and technology are complex and varied, with learners opportunistically appropriating whatever technology is ready to hand as they move between settings, including mobile and fixed phones, their own and other people's computers, as well as books and notepads.

*Learning is interwoven with other activities as part of everyday life:* Learning cannot easily be separated from other everyday activities such as conversation, reading, or watching television, and these activities can be resources and contexts for learning. It is integrated with non-learning tasks such as shopping or entertainment, it is organised into projects that are interleaved with everyday activities, and learning needs emerge when a person strives to overcome a problem or breakdown in everyday activity (Vavoula, 2004).

*Learning can generate as well as satisfy goals:* Learning can be initiated by external goals (such as a curriculum or study plan), or by a learner's needs and problems, or it can arise out of curiosity or serendipity, prompting the learner to form new goals which may then be explored through formal or informal study.

*The control and management of learning can be distributed:* In a classroom the locus of control over learning remains firmly with the teacher, but for mobile learning it may be distributed across learners, guides, teachers, technologies and resources in the world such as books, buildings, plants and animals.

*Context is constructed by learners through interaction:* To explore the complexity of mobile learning it is necessary to understand the contexts in which it occurs. Context should be seen not as a shell that surrounds the learner at a given time and location, but as a dynamic entity, constructed by the interactions between learners and their environment. For example, visitors to an art gallery continually create contexts for learning from their paths through the paintings, their goals and interests, and the available resources including curators and other visitors.

*Mobile learning can both complement and conflict with formal education:* Learners can extend their classroom learning to homework, field trips, and museum visits by, for example, reviewing teaching material on mobile devices or collecting and analysing information using handheld data probes. They could also disrupt the carefully managed environment of the classroom by bringing into it their own multimedia phones and wireless games machines, to hold private conversations within and outside the school (Sharples, 2002).

*Mobile learning raises deep ethical issues of privacy and ownership:* Systems such as myLifeBits (Gemmell, Williams, Wood, Bell, & Lueder, 2004) provide wearable 'experience organisers' that allow people to record their everyday life as sounds and pictures and then to recall them for later reflection. These have the potential to be powerful tools for lifelong learning and aids for those with failing memories. They may also allow parents or teachers to monitor every intimate detail of learning, so that play and leisure becomes an extension of school activity, to be checked and assessed as continuous records of achievement. This could be seen as a deeply disturbing vision of childhood without privacy, and the first steps have already been taken as companies bring to market electronic tagging devices for parents to track the location of their children.

Although some of the issues above apply more broadly to informal and everyday learning, the distinctive aspects of mobile learning are its mobility, the informally arranged and distributed participants, and the interaction between learning and portable technology. But to see mobile

learning as just another type of educational interaction is to miss its broader significance (Sharples, 2005). Every era of technology has, to some extent, formed education in its own image. In the era of mass print literacy, the textbook was the medium of instruction, and a prime goal of the education system was effective transmission of the canons of scholarship. During the computer era of the past fifty years, education has been re-conceptualised around the construction of knowledge through information processing, modelling and interaction. For the era of mobile technology, we may come to conceive of education as conversation in context, enabled by continual interaction through and with personal and mobile technology.

### A Framework to Analyse Technology-mediated Mobile Learning

In a companion paper (Sharples, 2005) we have developed an analysis of learning as conversation in context, drawing on Dewey’s philosophy of Pragmatic Technology and Pask’s Conversation Theory as foundations on which to build an account of the process of coming to know in a world mediated by mobile technology. Another related paper describes how an early version of the framework has provided a Task Model for mobile learning in the MOBIlearn project (Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006). In the remainder of this paper we describe an application of cultural-historical activity theory to analyse the activity system of mobile learning. We describe the dialectical relationship between technology and learning through an adapted version of Engeström’s expansive activity model (Figure 1) (Engeström, 1987).

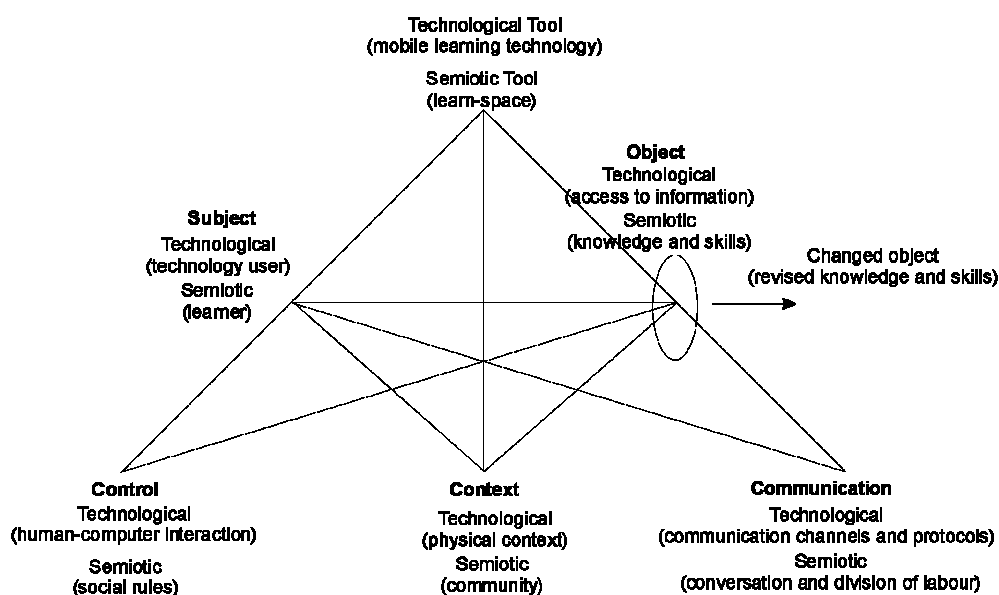


Figure 1. A Framework for analysing mobile learning.

In the tradition of Activity Theory we analyse learning as a cultural-historical activity system, mediated by tools that both constrain and support the learners in their goals of transforming their knowledge and skills. We have found that in analysing the activity of mobile learning it has helped to separate two perspectives, or layers, of tool-mediated activity. The semiotic layer describes learning as a semiotic system in which the learner’s object-oriented actions (i.e. actions to promote an objective) are mediated by cultural tools and signs. The learner internalizes public language, instantiated in writing and conversation, as private thought which then provides the resource for control and development of activity (Vygotsky, 1978). The

technological layer represents learning as an engagement with technology, in which tools such as computers and mobile phones function as interactive agents in the process of coming to know, creating a human-technology system to communicate, to mediate agreements between learners (as with spreadsheets, tables and concept maps) and to aid recall and reflection (as with weblogs and online discussion lists).

These layers can be prised apart, to provide either a semiotic framework to promote discussion with educational theorists to analyse learning in the mobile age, or a technological framework for software developers and engineers to propose requirements for the design and evaluation of new mobile learning systems. Or the layers can be superimposed (as in Figure 1), to examine the holistic system of learning. Here, the semiotic fuses into the technological to form a broader category of technology than physical artefacts. Following Dewey (Hickman, 1990), we could describe technology as any tool that serves the purpose of enquiry, enabling people to address problems in context and to clarify and transform them into new understanding. Thus, hammers, computers, languages and ideas may all qualify as technologies for enquiry, and there is no clear distinction between the semiotic and the technological.

We need to make clear that, for our framework, we are neither proposing the separation of the semiotic and the technological, nor the fusing of the two. Rather, we want to set up a continual dynamic in which the technological and the semiotic can be moved together and apart, creating an engine that drives forward the analysis of mobile learning.

Learning occurs as a socio-cultural system, within which many learners interact to create a collective activity framed by cultural constraints and historical practices. Engeström analyses the collective activity through an expanded framework that shows the interactions between tool-mediated activity and the cultural Rules, Community and Division of Labour. As we have adapted Engeström's framework to show the *dialectical relationship* between technology and semiotics, so we have taken the liberty to rename the cultural factors with terms – Control, Context and Communication – that could be adopted either by learning theorists or by technology designers. Of course, this risks the possibility that the terms will be interpreted differently by both groups and simply lead to misunderstanding and mutual incomprehension, so we shall attempt to clarify their meaning.

### *Control*

The control of learning may rest primarily with one person, usually the teacher, or it may be distributed among the learners. Control may also pass between learners and technology, for example in a dialogue for computer-based instruction. The technological benefit derives from the way in which learning is delivered: whether the learners can access materials when convenient, and whether they can control the pace and style of interaction. These are issues of human-computer interaction design.

However, technology use occurs within a social system of other people and technologies. Social rules and conventions govern what is acceptable (e.g. how to use e-mail, who is allowed to email whom, what kinds of document format should be used). A person's attitudes to technology can be influenced by what others around them think about it, for example, whether they are resentful at having to use the technology or are keen and eager to try it out. And individuals and groups can also express informal rules about the way they like to work and learn.

### *Context*

The context of learning is an important construct, but the term has many connotations for different theorists. From a technological perspective there has been debate about whether context can be isolated and modelled in a computational system, or whether it is an emergent and integral property of interaction. Work for the MOBIlearn project has developed an interactional model of context for mobile learning (Lonsdale, Baber, & Sharples, 2004). Context also embraces the multiple communities of actors (both people and interactive technology) who interact around a shared objective. For a fuller discussion of context and mobile learning, see (Sharples, 2005).

### *Communication*

The dialectical relationship between the technological and semiotic layers is perhaps the easiest to see in relation to Communication. If a technological system enables certain forms of communication (such as email or texting), learners begin to adapt their communication and learning activities accordingly. For example children are increasingly 'going online' at home, creating networks of interaction through phone conversation, texting, email and instant messaging that merge leisure and homework activities into a seamless flow of conversation. As they become familiar with the technology they invent new ways of interacting – 'smilies', text message short forms, the language of instant messaging – that create new rules and exclusive communities. This appropriation of technology not only leads to new ways of learning and working, it also sets up a tension with existing technologies and practices. For example, children can subvert the carefully managed interactions of a school classroom by sending text messages hidden from the teacher. On a broader scale, technology companies see markets for new mobile technology to support interactions such as file sharing and instant messaging. Thus, there is a continual co-evolution of technology and human communication, with each new development creating pressures that drive the next innovation.

### **Conclusions**

The framework described in this paper is a step towards an integrated theory of mobile learning that could inform both the analysis of learning in a mobile world and the design of new technologies and environments for learning. We describe learning as a labile process of 'coming to know' through conversation in context, by which learners in cooperation with peers and teachers construct transiently stable interpretations of their world. Learning is mediated by knowledge and technology as instruments for productive enquiry, in a mutually supportive and dynamically changing relationship. The mediation can be analysed from a technological perspective of human-computer interaction, physical context and digital communication, and from a human perspective of social conventions, community, conversation and division of labour. These two perspectives interact to promote a co-evolution of learning and technology.

We suggest that the implications of this re-conception of education are profound. It describes a cybernetic process of learning through continual exploration of the world and negotiation of meaning, mediated by technology. This can be seen as a challenge to formal schooling, to the autonomy of the classroom and to the curriculum as the means to impart the knowledge and skills needed for adulthood. But it can also be an opportunity to bridge the gulf between formal and experiential learning, opening new possibilities for personal fulfilment and lifelong learning.

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**Title of paper**

The Australian Mobile Learning Network: Australian Innovations

**Category**

Technical Showcases

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## Abstract

This presentation will provide a unique and interactive snapshot of current mLearning initiatives within the education and training sector of Australia.

Innovations in mobile learning include;

**Mobile Learning: Hand Held Innovations in Flexible Learning**, a National New Practices in Flexible Learning initiative, funded by the Australian Flexible Learning Framework and managed by the Institute of TAFE Tasmania.

The project examined the practical and cost effective application of handheld mobile technology (PDA) for the delivery of flexible learning in the workplace. Specialist applications were developed through a joint collaboration between the learning institution, industry, staff and the learners as well as key stakeholders from many industry sectors.

### **QTI m-Player: question and testing interoperability (QTI) player for mobile devices**

Selected businesses and registered training organisations (RTOs) around Australia will be the first in the world to use mobile learning in a secure environment.

It will allow the vocational education and training (VET) system to create assessing instruments for teachers and trainers to test students anywhere and anytime using mobile devices.

**TAFENSW – New England Institute**, another National New Practices in Flexible Learning initiative, which explored three initiatives for Handhelds:

- self-induction offsite by visitors - safety requirements of building sites, via dial-up to a website
- training and assessment in calibration skills for chemical mixing using interaction with a website
- GPS for personal interpretation of points of interest at sites such as zoos and botanical gardens.

**Access and General Education Centre, TAFE NSW** are in research trials engaging clients with m-learning initiatives including an interactive Mobile Film Festival, emailSMS broadcast activities as well as Mo-blogging and Video-blogging for workplace assessment, general education and Indigenous culture and story telling.

**Swan TAFE, Western Australia** conducted research as a New Practices in Flexible Learning initiative, in conjunction with the Australian Flexible Learning Framework (AFLF) in 2004 in the 'TxtMe: Supporting Disengaged Youth Using Mobile Technologies' project explored the dimensions of SMS messaging in the retention of disengaged youth via a collaborative, networked learning environment.

### **TAFENSW Access and General Education Curriculum Centre: EngageMe – Personal and Community Identity Online Project**

TAFE NSW Access General Education Curriculum Centre, in partnership with VIBEWIRE, and OPTUS are engaging young learners in e-learning by using the converged technologies of mlearning and online learning to create learner generated content in an on-line community. Learners generate content by moblogging text and images related to specific learning activities to an on-line site hosted by VIBEWIRE, an online youth media platform. OPTUS (an Australian Telco) provide subsidised rates and equipment for the project.

Young learners are being asked to investigate personal and community identity through images and text, by using the camera and text feature of the mobile phone. Each SMS text is attached to the

images on the phone, the learners then email the images and text from their phones to specific and community moblogging pages on the internet. Groups of learners are then required to review and respond to each others individual and community representations by commenting on-line.

This project has utilized a number of features to engage learners:

- the opportunity for the learner 'voice' to be heard through the use of learner generated content and responses
- social and collaborative learning
- using technologies that the learner group are familiar with and interested in using.

## **The participants**

The participants include 10 groups of 10 learners enrolled in the Certificate 1 in Foundation and Vocational Education (FAVE) and the Certificate 2 in General and Vocational Education (CGVE) . The groups of learners include indigenous groups, and groups from rural and remote areas with one group of learners having been drawn from each of the 10 participating TAFE (Technical and Further Education) NSW Institutes.

The learners in this VET area have some of the following characteristics:

- have come into contact with the juvenile justice system, including youth drug courts
- are homeless
- are long-term unemployed
- have left school early
- are economically disadvantaged
- are from an equity target group (i.e young Aboriginal and Torres Strait Islander people; young people from non-English speaking backgrounds; young women and young people with disabilities, including young people with mental health issues such as depression)
- have significant and/or numeracy difficulties
- are living in a region with a high concentration of economic and social disadvantage
- are living in rural areas
- are geographically or socially isolated.

The project was designed to meet the specific learning needs of the courses that the learners are enrolled in by supporting the achievement of the module 'Community Identity', a module common to both courses (FAVE and CGVE).

The module purpose of Community Identity states:

*"The purpose of this module is for participants to develop an understanding of their place in their community and their rights and responsibilities as active citizens.*

*On successful completion of this module, participants will be able to: investigate identity at personal and community levels"*

By undertaking the project the participants have engaged in learning the concepts of personal as well as community identity and improving literacy skills by practical application; by considering how best to present concepts through the use of learner generated images and the related text that describes these images.

The use of mobile and on-line technology has been a major feature of engagement for the learners as they readily embrace these tools in their everyday life. The project will continue to contribute to the development of foundation skills for learners to successfully continue to further education, or work.

The VIBEWIRE site <http://vibewire.net> , is an online youth media platform that is hosting the moblog, it provides an additional benefit to young learners by giving them access to resources and a sustainable on-line youth community. VIBEWIRE is a not for profit community organization that have provided an online community and events for young people to express themselves through art, politics, film, blogging for the past 10 years

## **The project supports e-learning and other needs of the target learners through**

- Recognising the nature of the community engaged in by young people today, which includes geographically dispersed friendships developed and continued through online technology
- Employing 'connected learning' using familiar and popular technology
- Allowing 'student voice' to be heard and displayed
- Supporting access to technology that may otherwise not be available
- Engaging learners by relating content to their own lives and constructs

Further information can be obtained through the EngageMe project space at:  
<http://engageme.wikispaces.org/>

## **TAFENSW – New England Institute**

A National New Practices in Flexible Learning initiative, which explored three initiatives for Handhelds:

- self-induction offsite by visitors - safety requirements of building sites, via dial-up to a website
- training and assessment in calibration skills for chemical mixing using interaction with a website
- GPS for personal interpretation of points of interest at sites such as zoos and botanical gardens.

### **1. Trial of Handhelds for Building Site Induction**

The trial was held in December 2004. The technology developed for the Handhelds allowed building site managers to construct building site inductions according to prevailing occupational health and safety regulations by uploading information from the Handhelds, including photographic images, to an induction website. Inductees off-site could induct themselves into a building site by dialing the induction website and working through the induction process on their Handhelds. The inductees presented themselves to the building site office for sign off and approval by the administrator that they had completed induction and were free to move around the site.

### **Technology and process**

#### **Technology**

The following technologies were used within this trial:

- O2<sup>®</sup> Xda<sup>®</sup> II personal digital assistant (PDA) with general packet radio service (GPRS) mobile access (code division multiple access [CDMA] version not available)
- *Snap*, a Windows<sup>®</sup>-based handheld device photo storage and retrieval application developed by a member of the project team
- Microsoft<sup>®</sup> Visual Studio<sup>®</sup> 2003 (VB.NET)
- OpenNET CF framework
- Microsoft<sup>®</sup> SQL Server<sup>™</sup> Enterprise Manager
- CodeKeeper .NET<sup>™</sup>
- ASP/ASP .NET
- Microsoft<sup>®</sup> SQL Server<sup>™</sup>

#### **Process**

An overview of the process is illustrated and described below.

#### *Handheld access*



Users login to the site using their personal logon permissions



If a user is not registered then they will fill in their personal details.



A user then selects a site that they would like to be inducted in.



Induction information is then displayed. As many pages as are needed by the site to display relevant OH&S and other safety information.



A final form is displayed allowing the user to agree with the site induction conditions

**Administrator access**

Administrator access to the self-induction resource enables site managers to modify, update, check and approve the resource data that is uploaded to the handheld device resource. The following screen shot displays some of the features of the self-induction resource that the administrator is responsible for including:

- adding new users, employees and trades
- setting user rights (that is, what the user can and cannot access and/or modify)
- adding new sites
- modification of induction content



Screen shot of administrator access options

## Trail outcomes overview

### General comments by building-site staff

General comments made by the staff at the trial building-site were that the handheld technology:

- had great potential of allowing site managers to construct their site-inductions 'on-the-fly' through the ability to incorporate new hazards into the site induction resource as these hazards emerged on the building-site
- would save site manager's time through only having to sign-off a site visitor upon the visitor's successful completion of the induction, rather than having to personally conduct the induction process themselves during a face-to-face meeting with the site visitor.

Clearly, the building-site managers require a system in which they can have confidence that visitors to the building-site have been thoroughly inducted and that the induction process conforms to mandatory requirements and regulations.

Equally, the technology has demonstrated the potential to save subcontractors (and other visitors to the site) considerable onsite time by allowing them to download and undertake the induction themselves, at their convenience, and prior to arriving at the site. In such instances, upon arrival at the site office, the site manager would simply locate the site visitor's name on the system database, see that they had successfully completed the induction and then sign them off as having been inducted.

### Organisational environment

During the trial, several subcontractors visiting the building site were reluctant to take the handhelds with them and to become more familiar with their use due to concerns related to the potential risk of loss or damage of the borrowed hardware.

An implication of this concern for the security of borrowed hardware is the need for the site-induction system to be reconfigured in order that it is able to run on all types of mobile phone-enabled handheld devices, or enhanced mobiles, that may already be owned by a site visitor.

An alternative option that may be considered, in the case of a large organisation such as a large building company, is to issue relevant staff and frequent visitors to their building-sites with a company-specific handheld that they could use during site inductions.

### **Suggestions for improvement**

The following suggestions for improvement of the trialed resource have arisen in response to observations during, and outcomes of, the handheld device site-induction trial.

- The trial site was unfortunately situated within a general packet radio service (GPRS) blackspot, which made dial-up at the building-site difficult. Consequently the handhelds had to be taken off-site in order to dial-up to the website when an upload or download of information was needed. In this situation, availability of a handheld linked to CDMA mobile service provision would have been a more versatile option.
- It is suggested that a self-assessment activity be incorporated within the resource content following each key section of the induction. For example, after providing content that discusses the relevant emergency response plan for the building-site, insert self-assessment questions such as, 'Where is the emergency exit?' and, 'Where are the fire extinguishers located?'. These questions/activities can require the inductee to check-a-box for a multiple choice or true/false answer etcetera. A further suggestion is that the user not be able to proceed with the next section of the induction until the inductee provides the correct answers to a preceding section.
- It is important to consider presentation of induction information in auditory as well visual text forms so as to take account of any literacy issues that the visitor may have. Through inclusion of such, the site visitor would have the option to listen to and view the site induction information, successfully answer the self-assessment questions (perhaps using voice recognition) and proceed through the induction.
- Consideration may also need to be given to the complexity of the language used to present the induction information (either verbally or in text form) in order to take into account the needs of any persons for whom English is not their fluent language.
- As a way of potentially increasing the integrity of the self-induction system, it is suggested that a protocol be established whereby each self-inductee is required to take a photo of themselves, via the handheld, as the first step in the induction process. This photo, together with their induction information, could then be uploaded to the website server. Then, when the visitor presents to the building-site and claims having undertaken the self-induction, the site manager can verify their identity (by examining their photo) in addition to verifying that they have successfully undertaken the induction.

## **2. Trial of Handhelds for Farm Chemical Calibration Skills**

This trial, to be completed in October 2005, involves agricultural industry learners using mobile technology in the field, to develop skills in calibration of equipment and mixing of agricultural chemicals.

Achieving an accurate mix of chemicals is vital to ensure that no harm is done to crops and livestock. Some students and trainees have difficulty with calibration skills because of lower level literacy and numeracy skills.

The process involves students downloading training materials and assessments by dial-up or synced 'cradle' connection to an internet-enabled PC and in turn to the project website. Students are provided with fixed scenarios which have one correct answer and they can then practice working through the calibration equation as many times as they like. They then undertake a specific calibration exercise that is relevant to their context and upload the answer to the website for evaluation by the assessor.

The project aims to 'personalise' the learning experience for students by:

- Providing an engaging learning program to suit the needs of the individual student wherever they are located
- Confirming individual mastery of a task considered important by industry
- Address individual student characteristics, for example lower literacy and numeracy levels by providing clear and accessible information and assessment where possible in audio-visual format to complement text-based information.

- Ensuring individuals receive immediate feedback on self-assessment activities related to a range of scenarios and at least 24-hour response time for summative assessment items.

## Technology and process

### Technology

The PDA software is developed using Microsoft Visual C# using .NET the Compact Framework.

Hardware and software:

- O2<sup>®</sup> Xda<sup>®</sup> II personal digital assistant (PDA) with general packet radio service (GPRS) mobile access (code division multiple access [CDMA] version not available)
- FTP function to transfer data/files to an external server and from the server to the PDA. In this context we are transferring XML and image files to the main server from the PDA and download XML files, Images, PDF and Word Documents to the PDA.
- Camera Capture Function to use the camera capabilities of the PDA.
- SD Cards to store all the data created by the students when working on the PDA.
- XML data used to transfer information to and from the PDA.

The Web Site uses an ftp account to allow secure transfer of data from the PDA to the server. A small database is then used to store all the relevant information created by trainers and students. The web site is developed using ASP and SQL technology to allow dynamic data to be displayed and created once the software transfers the data to the server.

### The Process

The process begins on the web site.

A new Activity or assessment is created.

Assessment Name:

Questions are then added to the Activity.

**New Question**

Title:

Type:

Question:

Value:

Calc:

Position:

Help/Additional Information:

Help Pop:

Type  
Answer: Use this to allow a student to type in a text box answer that you will mark.

Correct Answer: Use this type to allow the PDA to tell the student if they typed in the correct answer. The correct answer must be type into the Correct Value box before saving this item.

Calculation: This type allows you to use the ID numbers of some questions and check if the student answer equals the calculation of these items. You must type in the calculation into the Calculation box before saving this question. NB. ID numbered questions must be before this question and the answers must be numbers with no additional text charactes. eg: A12 + A14 \* A16

True False: True False type allows you to as a true false question and the PDA will let them know if the answer is correct. You must type the correct answer (True or False) into the Correct Answer Box before saving this item.

- A question or task can have an absolute answer. i.e. 26 (The user must type in 26 to get the answer correct)
- Help or additional information can be added to the help box to assist students with difficult questions.



Once all the information is entered into the web site. The tasks are compiled ready for the PDA to download.

The PDA is then inserted into the cradle on a PC that has Internet access. Or connection is made via dial-up to the website.

The user then selects Calibrate TAFE from the start menu on the PDA.



The PDA will check for internet access and then download any new assessments from online. At this time the PDA will also download any new library items (Word Documents, PDF or images) to add to the library.



The PDA will then ask for a student number and name. This creates an XML file on the SD card on the PDA for storage of individual students data. More than one person can use the same PDA using different student numbers.



An XML file of all the assessment questions is then loaded to allow the user to select the activity or assessment that they would like to complete.



The user will then be asked a list of questions or tasks to complete. They enter their answers in the Answer area at the top. (This allows room for the PDA keyboard to be opened.) They then continue through each task.

The options to take a photo using the PDA or view the library are given in the bottom menu bar.

Any photos taken will be transferred up to the server once complete.

If a user turns off the device or the battery goes flat, the data will still be stored on the PDA for next time.

Once the PDA is placed back in the cradle or has dial-up online access a user can start the Calibrate TAFE program and all the user's data and images will be transferred to the server -using FTP (file transfer protocol) - and will be available for the trainer to check.

The data on the PDA is then removed ready for more users.

### Boom Spray Assessment (Name) [14 September 2003 8:21:00 PM]

Area to be sprayed(ha)



Spray tank capacity in litres

Chemical to be used?

What is the minimum desired water application rate (if any)

What chemical rate is to be used?

Appropriate ground speed?

Record spray operation pressure.

Record nozzle type and size.

Record minimum boom height above target.

Record the number of nozzles.

Output (add all nozzles)

Record effective spray width.

Actual ground speed, i.e. The distance covered(m) X 3.6 divided by Time Taken (in seconds)

To calculate Water Application Rate, Total Spray Output (L/min) X 600 divided by Effective Spray Output (Metres) X Actual Ground Speed (km/h)

To calculate the chemical to mix in each tank, Use Chemical Application Rate (Litres/Ha) X Spray Tank Capacity (Litres) divided by Water Application Rate (Litres/Ha)

Use (ha) X (L/ha) = Litres of spray mix divided by Spray Tank Capacity (l) = Tanks.

### Example boomspray scenario

<b>Area to be sprayed</b>	53 ha			
<b>Chemical</b>	Paragon			
<b>Weed</b>	Cape weed (Arctotheca calendula), – 4 leaf growth stage			
<b>Crop</b>	Oats (Cooba Variety) – 5 leaf growth stage			
<b>Tank size of boomspray</b>	600 litres			
<b>Nozzle type/size</b>	Hardi F-110, size 01-orange			
<b>Pressure</b>	3 bar			
<b>Nozzle outputs (mls/minute)</b>	1	400	7	393
	2	415	8	411
	3	412	9	381
	4	429	10	428
	5	408	11	417
	6	427	12	433
<b>Speed calculation information</b>	Distance	100 meters		
	Time	57 secs		

**3. Exploration of the use of GPS and Handhelds.** This initiative provides a walk-through of a prototype process using Handhelds and GPS for instructional or interpretive learning resources in the field, for example in a botanical garden, heritage site or national park. The user positions themselves near a point of interest, and the Handheld provides textual, graphical and audio-visual information and activities related to the point of interest. More information and current updates on this initiative are available at the Australian Mobile Learning Practitioners Network: <http://www.groups.edna.edu.au/course/view.php?id=222>

# The Institute of TAFE Tasmania

## Mobile Learning: Hand Held Innovations in Flexible Learning

This project was inspired by the ongoing advances of handheld mobile technology and its potential to provide a valuable addition to the flexibility of training delivery. It has stimulated new thoughts and directions for the way in which learning can be delivered in the workplace.

The project was a National New Practices in Flexible Learning initiative, funded by the Australian Flexible Learning Framework and managed by the Institute of TAFE Tasmania. It has had a strong industry and community focus with an aim to ensure strong collaboration and mutual learning partnerships between industry organisations, community groups and TAFE Tasmania.

A large proportion of TAFE Tasmania students are workplace trained, creating a strong need for flexible approaches to the way job training is delivered. This includes hand-held on-the-job flexible delivery concepts for normally desk-bound activities, including the use of the World Wide Web and electronic assessment systems, these are just a couple of several ideas that has been examined by this project.

The project has had a strong industry and community focus with an aim to ensure strong collaboration and mutual learning partnerships between industry organisations, community groups and TAFE Tasmania.

### The project has focused on the following areas:

- **Horticulture and Tourism** through the development and trial of four innovative PDA resources for the Royal Tasmanian Botanical Gardens, which included:
  1. **Pete's Vegie Patch**, an information resource based on the Australian media gardening guru Peter Cundall and his popular vegetable garden, which is based in the Tasmanian Botanical Gardens. A statement from the original project report, Ragus (2004) states that 'Pete's Vegie Patch is one of the most visited sites in the RTBG and there is increasing community interest in establishing and growing vegetables in a similar way. The interest in organic gardening at home is undergoing resurgence, with all classes and talks provided by the RTBG dealing with backyard production, being well patronised. The 'Explore the Gardens' tour of Pete's Vegie Patch is one of the most successful of all the classes in the series.' The resource was produced as an interactive interpretive learning resource for those visiting the gardens it was designed in a manner that would enable it to be used by a wide audience including students and older age visitors.

Below are examples of pages within the resource, 1.1, Australian gardening guru Peter Cundall introduces the resource, 1.2, provides the main menu

1.1



1.2

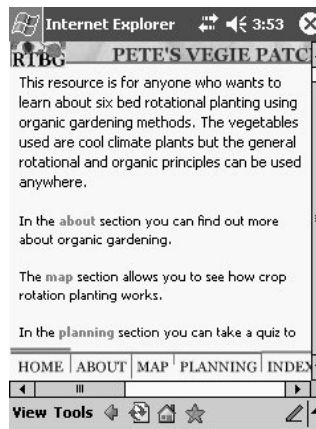
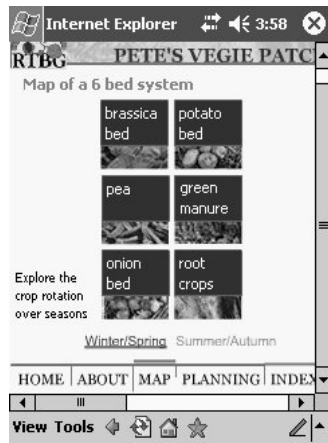


Image 1.3 details the rotational planting system and 1.4, provides a screenshot of the interactive planning tool.

1.3



1.4

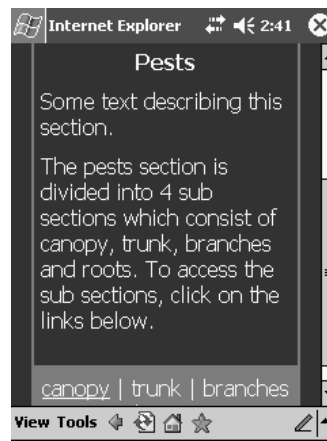


**2. The Catalogue of Tree Disorders**, which provides the user with written and pictorial details on tree disorders found within the Tasmanian Botanical Gardens.

2.1

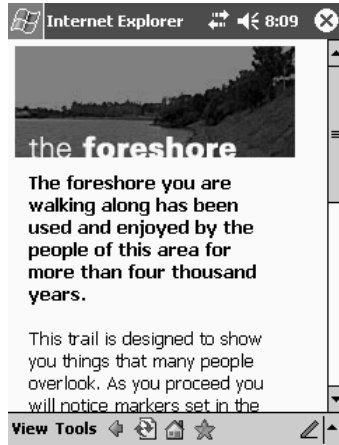


2.2



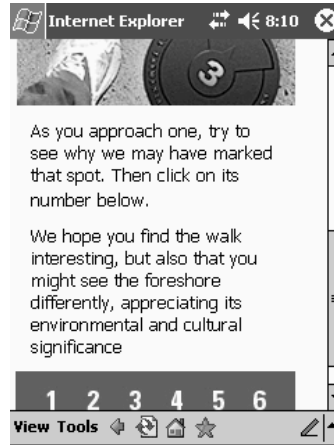
**3. The Foreshore Walk**, an electronic virtual tour guide for use on the Botanical Gardens Indigenous foreshore walk, where areas of the resource are linked to marker points on the trail (image 3.2).

3.1



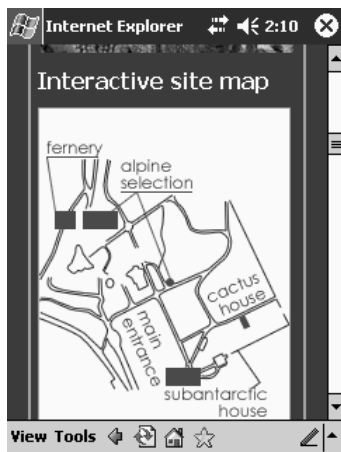
T

3.2



**4. The Plant Adaptation Trial**, provides an interactive interpretive resource for the learner as they make their way through a series of plant environments within the grounds of the Tasmanian Botanical Gardens including, rainforest, subantarctic, alpine and desert. The resource contains a hyperlinked map and a formative self-assessment.

4.1



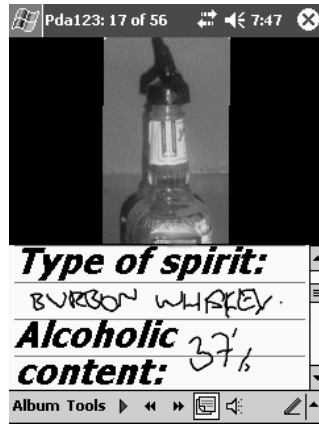
4.2



- **The food and hospitality sector** where trials were conducted as part of the food and hospitality programs run through the Drysdale Institute of TAFE in Hobart. These trials were set up to demonstrate the application of an existing PDA image program known as Conduits® Pocket Album™ that would be used in a unique way to compile a learning resource for the bar and gaming certificate. The learners used the product as a 'just in time' resource in the workplace and could engage with the resource by writing text directly on images (image 1.2) and adding voice files.

1.1

1.2

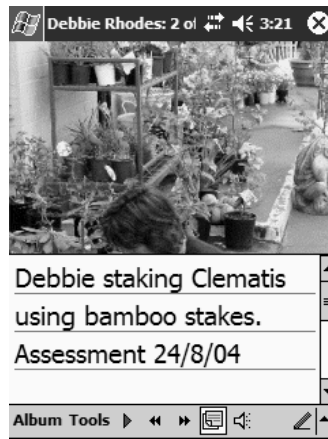


- **Workplace assessment practice** trials were undertaken within the horticulture sector with two specialist assessors. The aim was to use PDAs and a peripheral plug in camera to document assessment activities in the workplace as an evidence capturing exercise.

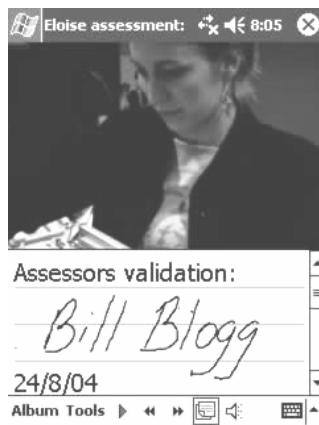
1.1



1.2

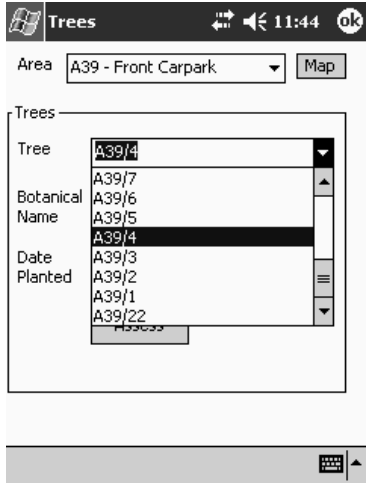


Assessors can validate the images by signing off directly on screen (1.4) or by adding a voice file to the image.



- **Tree evaluation database**

The evaluation database provided an answer to an ongoing issue of double handling of field data at the Royal Tasmanian Botanical Gardens. The program was produced using embedded visual basic for Pocket PC available as a free download from Microsoft®. The completed program enabled the user in the field to enter tree evaluation data on a mobile device and on return to the office the data could then be actively synced to a Microsoft® Access database on a desk top PC. Initial trials in 2004 produced good results with further updates and additional trials to be held later in 2005.



### Technology used

Hewlett Packard IPAQ™ 2210 were used primarily due to their dual memory card expansion options and their cost effectiveness. The peripheral devices included a plug in Hewlett Packard Photosmart™ camera.

### Additional to these trials the overall project also investigated:

- Issues of PDA accessibility for disabled persons
- Use of a PDA for remote mobile connection to weblogs, known as moblogging
- Evaluating the potential for the adaptation of an existing Institute of TAFE Tasmania student sign-up and enrolment database for use on a PDA in the field.

### Outcomes

Feedback from the trials indicated that most who participated were enthusiastic about using the handheld technology for learning within the workplace. The majority of participants indicated that, if provided with the opportunity, they would like to continue using the PDAs for work and as part of their ongoing learning practice.

### Further information, outcomes and case studies from this project:

<http://flexiblelearning.net.au/projects/mobilelearning.htm>

### Project web site:

<http://flexiblelearning.net.au/projects/resources/2005/Mobile%20Learning/resource/index.htm>

## The Institute of TAFE Tasmania QTI m-Player: question and testing interoperability (QTI) player for mobile devices

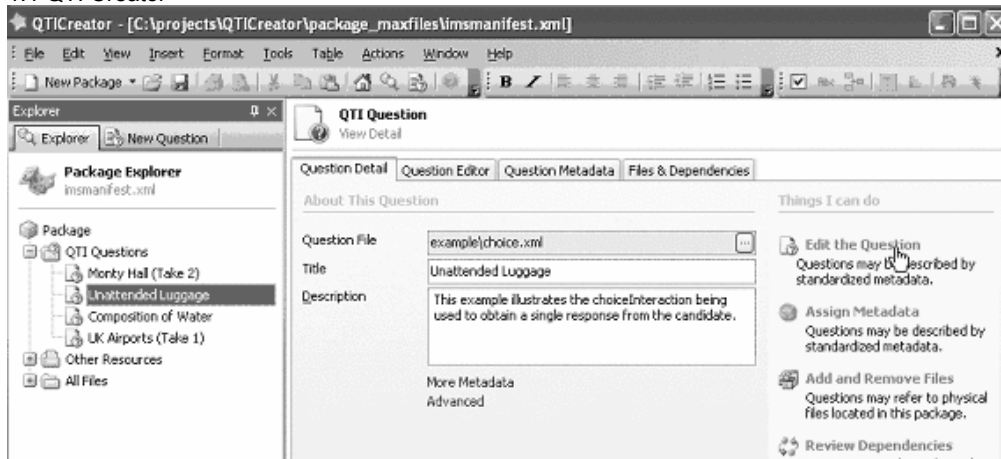
This project is a 2005 Australian Flexible Learning Framework funded, New Practices project. Its basis is to produce product-generating technology such as the QTI Creator™ to generate a wide variety of assessment tools and the capture of reporting in standards-compliant, extractable files on a mobile device.

This application will radically extend the current workflows and possibilities for VET assessment in Australian workplaces, including enabling assessment to:

- Be played and viewed in the format it was created in without variation.
- Span knowledge, learning and performance outcomes.
- Be based on older hardcopy or digital files that are converted into QTI.
- Occur over cellular, wireless, satellite or fixed networks.
- 'Reach' into enterprises where the internal networks are secure and thus prevent access by independent learning management and reporting systems.
- Report assessment results through data synchronisation over multiple different, low bandwidth networks, not just through docking devices.
- Occur whereby the assessor creates tools on a desktop or online environment and then can reuse them in any compliant course management, learning management, or learning content management system; or learning object repository.
- Operate within businesses' internal networks where systems are 'protected' and external LMS access is prohibited.
- Be designed and delivered on mobile devices with metadata aligned to IMS, SCORM or related regimes.

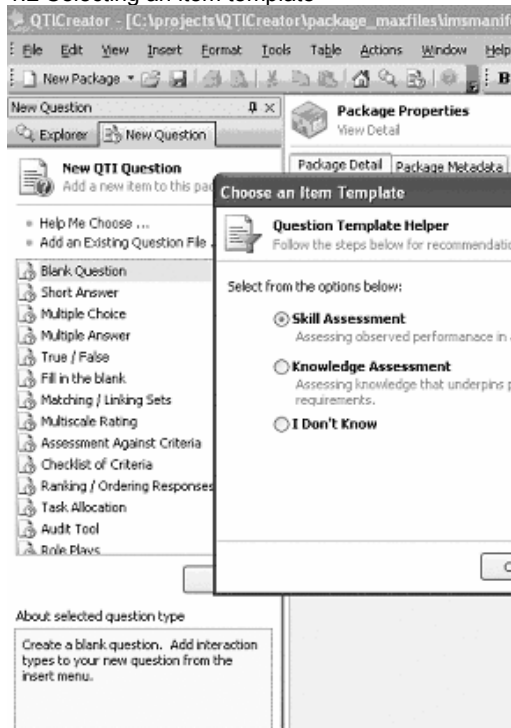
More information at: [http://www.flexiblelearning.net.au/projects/qti\\_m-player.html](http://www.flexiblelearning.net.au/projects/qti_m-player.html)

### 1.1 QTI Creator

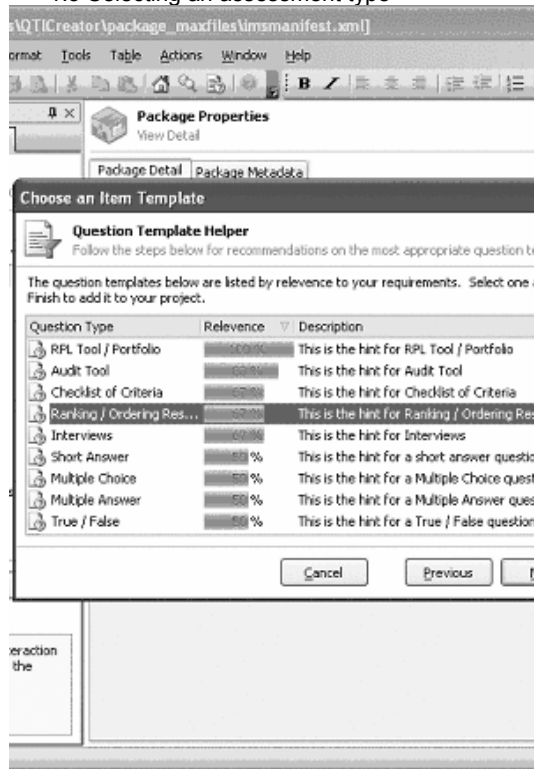




## 1.2 Selecting an item template



## 1.3 Selecting an assessment type



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## **Biography**

### **Alexander Hayes**

*BA (Education)*

*BA (Art)*

*Hons. (Fine Arts)*

*Certificate IV in Workplace Training & Assessment*

Alex Hayes provides consultation services to organizations seeking competitive business solutions which integrate mobile technologies in an educational training context.

Alex draws upon an extensive history of collaboration with government and non government education institutions, telecommunication industry specialists, industry training councils and community based organizations.

Hayes tailors professional development programs to extend upon existing mLearning knowledge in flexible delivery settings, often integrating e-learning discussion forums, workshops, and interactive online events to demonstrate best practice.

Recent and up-coming key note address and mLearning symposium presentations include ;

- Teaching & Technology: mLearning 2005 Symposium - Key Speaker
- DEET Training Forum - Keynote Speaker
- FLAN Conference, West Coast TAFE College WA 2005 - Keynote Speaker
- TRIC Conference, Central West College WA 2005 - Key Speaker
- South West Regional College WA, PD Workshops 2005 - Facilitator
- Killara Youth Support PD Workshops 2004 - Facilitator
- Sixth Annual Best Practice Teaching Forum, Central College WA 2004 - Keynote Speaker
- CSSN Gate Curriculum Advisory Group PD Workshops 2004 - Facilitator
- DEET EVE Pilbarra Regional PD 2004 – Facilitator
- Pilbarra College of TAFE FLAN 2004 – Keynote speaker

## **Biography**

### **Sam Meredith**

*BA (University of Queensland)*

*Grad. Dip. Media (Australian Film Television and Radio School)*

*B Lit. & Comm. (Murdoch University)*

*M Ed. Studies (University of Queensland)*

Sam has more than 20 years experience in provision of flexible education and training, within both the vocational education & training and university sectors.

Sam was an Australian National Training Authority (ANTA) funded Flexible Learning Leader in 2002 researching systems for sharing and trading of learning resources.

Sam has specialist expertise in:

- application of new technologies to teaching and learning
- project management
- instructional design
- systems for developing, storing, accessing and trading learning resources to enhance re-usability
- facilitation of staff development programs
- action learning
- distance education

## **Biography**

### **Anne Paterson**

*M.Ed. Sydney University*

*B.A Education Macquarie University*

*Diploma of Teaching, Technical, Sydney College of Advanced Education*

*Certificate IV Workplace Training and Assessment*

Anne Paterson is a workplace trainer and training consultant with over 20 years experience in general / vocational education training and instructional design.

Anne has experience in providing consultancy services, content design, conference and workshop presentations and professional development in using mobile and wireless communication technology for;

- workplace assessment design and implementation
- just in time training and product information for sales staff
- staff induction and orientation programs
- occupational health and safety and quality procedures
- coaching and mentoring programs
- team and community building
- organizational learning
- knowledge harvesting through the use of blogs, mo-blogs and video-blogs
- engagement of young people in learning
- training of remote and geographically dispersed staff

Anne has tertiary qualifications in Training and Development and Workplace Training and Assessment.

## **Biography**

### **Marcus Ragus**

Associate Diploma Science (Horticulture), Northern Sydney Institute of TAFE, Ryde School of Horticulture

Biology / Applied Science, UTS Sydney

Methods of Instruction, Hunter Institute of Technology, Gosford

Teaching & Learning Diploma, Hobart TAFE

Workplace Trainer II, Hobart TAFE

Workplace Assessor Certificate IV, Hobart TAFE

Marcus has been teaching within the VET sector for over twenty years and has been actively involved with technology for learning for ten of those years.

He is committed to the fundamental principles of workplace training and has been actively acknowledged as a leader in the move to implement training packages as part of real-on-the-job learning.

He has been a consultant to organizations and individuals, specialist committees and industry panels relating to learning innovation, product design and technologies to assist learning

**Recent mLearning projects include:**

Facilitator / Manager National LearnScope Online Special Interest Group 2004

Manager, National New Practices in Learning Project, Mobile Learning Technologies 2004  
<http://www.flexiblelearning.net.au/projects/mobilelearning.htm>

Co-Manager, National New Practices in Learning Project, Mobile Learning QTI player 2005  
[http://www.flexiblelearning.net.au/projects/qti\\_m-player.html](http://www.flexiblelearning.net.au/projects/qti_m-player.html)

Facilitator and Manager for the Networks of the Australian Flexible Learning Community, national M-learning practitioners network project, 2005  
<http://www.groups.edna.edu.au/course/view.php?id=222>

Marcus is a regular speaker, presenter at various learning conferences and symposiums nationally. Current confirmed engagements for 2005 include:

- 2005 Tasmanian Learning and Skills conference,
- Brisbane Adelaide TAFE, July 2005
- AusTAFE Conference 2005, NSW
- FLAN (Flexible Learning and Networking 2005), Western Australia, Perth and Pilbara
- ACPET, Australian Council for Private Education and Training, Adelaide 2005
- ICVET, International Centre for VET Teaching and Learning conference Sydney, 2005
- E-dayz Conference Adelaide 2005
- Botanical Gardens, Australia and New Zealand Congress 2005

## **Biography**

### **Additional project members**

#### **Daniel Dacey**

Daniel has over fifteen years of teaching experience in areas ranging from networking to multimedia. He has worked in almost all areas of Information Technology, including network, PC support, systems analysis, document writing, Project Management and software development. Over the last three years Daniel has been involved with many TAFE related projects as a programmer. He has developed CD-ROM, web and PDA based applications for state and national projects.

In the past year, Daniel has returned to industry, where he is leading a small team building cutting edge software and custom hardware for PDAs and tablet PC's, using GPS technology.

Daniel is a Microsoft certified developer and partner.

**Chris Richter**

[www.crcsmedia.com](http://www.crcsmedia.com)

Chris Richter is the Media Development Manager of Chris Richter Computer Services. Chris has qualifications in Music, Information Technology and Assessment and Workplace Training. Chris has over 6 years experience in developing Online/Web and CD-ROM based training materials. Chris has worked on various projects developing dynamic data driven applications, interactive flash applications and PPC PDA applications specifically tailored to the education sector. Over the past 4 years Chris has provided online learning support to staff and students, staff training in online platforms and media development workshops.

# Design Issues for Dual Device Learning: interactive television and mobile phone

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## Abstract

Designers of technological support for learning have an ever-increasing selection of platforms and devices at their disposal, as desktop computers are joined by mobile phones, PDA's, laptops, games consoles, digital television and wearable devices. It is unlikely that a single technology will be a perfect fit for all aspects of a learning task. Many situations will call on the strengths of a number of devices in combination. However, distributing functionality across different devices may create new problems for interaction and interface designers more used to creating consistency and coherence within a single technology. As an example, we describe the design and development of a system that facilitates language learning from a combination of two devices, interactive television (iTV) and mobile phone, drawing on the strengths of each technology. In particular we discuss some of the user interface design issues to be considered in the context of cross platform dual device systems for ubiquitous learning.

## Keywords

*interaction design, interactive television (iTV), mobile phone, ubiquitous language learning*

## 1. INTRODUCTION

“Beyond the desktop” technologies are currently being harnessed to support many applications for learning - formal and informal, for children and adults, in classrooms and out on field trips, at home and on the move. Each technology of course has distinct characteristics that facilitate some types of use and hamper others. The most successful applications are likely to be those that make the best match between each technology and the function it supports. This may involve distributing the functions of a particular application across different platforms, giving rise to new challenges for the interaction designer who will be called on to produce a design that is coherent and consistent across device boundaries. However, little is known about successful design for such cross-device interactions (Robertson et al, 1996). Each combination, e.g. desktop computer with mobile phone, PDA with wearable device or iTV with Web on PC, will bring different challenges. In this paper we discuss the design and development of the interfaces for TAMALLE, a dual device system for informal language learning. TAMALLE aims to capitalise on the strengths of two technologies, iTV and mobile phones, which tend to be used in different settings. After briefly discussing the potential of mobile and iTV technologies to support language learning, we give a summary of the functionality of TAMALLE with a rationale for its design. We then sketch the interface and interaction constraints involved in designing a unified application accessible via both devices.

## 2. BEYOND THE DESKTOP TECHNOLOGIES FOR LANGUAGE LEARNING

### 2.1. Mobile phones

The potential value of learning via mobile devices or m-learning has been widely realised (Leung & Chan, 2003; Naismith et al, 2005; Sharples, 2000). The mobile phone is a particularly interesting mobile technology for learning technologists as it has been very rapidly adopted by non-technically minded users who would not have ready access to laptop or PDA and has woven itself into the fabric of their everyday life. The mobile phone has the potential to enhance learning experiences by providing two way voice communication, by allowing access to learning materials outside fixed times and places and by supporting information retrieval and capture on the move, now including multimedia information. While many researchers have seen the benefits of mobile devices as a supplement to classroom teaching in formal school and college and training contexts, our main interest is in individual learners in informal (i.e. not necessarily curriculum-bound) settings. Here another characteristic of the mobile phone comes into play, its status as a personal companion device. For language learning in particular this is a valuable characteristic. Second Language learners are often to be found with a dog-eared pocket dictionary or a personal vocabulary book about their person, and the mobile can serve as a very natural digital equivalent of these personal technologies.

Several researchers have begun to investigate the potential of mobile devices for language teaching (Godwin-Jones, 2004; Kadyte, 2003; Tan & Liu, 2004). While many of these projects are oriented towards formal education, others target independent adult learners. One project that successfully exploits some of the strengths of the mobile phone is the INLET project (Pincas, 2004), which developed an innovative mobile phone support system to encourage tourists to learn some Greek language at the Athens Olympic Games. The system provided a number of facilities for learning useful Greek phrases in various categories such as “basic” (e.g. greeting, numbers, basic words), “where” (e.g. phrases for asking direction, going

by bus, taxi and trains), “when” (e.g. asking times, today, now, tomorrow), “Olympic Sport” (games name, athletics, fencing, etc.) and “buying” (asking price, money, expressions like expensive, cheap, etc.). Users, typically recruited at Athens airport, were able to register for free SMS messages containing useful phrases to be sent to their mobile phones each day. They could also request on the spot SMS translations from other languages into Greek.

Projects like this use mobile phones to retrieve information about individual vocabulary items and to interrogate information sources about their current context. For instance, a spectator at the Olympic Games might send an SMS asking how to say “pole vault” in Greek during the field events. Other aspects of mobile phones have proved less popular with general users and tend not to be exploited in research projects. Despite the prevalence of SMS messaging, lack of good input devices tends to restrict the length of text entries on mobile phones, so there is little point in designing a mobile application for extensive text composition. Mobiles also tend not to be used for display of long passages of text for reading, probably because of the small screen size, and although advanced phones are now capable of displaying rich multimedia, video viewing on mobiles has not been widely popular and is therefore probably not a fruitful path to follow in educational projects.

## 2.2. Interactive television

ITV is another new media technology that has great promise for learning (Atwere & Bates, 2003; Pemberton, 2002). Conventional television is already a powerful learning tool for language learners. There is a wealth of anecdotal evidence of individuals learning other languages from exposure to televised soap operas, films and sports reporting. Television offers a rich multimedia experience, where learners can immerse themselves in authentic materials from the target language and culture. This material, unlike some of the stilted exchanges found in text books, tends to be worth watching in its own right, with up-to-date ever-changing content displaying a range of speakers and contexts. Many television shows constitute important cultural events providing a shared reference for people sharing or aspiring to share a culture. In its non-interactive state it is an excellent medium for learners to practice comprehension skills and also to acquire background cultural knowledge (Sherington, 1973).

Subtitling is used on conventional television to support viewing in other languages and also, in the guise of closed captions, to help viewers with hearing problems. Several projects have analysed the use of TV with first and second language subtitles as an aid to comprehension, retention of second language vocabulary and improving reading skills. Studies suggest that even watching TV with an L2 audio track and L1 subtitling could lead to incidental second language learning (Koolstra & Beentjes, 1999; Meinhof, 1998). Koskinen et al (1996) suggest that captioned television can be used as an effective instructional tool in learning vocabulary and concepts. In a study of the effect of captioned television on incidental vocabulary acquisition by adult ESL learners, they assessed vocabulary knowledge in viewers who watched TV with and without captions, identifying “a statistically significant difference in favour of captioned TV” (p.368).

Digital interactive television (iTV) offers new facilities for information retrieval and communications (Gawlinsky, 2003), including the opportunity to go further with subtitling and captioning. The functionality provided by iTV is similar to that provided by simple web sites – mainly hypermedia navigation supplemented by simple interactivity via a return path, enabling voting, buying, mail and so on – but it is displayed on the familiar TV screen. Despite the fact that current levels of interactivity are relatively limited, constrained by the components of the iTV set up, i.e. the set-top box and its software, the on-screen display and the remote control, the potential for developing iTV as a learning technology is clearly vast. This is particularly important for providers aiming to extend learning opportunities to home settings, e.g. traditionally hard to reach groups, such as carers and the disabled, as well as time-poor professionals. Interactive facilities of interest to language learners include:

- Choosing amongst subtitling or captioning options
- Viewing supplementary information on screen – to access before, during or after a broadcast (known as “enhanced TV”)
- Accessing web pages on TV
- Selecting from alternative audio and video streams (e.g. choosing a scientific or generalist commentary stream)
- Using communication tools such as chat and email.

Interactive TV’s strengths, then, are those of conventional TV – provision of current, culturally relevant, video and audio in a leisure setting – plus additional, currently restricted, hypermedia and communication facilities. Like the mobile phone, television has its drawbacks as a technology for language learners. Broadcast TV is schedule-bound, non-interruptible and is often perceived by learners as just too fast (Broady, 1997; Fallahkhair et al, 2004). If a learner is watching alone, using a PVR can remedy this, but at the cost of “liveness”, which may be important in watching some programmes such as a sports fixture or a quiz show with its own interactive services. Television viewing is often a group activity, however, and replay via PVR would be unpopular in this situation. In addition, unlike the mobile phone, television is not normally perceived as a personal companion technology, and of course it is not designed for “any place, any time” interaction. It may be that commercial attempts to deliver TV to the PC and mobile phones will eventually capture the imagination of users, but for the moment our model of television is the traditional one of the TV as “digital hearth” (Moores, 1996).

### 3. TAMALLE PROJECT BACKGROUND

#### 3.1. Learning support

The TAMALLE (TV and Mobile Assisted Language Learning Environment) project was originally planned as a way of testing out the potential of iTV for language learning (Pemberton, 2002). As a result of both our own reflection on the capabilities of the platform and also of feedback from focus group studies with independent adult language learners, we decided instead on a dual device solution combining iTV and mobile phone. The aim of the system is to support advanced learners of English as a second language in their television viewing, as just one element in their language learning activities. As the focus of the learners will be on media consumption rather than on conscious language learning, this support is designed to be as discreet and non-intrusive as possible. The system provides support, in the form of captions and other on-screen displays, for comprehension of specific language (or sometimes cultural) items for viewers as they watch English language programmes. These items can be incorporated by learners into their personal “learning sphere”, a private data storage area, which is accessible both via the TV and on their mobile phone. The mobile can further support learners' understanding of the programme by enabling them to access the summary of programme as well as difficult language and cultural items that may appear in a programme. These language items can be accessed prior to, during and after the show. Viewers are also able to add, search and remove items from/into their personal spheres. Even without television, the mobile service is useful for learning the new recommended language items and as a tool for managing personal knowledge.

The following is a brief overview of the system’s functionality:

#### Just-in-time comprehension support

The “Words in Action” function provides textual annotation similar to subtitles on the television screen. The individual items may explicate a word (e.g. Tory = Conservative) or identify a scene or individual (10 Downing St – the Prime Minister’s residence). The design locates the call-to-action dialogue on the iTV side rather than the mobile phone since this just-in-time support will only be beneficial during the programme show time and not before or after. However, if the learner prefers not to display annotations on the TV screen, perhaps to avoid inconvenience to others or embarrassment to himself, the “Words in Action” content can be delivered to their mobile phone in synchrony with the programme.

#### Recommended language items

Difficult or unusual language items from the dialogue or commentary will also be transcribed for TAMALLE viewers in a static list. Viewers who are logged in may select “Recommended Words” to see a list of language items with explanation, which can also be added to their personal learning sphere. The service is also accessible via mobile phone.

Figure 1: Supporting comprehension of difficult language item across iTV and mobile phones



#### Supporting overall understanding

The viewer’s overall understanding may be improved by having access to a summary of programme content. This will differ according to genre, with the news being summarised as headlines, a drama as a brief plot summary and so on. This is augmented by an on-screen learner dictionary, also available on the mobile phone.

#### Managing personal learning sphere

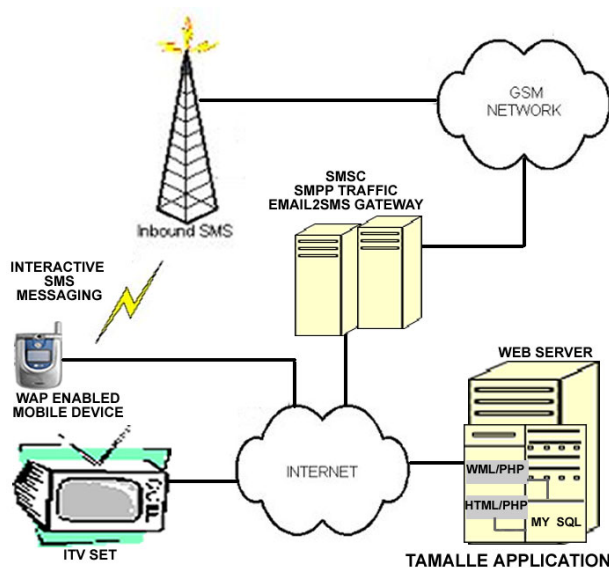


The system enables learners to manage their personal “learning sphere” via both iTV and mobile interfaces. The recommended words can be added to a personal vocabulary list for later practice. Learners can view all their saved language items from the main menu. They can also search for specific language items and remove those no longer wanted.

### 3.2 Technical background

TAMALLE is enabled via a learning management system located in the broadcast-end or back-end tier. This provides content to both set top box and mobile devices and also holds learning content or learning objects in a database on the back-end tier (MySQL). In the front-end tier we have the set top box and WAP enabled mobile devices. Two way communications can be established between set top box and back-end tier through telephone modem, ADSL or broadband cable, while mobile phone devices communicate with the back-end tier through the WAP protocol. For interactive SMS messaging we use an SMS gateway provider, in our case the UK SMS2mail provider (for details see Fallahkhair, 2004). This architecture is sketched in Figure 2:

Figure 2: TAMALLE dual device architecture



## 4. INTERACTION DESIGN ISSUES

We have attempted, in designing TAMALLE, to make best use of the strengths of each device and to distribute functionality and displays appropriately across them. However, another design aim was to provide consistency in terms of look (structure, icons, text) and feel (navigation, interaction) across both devices in order to guarantee the usability of the overall system. Many functions can be carried out via either interface, and it would be too much of a burden on the user to expect them to learn different methods for each device.

The physical characteristics and limitations of the mobile phone and the interactive television system, such as screen size, resolution and memory capacity, place heavy constraints on the possible display options and user interactions, which come as a shock to developers used to the relative freedom of PC and Web environments. The typical contexts of use for each device are a source of further constraints: the TV remote has to be usable while watching TV, with as few distracting “head down” moments as possible, while mobile phones are very often used while on the move or in combination with other tasks. In addition, relatively strong conventions have quickly grown up amongst users and manufacturers of these devices, and designers have to be careful to adhere to platform guidelines so as to avoid upsetting users’ expectations (or in the case of iTV applications, having their service rejected by platform providers). Unlike a PC or Web service, which will probably be the user’s entire focus of attention, TAMALLE will be just one amongst many others – the user will expect them to behave roughly the same as other services on the device.

The conventions of iTV have developed quite independently of those for mobile services, a situation which might cause difficulties for a cross platform design. On the one hand, the system needs internal consistency if it is to be usable, learnable and recognisable as the same application though on a different platform. On the other hand, an iTV service must be consistent with iTV design guidelines if it is to be usable and learnable, and similarly for a mobile service. In this section we set out

design constraints for iTV and mobile services and indicate how they have influenced the TAMALLE design (BBC, 2002; Gawlinsky, 2003; Motorola, 2005; Nokia, 2005).

#### **4.1 Display**

The traditional TV screen has an aspect ratio of 4:3, and within this, an area approximately 592 x 480 pixels is considered “safe” for display, i.e. not in danger of being obscured on a particular set. This leaves a remaining 10% around the edges as a “boundary” area, safe enough for background graphics and so on, but not for key information. Some iTV design involves web-like pages taking up the entire screen, possibly with continuity provided by retaining the audio stream. Other designs involve retaining the video image, typically in the top right hand corner, at one eighth size or larger. Thus textual and other information on an iTV screen tends to be displayed either in an L-shape around the video image, or on a semi-transparent overlay situated to the bottom or side of the full-screen video. A mobile service, on the other hand, once accessed, will typically take up the complete screen, usually, but not always, portrait orientation and may range from 2 x 3 cm upwards. We have tried to display text on the iTV screen in a portrait orientation in a semi-transparent overlay so as to mirror display on a mobile screen.

Text on a TV screen is typically being read from a distance of 2 or 3 metres distance, and needs to be designed with readability at this distance in mind. In the UK, broadcasters have adopted the RNIB’s Tiresias Screenfont as a standard, though Gill Sans, Zurich and other Sans Serif fonts are also seen, with a minimum size of 18 point. Colour combinations have a particularly strong impact on TV screen readability, with highly saturated and strong colours causing “seepage” problems when used in combination. Because of the required font size and the limited screen real estate available, iTV services can display only small amounts of text on a single screen. In addition, complex and detailed graphics display badly on the TV screen. Effects such as bolding or other variants may also go unnoticed.

The mobile screen is similarly limited when it comes to text display, though colour may be used with more confidence. Sans serif fonts such as Arial and Verdana are recommended, and font sizes are typically 5 or 6 point. Short chunks of text are recommended for each device, rather than extended passages. Single screens of information are generally found, though some developers have experimented with more complex layouts such as multiple columns. In terms of screen display, then, both iTV and mobile present very strict limitations, but they are not necessarily at odds with each other. Neither platform can support the reading of large amounts of on-screen text and for graphic design options for text are very constrained. We have tried to keep the design as consistent as possible by using white Tiresias Screenfont on a dark blue background on iTV and the default, rather similar, Arial in black on white for the mobile phone. In addition, although the physical TV screen is obviously much bigger than a mobile screen, it turns out that the amount of text that can reasonably be displayed on each at one time is roughly the same. Problems may arise, however, if the two devices are used together, as the viewer’s eyes will have to change focus very rapidly, which is more difficult for those with short/long sight.

#### **4.2 Navigation and complexity**

Users of both iTV and mobile phone are essentially limited to a menu-style interface. Although menu items may be graphical in some more modern phones, these are really graphical menu labels rather than the addressable icon objects familiar from the desktop metaphor. Vertical navigation in iTV applications tends to be limited to 2 or 3 levels, with some horizontal navigation between sections of longer articles. Hypertext, i.e. links from individual items embedded in a longer run of text, is rarely found. Complex navigation, whose effects are often compounded by latency delays and also by the fact that TV viewers tend to be less focused on the screen than PC users, is disliked by iTV viewers (BBC, 2002). For mobile phones too, shallow navigation structures are recommended, with no hypertext. In designing TAMALLE, these constraints are tackled mainly by simplifying navigation, making navigation controls very salient and minimising the navigation depth. In particular, it was felt important to keep categories and labels consistent across the devices.

#### **4.3 Interaction**

Essentially, interactive viewers can interact with the screen in three ways – navigation, action (e.g. “Set a reminder”, “Delete from my favourites list”) or text editing. The device used is generally the remote control handset, equipped in the UK with a variety of controls depending on the manufacturer. It may include numerical/character keys, four way arrows, an OK button, volume and channel changing controls, possibly with other specialised buttons (e.g. TV guide, teletext) but it will always provide four colour keys – red, green, yellow and blue, always displayed in that order. While the red button tends to be used as the principal “call to action”, i.e. invitation to switch to interactive mode, to such an extent that it is now synonymous with interactivity, it is probably fair to say that the functions of the other three colour buttons, despite platform guidelines (BBC, 2002; Sky, 2005) are not well established and need to be relearned by viewers for each application. Forcing the viewer to look down from the screen to the handset is to be avoided, so designers tend to replicate colour keys, arrows and often numerical keys on-screen, so that the viewer will not have to shift focus. Text entry is tedious (though some viewers use an infrared keyboard) and there has been no TV equivalent of the mobile SMS phenomenon. Mobile phone interaction is constrained in very similar ways. Navigation, action and text entry are achieved via the keypad and arrow keys, with the soft keys playing an important role. Like the TV remote, each mobile handset is different and uses different conventions.

Interaction with the TAMALLE application on the iTV side is via the handset. The red key takes viewers to the home page for the interactive service, in response to a red button on screen as a call to action, the yellow key is labelled Back and leads to the previous page, and the blue key is used to exit the application. Each menu item also has a numerical label allocated to it, giving an alternative selection mechanism. The arrow keys move the selection up and down the list, while the Select key adds a chosen word to a learner's personal sphere. On the mobile phone interface we use the conventions of the phone itself (Motorola): the user can move up and down the list of menu options using the arrow keys and use the right and left soft key to choose an option. The back button in mobile interface mirrors the iTV yellow button. A selected word is highlighted and can be added to the personal sphere by pressing the handset's Select key, giving a reasonable degree of consistency. The use of the mobile and TV in synchronous, co-located mode is currently being investigated, in particular the expectation of co-ordination identified by Robertson et al (1996).

This is an area where the clash of guidelines on consistency is clear. Users expect a new service such as TAMALLE to adhere to platform conventions for their TV and their mobile phone. However, there is no TV handset that currently mirrors works a specific mobile handset, meaning that a consistent interface that crosses devices is not possible. Whether this is a real problem is something we are currently investigating.

#### **4.4 Branding**

Unlike most desktop and web applications, services on iTV and mobile phones co-exist in a commercial environment with services from other providers. As Rondeau puts it, brand competition is prevalent on enhanced mobile phones, "with the device, wireless carrier, data provider, third-party software creator and many others trying to gain brand presence in an already complicated interface" (2005, p. 66). This is also true for commercial iTV, where the set manufacturer (Sony, Philips etc), the platform provider (Sky, NTL), the broadcaster of "families of channels" (e.g. BBC, Home and Leisure), possibly the individual channel broadcaster (BBC3, Home and Leisure Bright Ideas) and the production company are jostling for recognition. Physical branding then becomes a part of the drive for usability, as we try to help the user answer questions about what the service offers, who is providing it, what its relationship is to a broadcast programme, who, if anyone, is asking for payment and so on. In other words, clear branding may help the user develop a clear mental model of the service, which will enhance usability. (This is an opposite perspective from that provided by Spool (1996) who was concerned with the effects of usability on strengthening brands). At the moment we are simply using the word TAMALLE as a brand across both devices, but this is a stopgap measure as we look for a solution that instils brand awareness without confusing or distracting the user.

We have touched on four areas where platform design constraints might have created usability problems in a project combining iTV and mobile phone. Designers targeting this combination of devices are in a way fortunate: they are faced with very limited interaction paradigms, but both devices limit design options in fairly similar ways, demanding small amounts of text, menu based interaction, low complexity and a shallow navigation structure. Branding is a problem for both, but any solution found for one device will probably work on the other.

### **5. FURTHER WORK**

There are many unanswered questions both for TAMALLE and for cross-platform design in general. TAMALLE v. 1.00 is currently undergoing usability and acceptability evaluation, both with usability experts and with potential users. Like cross-platform design, cross platform evaluation is a much more complex challenge than evaluation of desktop applications, with both iTV and mobile phones bringing difficulties in their own right (Isomursu et al, 2004; Pemberton and Griffiths, 2003).

Further issues involve the nature of the content provided to TAMALLE users. We are currently conducting experiments with language learners to derive a set of guidelines for selecting elements of the broadcast material for attention. Without such rules to manipulating marked up video, automating the functionality of TAMALLE, which would be necessary if it is to be widely used and sustainable, will not be possible. We are also investigating the most successful format for summaries for broadcast material in different genres. Other areas for further work include the addition of manual input to the personal learning sphere, use of voice output and the possibilities for adaptivity and personalisation.

As far as cross-platform interaction design is concerned, while the heavily simplified facilities of current iTV and mobile phones mean that a "lowest common denominator" solution is reasonable first response to the problem, this situation will change as interaction possibilities become more sophisticated and as more devices enter the mix. Rondeau, for instance, writes in the context of a sports application to be used "on a variety of devices – mobile phones, PDA's, notebook and desktop computes, and interactive television – that would be used in a variety of settings – at home, while travelling, in a sports stadium" (2005. p. 62). The future for cross-platform learning systems is likely to be no less complex and no less challenging.

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# **TITLE: EFFECTIVENESS OF SMS COMMUNICATION BETWEEN UNIVERSITY AND STUDENTS**

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## **Abstract**

In distance learning, universities can only communicate with the students mainly by post, which at times gets lost or take too long to reach them. In view of unreliability of the post method, this article seeks to explore the probabilities, reliability and cost effectiveness of using another communication method via SMS. Given the fact that majority of Unisa students own cellphones, this article seeks to explore the possibility of using SMS as an alternative means of communicating. This can assist in narrowing the gap of contact between the University and students as the message goes directly to the intended receiver. It will as well present the opinions of students regarding the kind of information they deem necessary to be communicated to them via Short Message (SMS).

## **1. Introduction**

Open and Distance Learning (ODL) is an important method of increasing access to education and training. The University of South Africa (UNISA) is a pioneer provider of ODL in Africa and with enrolment figures of over 100 000 students annually, it is one of the world's mega-universities. UNISA's student population is scattered in all continents globally, though the majority of students are in South Africa (190 061 in 2004) and the rest of the African continent (11 102 in 2004). Communication with and providing support to ODL students, especially those in remote and rural areas and informal settlements with limited infrastructure is however, one of the major problems facing ODL institutions. The postal system, telephones and recently computers are some of the main means of communication in ODL in South Africa. However problems of delay and reliability of the postal system, access and costs of telephone and computers continue to present major challenges for ODL providers and students. The increasing use of mobile/cell-phone short message service (SMS) among South African youth and adults presents opportunities for using this technology in communicating and providing support to ODL students.

This paper reports on the preliminary findings of a collaborative research project between UNISA, Institute for Continuing Education (ICE) and the Commonwealth of Learning (COL).

The aim of this research is to investigate whether and how SMS can be used to improve communication with and/or provide support to students enrolled for the Diploma in Youth Development at UNISA.

## **2. Literature review**

The All-Africa Ministers' Conference on Open Learning and Distance Education held in Cape Town from 1-4 February 2004 acknowledged the contribution of ODL to meeting Africa's particular educational needs and the potential of ODL in providing education at all levels.

Among the recommendations of this meeting on areas that need to be addressed was "collaboration at regional and Pan-African level, including sharing information, experiences and research in Africa and other countries". Presentation of the preliminary findings of UNISA-ICE/COL research to M Learn conference is one way of sharing information at regional, Pan-African and internationally.

Communication between ODL institutions and students presents major challenges. Some of these challenges relate to costs, unsatisfactory services and access to information and communication technologies (ICT) like postage, telephone and computers. In a forthcoming DEASA (the Distance Education Association of Southern Africa) and UNISA Press publication (Dodds 2005) some of the problems mentioned include the fact that:

- Students from remote and rural areas constitute a sizable number in some countries. At the University of Namibia, Centre for External Studies for example, rural students constituted 88,7% of the 1998 student population and these students mentioned isolation from the institution as a major problem (Beukes 2005). In another study from UNAM-CES, 61% of respondents complained that mail from the institution takes too long to reach them and post offices return mail back to sender too soon. (Mowes 2005). In comparison to these two examples, students from the VUDEC study who were mainly teachers reported no problems with the postal system.
- Remote and rural students reside more than 100 kilometers from the nearest learning centre. In 2000, some of the students registered for Institute for Continuing Education's Diploma in Youth Development had to travel more than 800 km to the nearest learning centre in Kimberley (Nonyongo 2004).

It is worth noting that none of the research studies in this important publication produced by a sub-regional ODL association, the Distance Education Association of Southern Africa (DEASA), mentions the usage of SMS as a mechanism for addressing some of the above problems. The late 1990s - 2000 timeframe of the research studies might be the reason for this as at that time SMS usage in some Southern African countries were not as popular as now. Neither was cell-phone coverage as widespread as now. Hence these studies tend to concentrate on the usage of landline telephones, computers and television and some of the difficulties experienced with these ICTs. For example, Hay and Beneke (2005) note in 1998, 81% of VUDEC students who were teachers had no access to audio cassette recorders at school, 89% had no access to television and only 8% has access to a computer.

Research on SMS communication which confirms that SMS communication is quick, efficient, cheap and convenient and it has been used around the world for different purposes.

According to Power (2004) deaf people have taken readily to this technology as they now have the same access to phone communication involving SMS communication as do hearing people.

According to Michael Howie (2004), Trevor Bryant has devised a system that allows pupils to do homework using their phones. They text a number and download the information on the subject. A lot of youngsters have cellphone and use them frequently therefore this present alternatives for ODL that takes SMS communication to include teaching possibilities,

Famborough College use SMS tool to communicate with students and parents about day to day college information such as timetable details, assignment due dates, parents' evenings and college events (Terrettini: 2004).

The above shows that SMSs continue to be used, at schools socially and by people who need to be in contact with each other.

This research study shifts the focus to open and distance learning where there is a need to further bridge the gap of communication between the ODL providing institutions and students through the new and increasingly accessible technologies like cellphones and their SMS service.

### **3. Research Methodology**

A survey of students enrolled for the Diploma in Youth Development during the 2<sup>nd</sup> semester of 2004 was conducted between the months of November 2004 and February 2005.

The students contacted through cell phones had all provided their cell numbers on their UNISA registration forms. These students are enrolled for first and/or second level of the DYD.

The survey questionnaire was, however, sent out to all UNISA DYD second semester students to sensitise all students on UNISA's use of the SMS and in this way encourage them to update their cell phone records at UNISA.

An SMS was sent to inform students on the due date of their examination results and the closing date for the 2005 first semester registration. The text on the SMS read:

"Unisa results for Dip Youth Dev to be released on 13 Dec 2004. Registration for 2005 closes on 1 Feb 2005. Enq: Khomotso (012)4296919"

A questionnaire was later mailed on the 16<sup>th</sup> February 2005 to all DYD students (168 students) to assess the effectiveness of SMS communication. Responses from 57 students were received representing 34% return. This paper reports on the findings from these responses.

The second stage of this research involves surveying the 2005 DYD students. Already three SMSs have been sent to students. The first 2005 SMS was sent in May to 132 students registered for DYD in 2005 encouraging them to send all outstanding assignments. The second SMS was sent to all students before they wrote June/July examinations wishing them luck. The third SMS was sent to students informing them of the date when the results will be released and also the closing date for 2005 second semester registration. Questionnaires are due to be sent to students in August to assess the effectiveness of SMS. The results of these will be compared with the findings contained in this report.

34% questionnaire return rate was regarded as good under the circumstances (many rural students), though the authors would have preferred a higher figure. Telephone follow-up on questionnaire return were made. 53 students (31.4%) had their phones on voice mail or the number did not exist. Voice messages were left for 30 students (17.8%) who did not answer their calls. A second follow-up telephone call to these two groups was made a day after with limited success. Others called back after receiving the voice message.

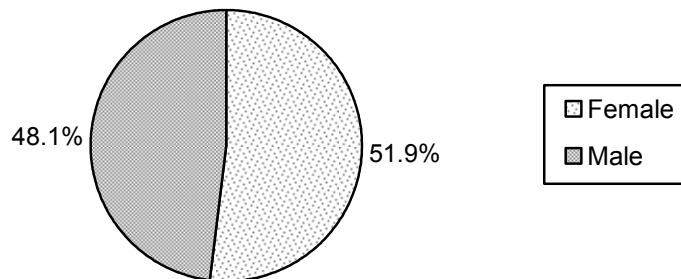
From the questionnaires received, some of the students did not answer all the questions, hence the difference in numbers on the different questions discussed in the findings below. 21% of those who did not answer question 3 and 4 are students who did not receive any SMSs because they did not provide numbers or these had changed. Below are findings from the survey.

## 4. FINDINGS

### 4.1. Demographic details

#### *Gender*

Of the 57 respondents who returned questionnaires, 54 (94.7%) indicated their gender. The gender break down was 30 (51.9%) female and 28 (48.1%) males.

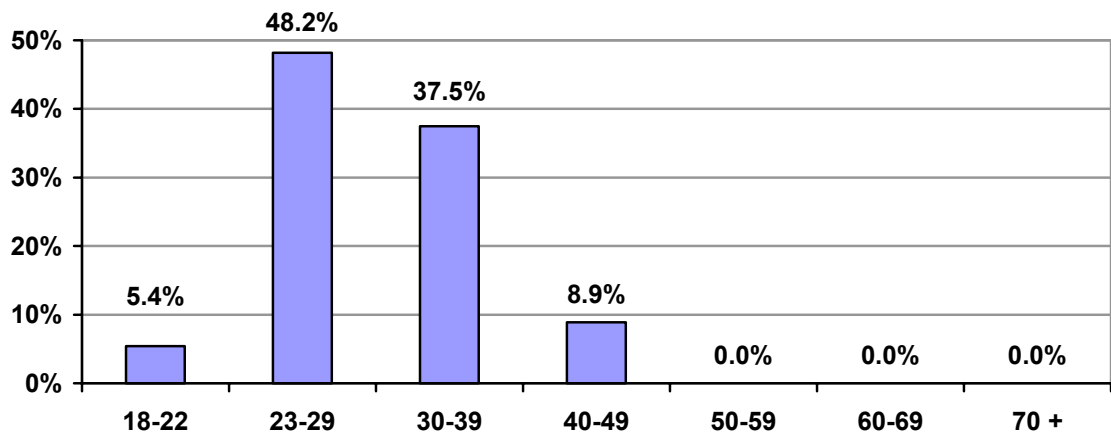


#### *Age*

Number of responses = 54 (98.2%).

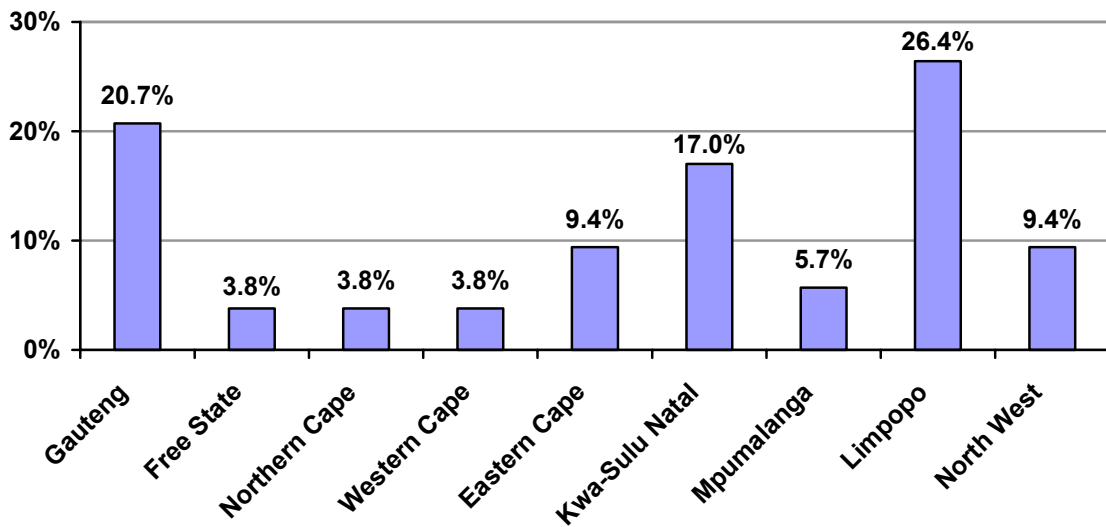
A large majority of the respondents fall under the youth category, that is ages 18 to 35. Looking at students aged between 18 to 29 only, they made up 59.6%. For a youth development programme, this is apposite indicating that the programme is reaching its main target audience. This also confirms the popularity of cell phones among youth.





*Province of Residence*

Number of responses = 53 (92,9%)



This indicates that DYD in all nine South African provinces have cell phones.

Most of the respondents (26.4%) came from the Limpopo Province followed by Gauteng with 20.7%, and KZN with 17%.

The Eastern Cape and North West provinces responses were 9.4 % each.

The lowest responses of 3.8% were from Free State, Northern and Western Cape.

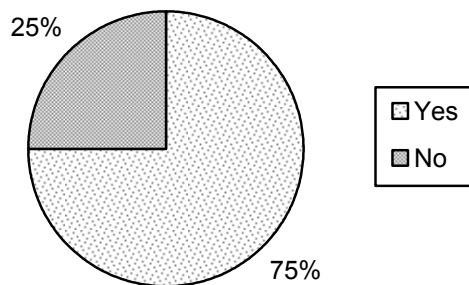
#### 4.2. Views on SMS communication.

The questionnaire also solicited students' views of on various aspects of SMS usage for communication between the institution and students. Responses on questions covering these aspects are summarised below under each of the questions asked.

**Question: Have you received any SMS communication from UNISA?**  
(N = 57 responses)

75% of the responses confirmed receipt of SMS communication.

As indicated above, the questionnaire was sent to all second semester DYD students, that is, including those who had originally not provided cell phone numbers on their registration forms. The 25% no response represents this latter group.



**Question: Have you changed your cell phone number recently? And if so, have you provided your new number to UNISA?**

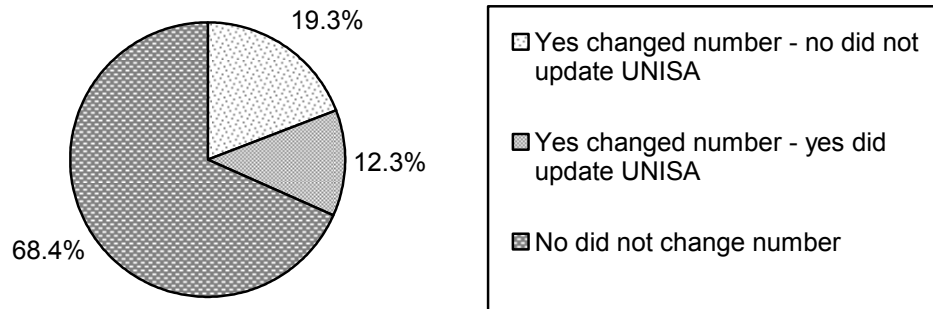
(N =57)

All respondents answered this question.

The cell phone numbers of 80,7% of respondents were current, that is 68,4 % had not changed their number since registration and 12,3% had changed numbers and informed UNISA.

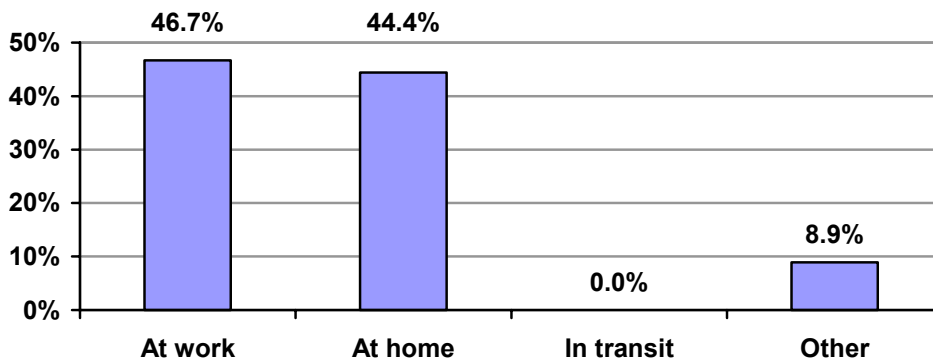
That 19.3% of the respondents changed numbers but did not update Unisa, indicating the need to regularly request students to update their information.

It can be deduced that 68.4% was part of the 75% that indicated receipt of SMS communication in question 1 above while the 19.3% were part of the 25% that did not receive SMS communication.



*Question: If you have received SMS communication from UNISA, where were you typically when you received the SMSs?*

(N = 45)

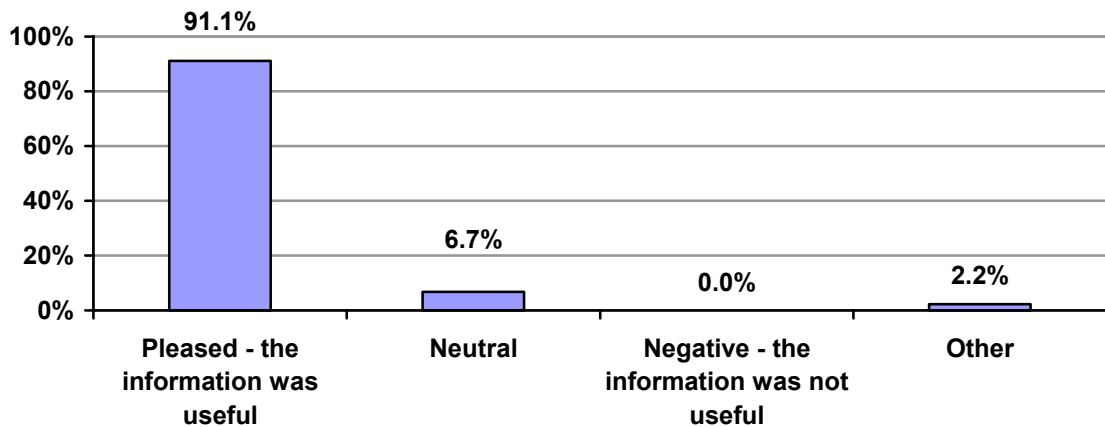


The majority of respondents were either at work (46,7% or at home (44,4%)

The 8.9% "other" responses were either far from the phone, had left the phone with someone else (wife), were in town shopping or had not informed UNISA about their new cell numbers.

*Question: How did you feel when you received the SMSs?*

(N = 45)



That such a high majority of respondents (91.1%) were pleased and found the information communicated to them to be very useful and also that there were no negative responses, indicates support for SMS communication between the ODL providing institution and its students.

It is assumed that the “neutral” (6,7%) responses were from the same group as the “other” (2,2%) who had found the question either not applicable or had mentioned that they did not receive any SMS from UNISA.

As students were never informed before hand that they will be receiving SMS communication at any time during their studies, the reasons why they were pleased are crucial. These reasons fall within the following categories and a few actual students’ views have been cited:

Category	Reason
Happy/pleased/glad/great	<p><i>I know the time and date for my results in order to be ready for them.</i></p> <p><i>It came to me that now the information will flow fast to students and time will be saved. I also believe the institution will not hesitate to keep us posted in terms of any information regarding studies.</i></p> <p><i>UNISA is the only institution with thousands and thousands of students but can afford to make sure that each students receive the necessary information in time. All the information will reach their students in good time, good in consultation. This university cares much about their students.</i></p>
Surprised	<p><i>I did not know they (results) will be very early before Christmas. But I said it's okay so that we have leisure time knowing what's up about my status, whether I completed or not.</i></p>

Felt important/special/proud	<p><i>That urgent messages can be delivered in time for I was eager not knowing when will I get my results.</i></p> <p><i>Felt special</i></p> <p><i>Felt good and proud to have received this from UNISA.</i></p> <p><i>That I am an important person to UNISA although I'm studying through distance learning.</i></p>
Anxious	<p><i>I wanted to call immediately to know my results.</i></p>

Even those students who did not receive SMSs were very positive about this method of communication:

*I have not received an SMS, however, if I could have received I would be excited.*

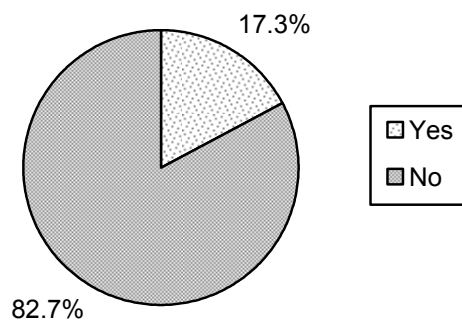
*I was a little bit surprised, because I never received any SMS from UNISA before. But all in all the SMS was helpful.*

**Question: Did you respond to any of the SMSs UNISA sent you"**

(N = 52)

The 82.7% that did not respond felt that the message did not need any response.

Those who responded (17,3%) used the number provided on the SMS. This gave some of the students a platform to ask other questions relating to other aspects of their studies and/or to express their gratitude on being recognised as important clients of the University. Some responded because they were "checking the service mentioned on the SMS; "enquired about the results and I was helped with my results"; responding to "show sender how thankful you are for the SMS.



**Question: Would you like to receive regular contact from us through SMSs?**

(N = 54)

Only 1.9% of the respondents would not like to receive regular contact from the University. The reasons for this need to be investigated but could relate to not having cell phones.

96,2% want regular contact through SMSs and 38.9%, 40,7% and 16,6% respectively would like to receive contact weekly, monthly and twice a semester.

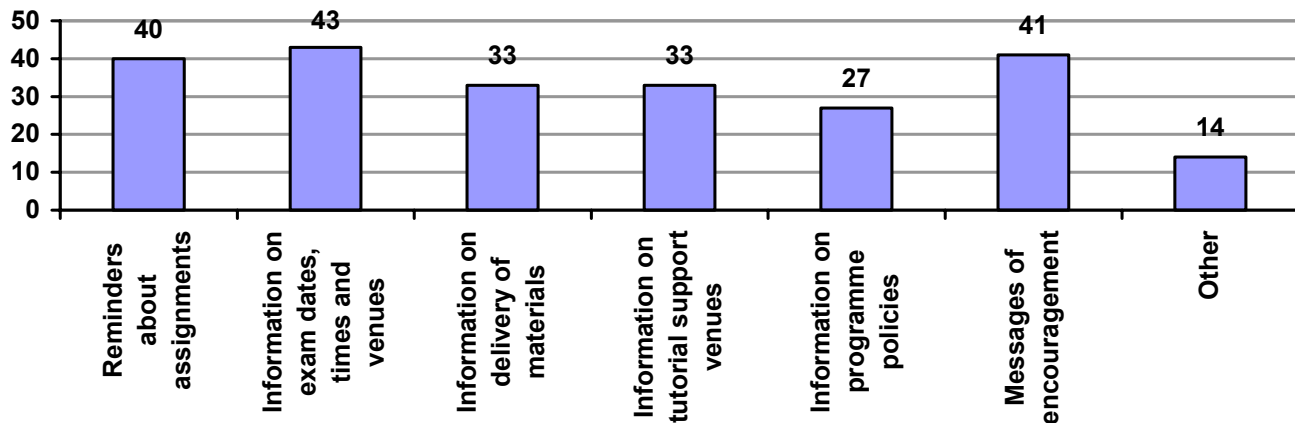
The “other” responses wanted contact for “important stuff pertaining to my course” or “just with things related to my specific needs.

**Question Please comment on your preferences for continued contact with UNISA through SMS communication. Why would you like to receive regular contact.**

<p><i>To keep up to date with the studies</i></p>	<p><i>To help keep me updated about issues regarding my course.</i></p> <p><i>To be updated on new developments with regard to the programmes registered for.</i></p> <p><i>To be updated of my tutorial classes and also to know if all my assignments are received.</i></p> <p><i>To provide me with latest information/changes.</i></p> <p><i>It will help me to be kept posted regarding the latest development in connection with our studies.</i></p> <p><i>Because I'm from rural areas, so this would help me keep updated about my education and assignment</i></p>
<p><i>To be informed</i></p>	<p><i>Why I will like to receive regular contacts because I will like to be inform on what is happening, To keep in touch and be informed at a regular basis.</i></p>

**Question: What aspects of your studies should these SMSs cover? (please check all that apply)**

Note: Numbers in the chart below are tallies of number of responses and not percentages.



The “other” responses included miscellaneous items like graduation dates, new available courses, examinations and assignment results, registration closing dates, payment due dates and SRC meetings and elections.

*Question: Please comment on the effectiveness of a SMS system for supporting learners in a distance education programme. In what ways do you believe the use of SMS will affect your learning experience?*

Responses to this question covered the following categories:

Category	Reasons
Demonstration of UNISA’s interest in students’ studies and keeping them updated	<p><i>Well in my opinion this is the most effective way of communicating with students and helps them to see that UNISA is as interested in their studies as they are and it will also help to keep students updated</i></p> <p><i>It will help us to be informed of what is happening about education</i></p>
Increase students’ motivation, confidence and gives direction	<p><i>It gives direction and confidence that you’re heading in the right direction since the campuses are far from easy (access) and it’s not easy to get information in the right time and you become outdated.</i></p> <p><i>Will keep on motivating me on issues pertaining to my studies. Particularly issues pertaining to youth in my country.</i></p> <p><i>It affects my learning experience by making sure that I am aware of what I am supposed to do and by when. Since there are no regular classes to attend one can feel sort of on his own and the information that is sent via SMS helps students to be on their toes and serious about their work. It bring about</i></p>

	<i>accountability, one cannot claim they didn't know what was going on as they are regularly updated on the progress of their studies.</i>
Keep abreast with ICT development	<i>Development is part of our lives, so let's give it a chance and see what it bringing into our lives. If the system is not working then a chance of changing is there.</i>



## **5. Conclusion and next steps**

These findings clearly indicate DYD students' approval of communication between themselves and UNISA through SMSs. Students were pleased, and/or pleasantly surprised to receive. ODL students are isolated and such contact from the university is reassuring and motivating.

They also indicate the suitability and reliability of SMS communication in instances where up-to-date cell phone numbers are available. Students have also found it to be efficient and convenient. The importance of regular updating of students information is, therefore, essential. There is also an indication that if students know that the institution uses SMSs as a means of communication with them, they are likely to update their records.

The students' preferred frequency of SMS communication, that is weekly and monthly, might turn out to be costly for institutions, especially where there are large student numbers and course offerings. The twice a semester suggestion seems feasible and could even be increased to three or four SMS covering such aspects as welcome and introductory messages; contact about progress with studies e.g. assignment due date reminders and/or tutorial support matters, pre-examination, support, results/feedback and registration matters.

The next steps of this research are to survey the 2005 DYD students who received 3 different SMS in 2005. The results will be compared with this SMS survey of 2004.

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# Mobile Dynamic Frequently Asked Questions (DFAQ) for student and learning support

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## Abstract

Most students are communicatively competent with SMS (short message service) texting. To the extent that SMS is text based and academic discourse is mainly text, it seems reasonable to exploit the communicative competence of SMS for teaching and learning. This paper discusses a project in which the communicative competence of SMS texting among students is being used to address some of the educational challenges, in particular the under prepared students, diversity, and large class sizes. Mindful of many unsubstantiated claims in literature about the revolutionary potential of ICT to improve the quality of education and many suggestions but few demonstrable examples, we did not want to add to the suggestion list. Thus, the objective of the paper is to demonstrate how an ICT application is being used to add value to student learning. The seamless integration of the SMS and the web interface coupled with communicative competencies and anonymity has had some impact on student learning. There are four ways by which learning has been impacted: firstly, exposure to other students' questions mirrored their own understandings / misunderstandings; secondly, the anonymity created a feeling of a safe environment which empowered students to ask and respond to questions; thirdly, students were able to monitor their own growth / development through observing their own changes in the way they asked questions; fourthly, the educator received feedback on where the students learning difficulties lay and was able to quickly respond to their learning needs.

**Keywords:** *Short Message Service (SMS); Knowledge Sharing; Student Support; Dynamic FAQ*

## 1. Introduction

Mobile-phones are extremely popular among students. However, these phones are used for social interaction as opposed to being an educational tool. One of the popular uses of mobile-phones among students is text messaging. The popularity and success of SMS text messaging among students suggest that students are communicatively competent with texting. To the extent that SMS is text based and academic discourse is mainly text, it seems reasonable to exploit the communicative competence of SMS for teaching and learning. Thus, texting competence provides an opportunity for creating learning environments that support students. For this reason, we wondered about ways we can use the social dimension of mobile-technologies and the existing communicative competence in text-messaging among students for the creation of a knowledge resource.

In conceptualising the construction of a knowledge resource, there were two challenges, the technical and the educational challenge. The technical challenge lay in the need to create a seamless two-way interface between SMS, web browser and database backend. The educational challenge was on how to use the informal consultations among students to support individual and collective groups of students, and how to create feedback loops to educators on the students' knowledge levels based on the questions they ask and the responses they receive from peers.

The motivation for extending the interface to SMS was drawn from the fact that the majority of students had mobile phones and were competent in using SMS. The other reason was the need to optimise student contact time with educators and fellow students for academic support as Toohey (1999) suggests, “whether students are officially ‘on-campus’ or ‘off-campus’, contact time with teachers is becoming increasingly precious and we need to use it for those kinds of learning which are difficult to achieve by other means” (p. 120). Mindful of many unsubstantiated claims in literature about the revolutionary potential of ICT to improve the quality of education (Hepp et. al., 2004) and many suggestions (Laurillard, 2001; Khine, 2003; Woods et al., 2004) but few demonstrable examples, we did not want to add to the suggestion list. Thus, the objective of this paper is to illustrate demonstrable value of how an ICT application is being used to support student learning at the University of Cape Town.

The paper is organised as follows. It begins with a discussion of the background to the project, describes the case study and gives a detailed description of the DFAQ environment. It then reports on the findings based on student experiences and concludes.

## **2. Background**

The traditional classroom based pedagogies alone are inadequate to address the current educational challenges of under prepared students, large class sizes, diversity, renewed demands for graduate throughput to mention but a few. Hills (1987) points out that, “even the ways of traditional teacher have now been eroded and outmoded, for classes of mixed ability cannot be taught effectively by the traditional classroom method” (pp. 118-119). Most South African universities increasingly have to deal with large and pluralistic classes. The use of ICTs to complement traditional teaching is therefore inevitable in these circumstances as Nicaise and Crane (1999) observe, “technology may help to create reflective students and pluralistic classrooms” (p. 47). However, the use of technologies for teaching is not a panacea of all educational challenges. Careful designs of learning environments, alignment of teaching and learning outcomes, and integration into the curriculum are some of the critical success factors. Lelliot et. al., (2000) argue that “educational possibilities of ICT are constrained or enabled both by the technology and the curriculum it transmits and by the context in which it is received” (p. 42). The availability of technologies and their pervasive use among students’ demand a rethink of learning and teaching strategies as Khine (2003) postulates:

*New learning and teaching strategies may have to be introduced to prepare students to become independent learners. ICT may provide an opportunity to introduce such strategies. Through the use of technology, teachers can provide opportunities for students to learn, think critically and have discussions with peers supported by ICT (p. 22).*

While technology, curriculum and context are important, the challenge is identifying ways to effectively use the tools in ways that impact on student learning. The envisaged impact was in terms of anonymous peer to peer consultation for knowledge acquisition and the feedback to the educator based on the artefacts of student interaction. The web version of DFAQ (without SMS) was first implemented in a course in 2002 with 20 students (Ng’ambi and Hardman, 2003). The mobile DFAQ (with SMS) was first implemented in a course in 2004. We therefore report on a research project which is in its third year. The mobile DFAQ extends and builds on the web-based knowledge sharing DFAQ project (Ng’ambi and Hardman, 2004; Ng’ambi, 2002a) and question-based chat rooms project (Ng’ambi, 2002b). Other projects have focused on the analysis of DFAQ artefacts (Ng’ambi, 2002a; Ng’ambi and Hardman, 2003; Ng’ambi, 2004).

## **3. Case Study: Creation of knowledge resources from informal consultation**

Most students had no PCs at home with internet connection and were dependent on campus computer laboratories whose access was not always practical due to time, distance and location constraints. Computer laboratories on campus are not available 24 hours/7days a week and student commute to gain access. All students had mobile phones and were competent in using SMS texting. Although the educator had set aside

consultation times (office hours when students could consult with her), the times were impractical for some students and sometimes unrealistic. For example, in 2003 one educator had set aside 2 hours in which students could consult with her, twice a week for a class of 800 students. It was in the context of the above circumstances that DFAQ was deployed to facilitate student access to knowledgeable peers for consultation and saw the potential for a knowledge sharing resource. The anonymity with which interaction is mediated in DFAQ allowed students to focus on the content of the messages rather than its source. The anonymous feature was important in allowing students with low self esteem to confidently communicate and attempt to answer questions from peers. Thus, the incorporation of anonymity in the DFAQ design was premised on the need to acknowledge diversity of the student body which includes students from previously disadvantaged social groups whose cultural histories may disadvantage them from equal levelled social interaction.

Collis and van der Wende (2002) argue that students are the main clients of the university and directly or indirectly the main source of income. Their characteristics and needs steer the University in its programs and approaches (p. 15). Mindful of both the “diverse learning needs of heterogeneous learners and the cognitive complexity of a classroom” (Ng’ambi and Hardman, 2004: p. 187), the DFAQ allowed students to ask and respond to questions anonymously. Ng’ambi and Hardman (2003) postulate that “questioning is a very useful indicator of what assistance the learner needs. As such, it is a useful learning-teaching tool for the teacher. The learner’s question, then, is not only a useful pedagogical indicator of the learner’s knowledge base; it is also a cognitive tool, capable of regulating mental actions” (p. 40). Thus, DFAQ is a versatile educational tool which allows students to have their questions responded to, allows the interactions (questions and responses) become a resource for all students, tracks frequencies by which questions are referenced, and provides feedback to the educator on the aspects of a course where students are struggling.

#### **4. Description of DFAQ**

When a question is posted into DFAQ two processes are automatically activated. First, the question waits in a publicly visible queue for a response. The public waiting space allows peers to read the question and where possible respond. Second, an email notification is sent to a forum manager or convenor or educator for his/her information. Although most questions are responded to by peers, occasionally questions may require an educator’s response particularly course administration type of questions. Figure 1 depicts a question “Are SMS questions anonymised?” being posted to the DFAQ via SMS. The question is prefixed by a forum name (i.e. cet000) which is usually a course code. In figure 2, DFAQ sends an acknowledgement SMS to the user and additionally sends a class announcement “This DFAQ demo is for the Mobile Learning Conference”.

DFAQ recognises that questions waiting in the queue may cause authors’ anxiety if left unanswered for too long. In order to shorten the waiting time, DFAQ monitors the age of questions and when questions wait for thirty minutes, DFAQ assumes that forum manager may not be available to read emails and so an SMS is automatically sent to him/her. When the question is answered, it is SMSed to the question author and leaves the waiting queue to become part of the knowledge resource.

There are two ways of sending responses: if a question was authored using the web version of DFAQ, a response is emailed and for questions received via SMS the response is SMSed back. Figure 4 shows a response which the DFAQ sends to the user who posted the question via SMS.

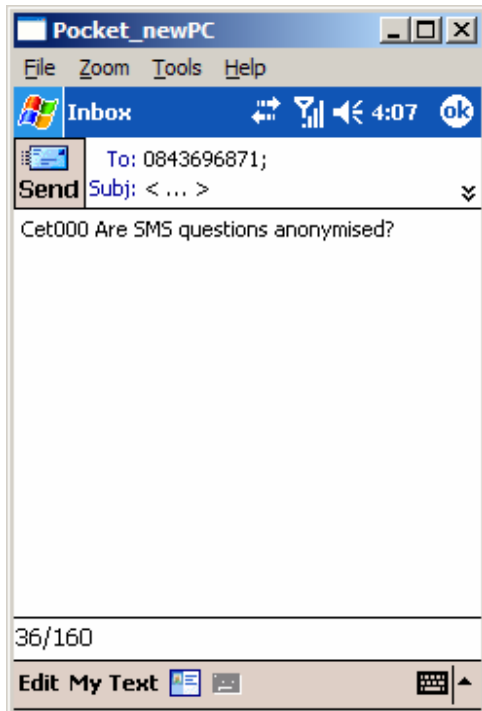


Figure 1: Posting question via SMS

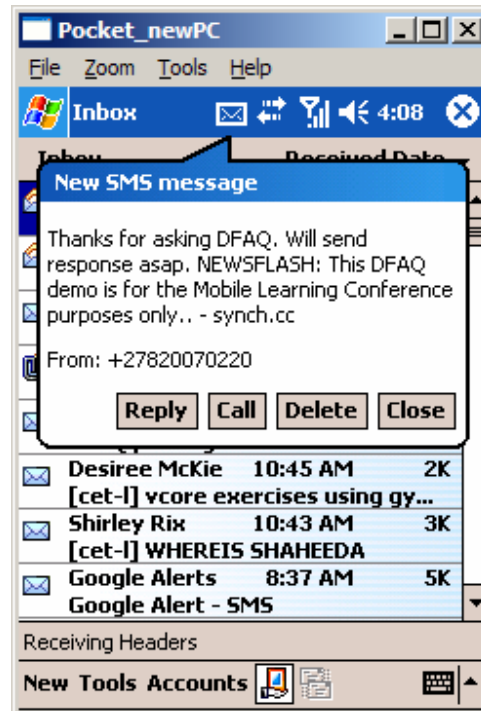


Figure 2: Receipt confirmation with newsflash appended

The features described so far are designed to benefit a knowledge seeking individual with access to either a mobile phone or the web. Ng'ambi and Brown (2004) report on other questions that this project sought to address (p. 47):

1. Can an educator provide individualised help to students at minimum cost to the educator in terms of time/effort?
2. Is it possible to increase the number of students being helped without each increment of student demanding more time and effort on the part of an educator?
3. Can student access to an educator and fellow students for academic help purposes be maximised without additional costs on part of a student?

Rather than expecting the educator to respond to all questions posted in the DFAQ environment, the making of the waiting queue public allows peers to respond to one another's questions hence creating a resource for students by students. The process of creating a resource while helping and providing support to individual students is worthwhile than attempting the creation of a resource in the hope that the resources will be used. An important feature of DFAQ is the tracking of how the knowledge resource (artefacts of interaction – questions and responses) are used by students.

There are three features that monitor resource usage:

#### 4.1 Recently referenced questions

Questions that are recently looked-up appear on top of the list. The list also indicates when a question was last referenced. This is particularly useful in determining patterns of reference. Knowledge of the sequencing patterns is a resource for “predicting and pre-empting student questions” (Ng'ambi, 2002a).

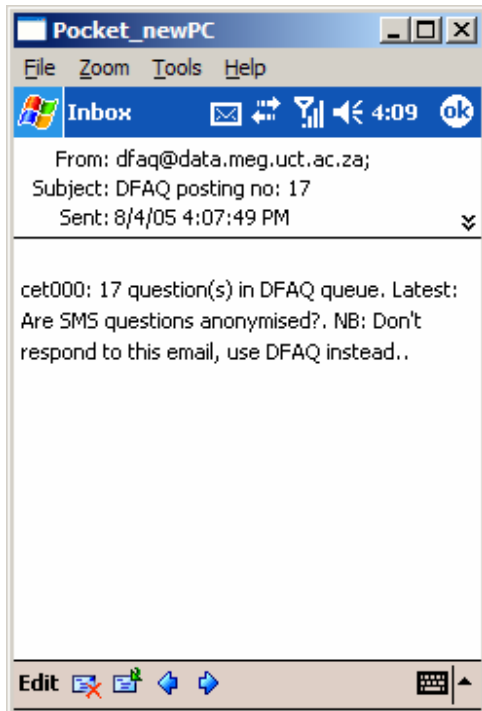


Figure 3: Lecturer notification of outstanding questions

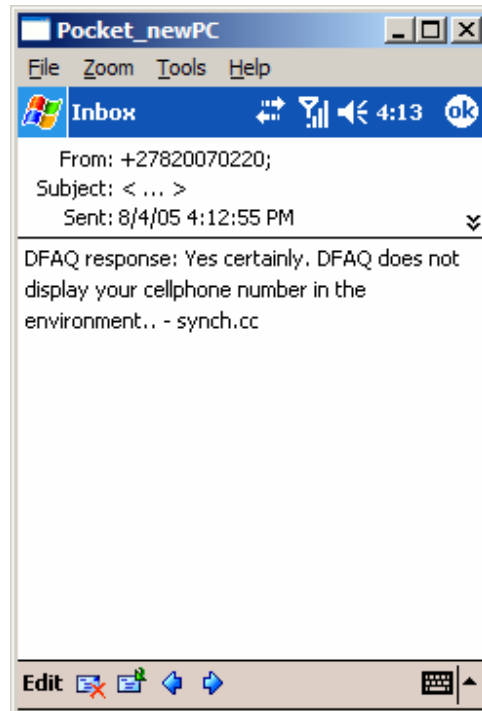


Figure 4: Response question sent Via SMS

#### 4.2 Frequently referenced questions

Related to sequencing patterns, the frequently referenced questions indicate popularity of resources (see Figure 5). This list is premised on the argument that relevance and need for resources is dynamic in that as new knowledge is acquired, new questions arise and old questions become irrelevant or less important because answers become known. Although the relationship between knowledge acquisition and change in questioning is common sense, it is a mammoth challenge to track such behaviour. DFAQ provides a way of visually monitoring the “change in questioning as knowledge increases” (Ng’ambi, 2002b).

#### 4.3 Frequency of response posting

Anecdotal evidence shows that few students ask questions in face to face sessions and even fewer students volunteer to respond to questions in face to face sessions. In DFAQ open ended questions may attract multiple perspectives. Belanger and Jordan (2000) observe that “learners each bring their analytical perspectives into the classroom and share their multiple perspectives in a group interactive session; the group environment can help facilitate the creation of new patterns of understanding built on the foundation of shared individual perspectives. These multiple perspectives also facilitate the process of evaluation of concepts, as learners begin to assign relative value to the individual perspectives” (p. 23). DFAQ provides a way of creating a knowledge resource from the students’ multiple perspectives whereby allowing students to assign relative value to responses and the educator to monitor how preconceptions / understandings shift over time.

Both the way questions are asked and the responses they get are useful indicators of the meaning making processes and hence may expose misconceptions which, if identified early, can have ramifications on pedagogical designs and learning outcomes. It was therefore imperative that DFAQ provided anonymity of sources of questions and responses so as to shift attention away from sources of messages to message content. However, an educator may choose to respond either anonymously or may prefix a response with an educator icon to bring closure to a debate, if such an action is deemed necessary. Figure 6 depicts three responses, two anonymous and one educator prefixed response.



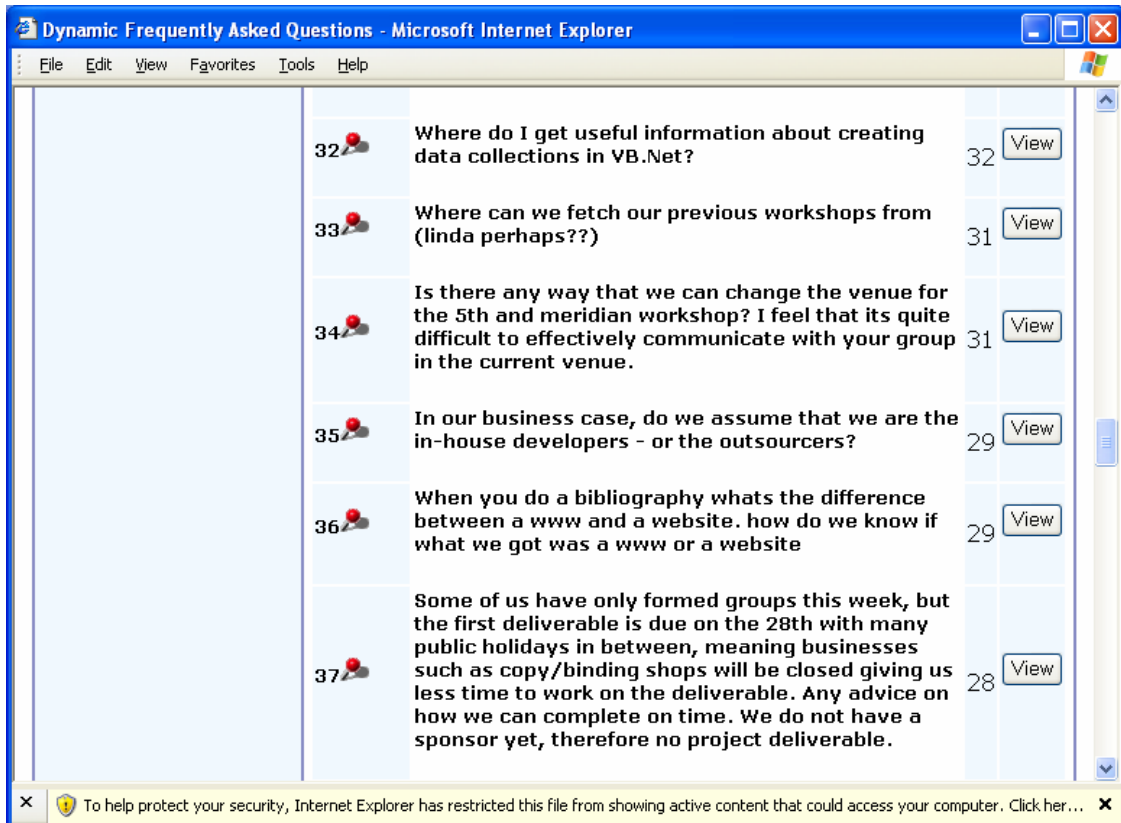


Figure 5: Frequently referenced questions

## 5. Observations

The experiences of students and an educator with the DFAQ were solicited through group discussions and interviews respectively. The following are some of the unedited comments:

Comment 1: “If I just look at what was absolutely amazing about this course, which I’ve, for me specifically, I’ve found at school, was if I didn’t understand something, you just shut off; it’s easier. Because you can just hide behind a class of twenty, you know what I mean, if you don’t understand, you just keep very quiet, you know; nobody knows. Whereas, with this (DFAQ), you could actually, for me, one of my biggest learning curves was, um, looking at other people’s questions. A lot of mine were answered by looking at how other people think. ‘Cause you immediately get things mirrored”.

Comment 2: “I realized that the whole class didn’t understand. And then there was, you could just see this anxiety lifting, and it was the same with us. Once you looked at everybody else’s questions, you felt freed up to actually ask, and to say to one-another, you know, what about this, and ask one-another questions, you know, and not have the fear of, I’ve got completely the wrong tail-end and I look completely ignorant; ‘cause it’s like that when you go into a class with new people”.



Figure 6: Anonymous response and educator pre-fixed response

Comment 3: “But this is almost like having a window on the student’s brain and their development, as such. So if they login on different levels, you actually have got a window on their development; you can actually see where they’re going. And it would allow you to, um, that’s why I say, I can’t believe we don’t use it, because it would allow you to structure your lectures in such a way that you’re specifically guiding it. So that you are navigating them in that you know where you’re going, and you kind-of just set course and hope, you know, that they get there but this way you could actually manipulate it according to where they were going with it and according to the group; maybe you have a group that’s very strong in a certain area or learns in a very specific way. So you could actually manipulate it”.

Comment 4: “It’s a safe environment where you’ve got the anchors, to go and ask questions and look at things, review things and think things through. I’ve found you just go to your next lecture just a little bit more mature, sort-of on the next scaffold, slightly. You just step from one phase of your development to another but more comfortably and with more confidence; as opposed to kind-of grappling”.

The above reflections of students on their experience of using DFAQ focuses on the impact of being exposed to others questions as having a mirroring effect (comment 1); anonymity of interaction as having an empowering effect (comment 2); questions and responses as indicators of knowledge hence a feedback effect (comment 3); and a knowledge resources from artefacts as having a learning anchor effect (comment 4).

## 6. Conclusion

The paper has discussed a project in which the communicative competence of SMS texting among students is being used to address some of the educational challenges, in particular the under preparedness of

students, diversity of backgrounds, and large class sizes, at a tertiary institution. The seamless integration of the SMS and the web interface coupled with communicative competencies and anonymity has had some impact on student learning. There are four ways by which learning has been impacted: firstly, exposure to other students' questions mirrored their own understandings / misunderstandings; secondly, the anonymity created a feeling of a safe environment which empowered students to ask and respond to questions; thirdly, students were able to monitor their own growth / development through observing their own changes in the way they asked questions; fourthly, the educator received feedback on where the students learning difficulties lay and was able to quickly respond to their learning needs.

Finally, the paper has given insight on how the mobile DFAQ contributes to providing individualised help to students at a minimum cost to the educator in terms of time/effort; how the number of students being helped need not lead to an increase in time / effort on part of an educator; and how students can have access to the educator and fellow students through a shared resource, and how an educator can have access to the knowledge levels of a class.

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# Evaluation of CAERUS: a Context Aware Mobile Guide

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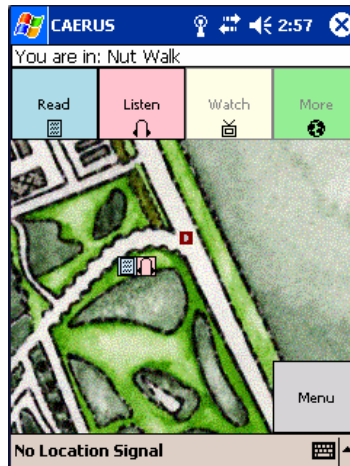
**Abstract:** This paper reports on the results of a user evaluation of CAERUS, which is a complete context aware educational resource system for outdoor tourist sites and educational centres. CAERUS consists of a handheld delivery application and a desktop administration application and provides a visual interface to add new maps, define regions of interest, add theme-based multimedia tours, and deliver this information to visitors through Pocket PC devices with GPS capability. Fourteen participants used CAERUS in the University of Birmingham's Botanic Garden at Winterbourne in May 2005. Participants reported high satisfaction with the location-based content provided, particularly the audio commentary. Significant problems with positioning and navigation were experienced, especially amongst the participants using the system in 'guided tour' mode. Younger and older visitors differed in opinion as to how easy CAERUS was to learn and the clarity of the user interface. The main effect of CAERUS with respect to learning was to increase the participants' engagement with their physical surroundings.

**Keywords:** *tourism, informal learning, context aware, museum*

## 1. Introduction

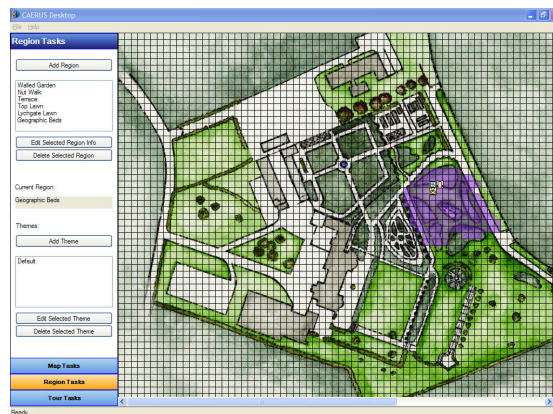
The main aim of outdoor museums and field centres is to encourage learning within an authentic context (University of Birmingham 2001; Birmingham City Council 2004). Visitors are encouraged to explore and discover in order to learn the processes of inquiry and even of learning itself (Hawkey 2004). Due to a lack of preparation and follow-up (Oppermann and Specht 1999) and supporting materials that cannot easily adapt to the range of visitor interests and needs (Not and Zancanaro 1998), visitors often do not make good use of the range of learning opportunities available within these sites. Mobile technology presents the opportunity to support educational visits by providing both location-based information and guidance through this information based on the visitor's interests and needs.

CAERUS is a working implementation of a complete context aware educational resource system for outdoor use. Location-based multimedia content and activities are presented to visitors through Pocket PC handheld computers with GPS capability. The visitor can view his or her location on the map-based interface (Figure 1) and is presented automatically with audio content upon entering a region of interest. Visitors can then select to view additional multimedia content for that particular location, capture their observations or continue with their exploration or tour.

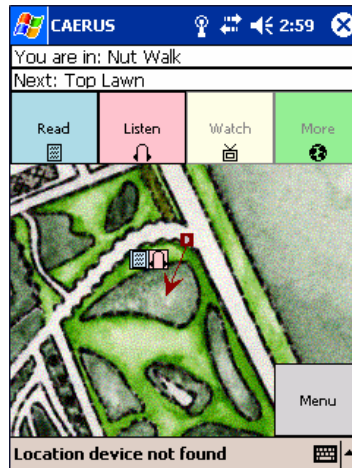


**Figure 1: CAERUS Handheld Interface (Theme Mode)**

Administration of location-based content is accomplished through the CAERUS desktop application (Figure 2). Maps in any image format can be imported into the desktop application and calibrated with the assistance of the GPS-enabled handheld application. Once calibrated, the curator can divide the map up into *regions*, which correspond to physical areas within the site. Each region may be associated with one or more *themes*. Themes provide a specific perspective (such as “history” or “environment”) on a multi-faceted artefact or exhibit and can be used to group media such as text descriptions, audio, video and HTML. The system supports both free exploration based on a selected theme and ‘guided’ tours, where the next region of interest is suggested to the learner. Figure 3 illustrates the handheld application interface for a guided tour. A standard synchronisation procedure is used to transfer information between the desktop and handheld applications.



**Figure 2: CAERUS Desktop Interface**



**Figure 3: CAERUS Handheld Interface (Tour Mode)**

### ***1.1 Design Methodology***

The main aim in the design and development of CAERUS was to produce a system that could be applied in both tourism and education contexts. In addition to providing an engaging end user experience, a key requirement was that individual sites be able to manage location-based information and scenarios themselves and transfer this information to the handhelds efficiently.

Requirements for the design of the handheld CAERUS application were solicited through a questionnaire and focus group consisting of 8 regular visitors to the University of Birmingham's Winterbourne Botanic Garden. All participants were willing to trial a location-based handheld application but only if it 'just worked', indicating a low tolerance for technology failure. Specific design challenges from the perspectives of designer, implementer and user are described more fully in (Naismith and Smith 2004).

A preliminary user trial was conducted with a group of six participants, primarily to assess the usability of the handheld application. An issue that arose from this user trial was, again, a very low tolerance for technology failure. Audio content was preferred due to the rich visual nature of the botanic garden, echoing the findings of (Oppermann and Specht 1999). Participants stressed the requirement for the audio to be very high quality and specifically relevant to what they were seeing.

## **2. Evaluation**

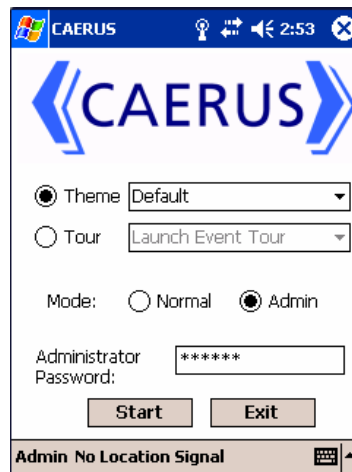
Fourteen visitors to the Winterbourne Botanic Garden participated in a trial of the CAERUS Handheld System in May 2005. The trial consisted of four sessions and was conducted on two separate days a week apart. A planned activity was designated for each session and all participants within the session performed the same activity.

Table 1 describes the organisation of participants in the trial.

**Table 1: Trial Organisation**

	Day 1		Day 2		Total
	Session 1 (Theme)	Session 2 (Tour)	Session 3 (Tour)	Session 4 (Theme)	
Number of Participants	3	5	3	3	14

Trial participants gathered in a central meeting space for a scripted overview and demonstration of the CAERUS handheld application. At this time, they were also asked to give a short statement of their knowledge of the garden. The appropriate option for the particular session was selected from the title screen (Figure 4), and then the trial participants were free to wander around the garden and use CAERUS as they wished. Informal observations were made while the participants were in the garden. Participants were instructed to return to the central meeting space when they were satisfied they had experienced the full functionality of the system. A short questionnaire was then administered, followed by a semi-structured interview on their experiences.



**Figure 4: CAERUS Handheld Title Screen**

The main objectives of the trial were to:

- Assess general usability of the system.
- Assess how the different modes (theme, tour) affect user behaviour and ability to navigate around the garden.
- Assess desirability of the system amongst different user groups.
- Assess desirability of different types of content amongst different user groups.
- Gather evidence for learning.

## **2.1 Equipment**

Three handheld devices were used during the trial, all running the Pocket PC 2003 operating system. Two of the handheld devices were Mio 168 DigiWalker models with integrated GPS. The other handheld device was an HP iPAQ 5500 series with a Navman GPS 3300 in an expansion sleeve. The CAERUS handheld application was preloaded on all devices.



Except for Session 2, each participant was loaned a handheld device and earbud headphones for individual use. In Session 2, there were two pairs and one individual. The pairs in Session 2 opted not to use the headphones.

### 3. Results

The trial participants covered a range of demographic groups. Table 2 shows a breakdown of the trial participants by sex, age, experience of the garden and handheld device ownership. Trial participants spent between 30 and 45 minutes in the garden.

**Table 2: Trial Participant Demographics**

Sex	Male	8
	Female	6
Age	20-29	5
	30-39	3
	40-49	0
	50-59	1
	60-69	3
	70-79	2
Experience of Garden	First Time Visitor	5
	Returning Visitor	9
Handheld Device Ownership	Own a Handheld Device	4
	Do not own a Handheld Device	10

Trial participants were asked to rate a series of statements on a five-point Likert scale. Table shows the mean and standard deviation of the response to each item, in the range from 1 (Strongly Disagree) to 5 (Strongly Agree). A one sample *t*-test was performed on each mean, with 3 (Neither Agree nor Disagree) as the constant value. Five statements show a significant difference from 'Neither Agree nor Disagree' ( $P < 0.05$ ):

- CAERUS was easy to learn (a)
- It was not difficult to manipulate the push button interface (c)
- Participants did not feel like they were in control of CAERUS (d)
- Participants did not feel self conscious using CAERUS (h)
- Participants would recommend CAERUS to other visitors (k)

**Table 3: Mean and Standard Deviation of Responses to a 5 point Likert Scale**

Statement	Mean	SD	N
a. Using CAERUS does not require much training.	3.55*	0.69	11
b. It was easy at a glance to see what the options were for each screen.	3.31	1.03	13
c. It was difficult to select the option I wanted with the touch screen.	2.15*	1.14	13
d. I felt that I was in control of CAERUS.	2.46*	0.78	13
e. CAERUS responded too slowly.	3.50	1.22	14
f. I found it difficult to read the text on the screen.	2.46	1.27	13
g. CAERUS helped me to navigate around the garden.	2.71	1.20	14
h. I felt self conscious using CAERUS.	1.93*	1.07	14
i. The way that CAERUS presented information was clear and understandable.	3.50	0.94	14
j. It was difficult for me to determine where I was in the garden.	3.79	1.37	14
k. I would recommend CAERUS to other visitors.	3.57*	0.94	14

Starred items are significant at  $P < 0.05$

The Mann Whitney U Test was used to compare the responses between groups. Comparisons of First Time Visitors versus Returning Visitors, Handheld Device Owners versus Handheld Device Non-Owners, Theme Participants versus Tour Participants and Male versus Female did not show any significant differences of opinion. Comparisons between the group of participants over 50 and the group of participants under 50, however, showed a significant difference of opinion for the following statements:

- Using CAERUS does not require much training (a) – older participants slightly disagreed (mean response 2.8), while younger participants agreed (mean response 4.0).
- It was easy at a glance to see what the options were for each screen (b) – older participants disagreed (mean response 2.5), while younger participants agreed (mean response 4.0).

Overall, the reaction to CAERUS was positive. Participants found the content provided during their visit to be both interesting and informative. As with the previous trial, audio was the preferred method of delivery. Several participants commented that the audio commentary was particularly clear. Participants described their experience with CAERUS as novel and liked the experience of looking at something while being talked to.

Problems with navigation and positioning, however, were paramount. GPS was described by the participants as slow and imprecise. Participants felt that too much mental effort was required to navigate and didn't want to have to look at a map to find interesting and relevant information. These problems were compounded by the fact that the handheld device screen was very difficult to see in bright sunlight.

Usability issues with the application itself were prevalent amongst the over 50 age group, with several participants citing a need for individual tuition (the application was demonstrated to the group). A common usability problem across age groups was that it was very easy to switch into 'demo' mode by touching the map area of the screen. In this mode, the GPS receiver is turned off so that the user can access information for other parts of the garden, without having to physically move. The demo mode is indicated to the user by a change in icon, but could be difficult to see, especially if it was done unintentionally. Participants can return to normal mode by clicking 'Find My Location' on the menu bar.

When asked what they would change, most participants requested enhanced positioning capability and information for more points in the garden and at a greater level of detail. While most participants said they would use CAERUS again in another location, a few of the older participants expressed dissatisfaction with the general concept and stated they would prefer a no-technology solution such as a paper map or leaflet.

## **4. Discussion**

### **4.1 Comparison between different modes**

All participants using the Tour mode made an initial effort to follow the suggested tour points in order, but all experienced difficulties with positioning and or navigation. Participants employed a number of different strategies to overcome these problems:

I started off using it trying to follow the guide, but then it just got infuriating, cause it pointing in the wrong direction, didn't go where I wanted to go and the GPS was inaccurate. So in the end I just forgot it and walked around. (male, 20-29, tour, first time visitor)

I looked for the icons and I walked to them. (female, 20-29, tour, first time visitor)

So I still used the suggested route, but I used the demo mode instead, towards the end. I roughly know where I am on the map, so I walked towards the point. (male, 20-29, tour, first time visitor)

The tour points consisted of both points within regions, and thus with attached content, and waypoints, with no attached content. Some visitors expected content to be available at all of the suggested points and were confused when no content appeared at these locations:

We tried to follow the tour; that was where we started having the difficulties. The tour sent us to places like go to the path towards the terrace, well what can you say about the path towards the terrace and it didn't say anything. (male, 60-69, tour, returning visitor)

The application didn't have a significant impact on the movement of the participants using the Theme mode. These participants were more likely to follow the natural paths in the garden, and wander between regions based on what visual sights piqued their interest.

Interestingly, several Theme participants requested greater guidance:

If you suggest to me you should go this way or that way and see this plant, that would be helpful. I would like to follow it. (female, 30-39, theme, first time visitor)

## **4.2 Navigating in information space**

CAERUS requires visitors to navigate simultaneously through both physical and information space. A variety of factors impeded this process for trial participants including a lack of labelling both on the digital map and in the garden, a static map that didn't respond to changes in the user's orientation, difficulty seeing an overview of the garden on the handheld device and inconsistent performance of the GPS receiver.

Several participants used physical movement to verify they were navigating properly within the information space. This ranged from standing still while rotating the handheld device to match the visual surroundings to repeatedly walking back and forth along a particular path in the garden.

The participants felt that significant mental effort was required to use the application, which correspondingly led to a large amount of 'heads-down' interaction (Hsi 2003). The use of the handheld application was far from seamlessly integrated with the visitor experience:

It's not a physical experience; it's still attached to a device. (female, 30-39, theme, first time visitor)

Participants suggested a range of navigational aids to facilitate this process. These included simple solutions such as increased labelling, providing an accompanying map on a paper leaflet and an overview wall chart map available at the garden entrance. Technical solutions included enhanced positioning, displaying an arrow indicating the user's current direction of travel and automatically orienting the map to the user's current direction.

## **4.3 Evidence for learning**

This trial did not attempt to measure learning against on a predetermined set of outcomes. Measuring the free-choice learning that occurs in informal settings is difficult for a number of reasons. Visitors come in with a range of prior knowledge, interests and motivations and continually interact with the physical and sociocultural settings in unique ways (Falk and Dierking 2000).

After their experience in the garden, however, participants were able to cite specific examples of things they had seen or heard:

The bit about the metasequoias, the history of the trees down there, and also a bit more about the history of the house. (male, 20-29, theme, returning visitor)

I might've heard about the petal garden, but the shapes of the petals, I didn't know that. (female, 60-69, tour, returning visitor)

The two on the balcony the two [wisterias], one goes clockwise and the other goes anti-clockwise. Little things like that stick in your head. (female, 20-29, tour, first time visitor)

Participants also reported increased knowledge of the layout and organisation of the garden:

I worked here and I didn't know where the petal garden was. (male, 60-69, tour, returning visitor)

The garden is larger than I thought. I went down there and there's a natural path down there that isn't actually part of the garden, but you can walk along it to explore. (male, 20-29, tour, first time visitor)

CAERUS also prompted at least one participant to explore further:

I did look at some of the other information and I did actually try to find some of the trees as well. Just out of interest. (male, 20-29, tour, first time visitor)

Perhaps the best evidence for learning is that fact that most of the participants expressed a strong desire for more information, in multiple media formats:

I was just saying on the way back that although I didn't particularly want to listen to it at first, cause I thought I knew it anyway, it was so interesting and it could've been longer, even twice as long would've been fine. (male, 60-69, tour, returning visitor)

I want to know more about the rose collection. (female, 30-39, theme, first time visitor)

You really need [more] photographs as well to make it a good experience. Something in blossom now will not have blossom later. (male, 20-29, tour, returning visitor)

## **5. Conclusion**

CAERUS uses mobile technology to support visitors to outdoor tourist sites and educational centres by providing location-based information and guidance. Visitors using the CAERUS Handheld application on a trial basis reported high satisfaction in receiving location-based audio content and reported the use of CAERUS Handheld to be a novel and informative experience. A statistically significant difference in opinion was observed between older and younger visitors as to the amount of training required to use the application and how easy it was to see what the options were at a glance.

Significant mental effort was required for participants to navigate successfully through both physical and information space, leading to heads-down participation and detracting from the rich visual environment of the garden. Participants experienced particular frustration trying to use the Tour mode functionality, while those using the Theme mode expressed a desire for further guidance. This suggests that a rethinking of the Tour mode implementation is necessary, in conjunction with an investigation of both technical and non-technical navigational aids.

While the trial did not seek to comprehensively evaluate participant learning, participants cited several examples of things they had seen or heard that were of interest to them. They also showed a generalised increase in their knowledge of the layout of the garden and a strong desire to obtain more detailed information in multiple media formats.

## **6. Acknowledgements**

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## 7 reasons why mlearning doesn't work

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*"In the past the enjoyment of the few has come at the expense of drudgery of the masses." Csikszentmihaly 1975*

### Introduction

I was reminded recently that the cacophony of personal technologies has become very stressful for many. I was sitting down with my personal devices, wondering which ones I should carry around with me. I have an Apple PowerBook G4, my Kodak L753 Camera, my iMate SP3 Phone, my Apple iPod Mini 4GB and my Maxtor 200GB Hard Drive.....exhausting isn't it. Add to this the next connectedness...I am simultaneously connected by Wireless 802.11G, ADSL2+, Bluetooth, GPRS, Infra Red, USB2, my headphones and good old fashioned Broadcast TV tuner.

And these are just the gadgets I use most days. They are all potential Mobile Learning devices and they all have compelling features and irritating limitations.

At this point I turn to my "mobile psychoanalytical service" represented by my copy of the works of the great Hungarian-American academic Mihaly Csikszentmihalyi of the Drucker School at Claremont in Los Angeles. I contemplate the role of *Flow* in this noisy orchestra of mobile devices.

Sometimes I think there is a conspiracy to make no one device adequate, just to make me buy more devices. I am sure there is some Zen Master Marketing Guru in the mountains of Japan secretly conspiring against me, never allowing me to have just one device that enables *Flow*. (Csikszentmihalyi M, 2004)

Is this experience just *Adult Play* or am I trying for *Flow*...a process of human evolution to make everything move together in harmony with out denial of equitable access to anyone? (Csikszentmihalyi M, 2004)

Without *flow* or at least network relationship management that is educationally contextual then mlearning is discordant, immaterial and destined to the backwaters of educational methodologies. There are seven reasons I can see why this is so.

### The 7 reasons

Mlearning as a concept alone is doomed to failure because as a learning model it appears:

- To be Technology Driven:** Mlearning alone is a Technology driven concept
- Not cogniscent of Market Usage:** We know too little about what mobile devices are used for
- Yet to adopt discoveries in Cyberspsychology:** We know too little about Flow and Learning relationships/Networks or the Transactional Analysis of Mobile Relationships
- Not to change Entrenched Institutionalised Education Models:** cultures of Education and Communications reflect government control measures
- To rely on nascent consumer Technology:** Mobile devices are inherently dissatisfying by never quite meeting every promised need for the consumer.

**To be short on Standards to overcome Cultural Differences:** while standards are slow to emerge Governments are rapidly regulating and limiting the use of Mobile Communications technology

**To lack a Mobigogy (Refer attachment):** teaching and learning models are needed

Into this setting we can introduce the notion that *Flow* comes from action rather than consumption - as does learning. Learning is not about “Publishing and Distribution” or even “Examination and Institution”. True learning is integral to *Flow*, indeed a foundational action in the evolution of humans. At Archer College we know we cannot control one’s experience of *flow*, as that is for individuals to manage for themselves. But we are seeking to address the educational context in which the networks that support mobile devices are managed.

A key finding began for me while developing Learning Models for Monster.com in 2000. We made a discovery through market research that Learning and Work were less connected in people’s minds than you would imagine. Since that time we have reviewed, refined and are now researching the real impact of applying a new Educational management methodology that is culturally relevant and a genuine paradigm shift in the meaning of Educational Institution.

Since the dawn of the web, people in their millions have been learning online. Since the advent of Google as a popular search engine and populist governor of learning behaviour, learning behaviours themselves have changed significantly. It is reasonable to suggest that the Institutionalised Education community has had trouble keeping up.

The educational community is, quite reasonably Aesop’s tortoise, and the marketers of consumer-based mobile technologies are the hare. In order to ensure we are still running at the finish however we must stay within sight of the hare. That does not mean immediately trying to behave like hares as we extend the analogy, but that is what many of us do. Instead we must build sound new methods.

### **Learning Relationship Management**

Our models for elearning must be constructed in the science of human learning behaviour and that is slow to change. Manuel Castells (2001) has described how new global, urban networks will likely emerge, beyond the current geo-political institutions. The traditional independence of the education community from the constraints of national borders is being mirrored by the behaviour of consumers, including consumers of education services.

We have proposed the model called Learning Relationship Management or LRM.

It is a 7 layer model for learning and development, primarily in a vocational context which relies on but is independent of technology. At its core is a respect for the Learning rights of the individual learners. It is right for their situation to be recognised, their skills and knowledge to be recognised and the right for learners to grow through an extension of their situation rather than a requirement for them to respond to institutional requirements.

The Learning Relationship management (LRM<sup>TM</sup>) model integrates contemporary philosophies of perpetual learning, learning communities and active personal support in pursuit of ongoing professional and personal development. This complex interplay of learning elements means that participants are able to choose their own “mode” of learning suited to the course content and their personal training needs.

On all levels the LRM<sup>TM</sup> model is specifically designed to resolve any sense of isolation and dislocation that learners have expressed regarding the use of more traditional e-learning platforms. It recognises the importance of ensuring that any integration of the Internet with learning (i.e. e-learning) incorporates a sense of ‘place’ and community for learners and instructors.

Members of the learning communities participate in regular communication including surveys, quizzes, career counselling, development plans, news and utilities all



embedded in a consistent model. The community has access through the Archer College website to a constant stream of news via blogging and podcasting techniques.

The Archer College LRM™ model promotes training delivery that is more convenient, cheaper and more value laden than that of traditional learning institutions. It is also socially inclusive, providing access to people unable to access a traditional learning institution with a low cost entry point and the use of technology in delivery.

All age-groups and learning levels from high school to management to retirement are catered for, including those learners re-entering the workforce, just starting their career or looking for a career change. The LRM™ model encourages lifelong learning, meeting people where they are.

*Note: The Learning Relationship Management (LRM™) model is developed more fully in papers available from Archer College.*

We can take the seven layers of the LRM Model and describe the Mobile Technologies that are used in the model.

<b>LRM Level</b>	<b>Mobile Technologies Used</b>	<b>Benefits</b>
<i>Qualification</i>	Verification PDF Doc distribution	Verify your Qualifications and Skills profile while on the move.
<i>Assessment</i>	Certification Reminders SMS quizzes	Never miss re- licensing again. Ensure Compliance with professional requirements
<i>Simulations and Games</i>	Seminar Reminders Video Recording and Publishing Podcasts	Listening to master Class podcasts in the car.
<i>Classroom</i>	Event reminders Outlook Integration Review Missed Lectures	The mobile phone and its Internet Facilities as a seat in a Classroom
<i>Self paced</i>	Quizzes E Purchase	SMS quizzes for self -assessment. Purchase of Courses and in some cases delivery of courses
<i>Resource Review</i>	Standards and Documents available on the job...Mobile email Mobile Chat	Immediate publishing of Standards, best practice models
<i>Communities of Practice</i>	Moblog	Journaling events as they happen and

At Archer College we have recently engaged with a very large Canadian corporation for the management of their education programs. All the services are delivered in a 100 locations across Canada and served from Adelaide in Australia. The network technologies upon which mobile devices rely already exist and service models over those networks are maturing.

However many, if not most Governments, frightened by the notion so eloquently explained by Maffesoli 1996, that their power is diminishing in significance, are attempting to increase regulation or reduce liability in respect of internet based trade of communications.

Their response is to grab back power and control of these communication networks, in some places as a totalitarian act. We will see if they have any possibility of success. The same response may limit the role of educators in delivering teaching and learning services over mobile devices.

They may be too late. The recent emergence of Podcasting as a publishing medium for Audio files is the latest move in the market driven process first pioneered by Peer to Peer networking models such as Napster.

Archer College's Non-profit NGO derivative called Learndog is pioneering the use of this technology for recognition of skills among young learners. Learndog has been capturing music and audio-textual outcomes of out-of-school activities in vocational education and publishing them over Itunes. Collaborative Learning is there peer reviewed across the world using Podcast techniques to iPod and similar Mp3 playing devices.

Although there are many audio standards in use, MP3 is by far the most pervasive and we expect Mp4 to become the standard of choice for Video.

But where are the models to overlay these technologies in a Learning Framework.

Siemans suggests that this phenomenon is a new "ism" in his paper published this year (Siemans 2005) I think it is helpful to explain the new network age as an extension to behaviourism, and constructivism. I wonder however if we are giving the technology too much credit. Our ongoing review of real behaviours with our students will tell us more. I suspect that there is no new "ism". There is merely an evolution in the construction of learning. We may need a "mobigogy" for the connected.

The institutional attachments such as registration, attendance, examination, provision of testamurs and compliance with educational technologies are peripheral to the learning relationships. The key to learning has always been relationships. There is nothing new about that. Just their location is different.

In this model we have placed technology at its correct level. We use the latest technologies to enhance services and provide options. Staff at Archer College are neither Ludites, Troglodites or Geeks. They are all training as educational counsellors and vocational teachers and are expected to provide both of these services to their clients. They are the masters of the technologies and the correct and properly managed situational use. This process reduces costs and enables the delivery of Vocational Education that is specifically relevant, contextual and up to half the price of the Government-sponsored provision.

Yes you can use mobile devices in learning. But they are mostly designed for use as consumer products, not education mediation devices. But as a learning in our model you are not a captive of them.

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# Appendix

## Mobigogy

Mobigogy, as delivered by Archer College in 2005, is a new learning model that attempts to integrate pedagogy and andragogy into a personalised learning philosophy for the digital age. While other learning theories are constructed from a belief in a linear, chronological change in an individual's learning preferences, mobigogy identifies learning preferences in terms of how learning is gained rather than what and from whom.

Mobigogy recognises the networked individual as the central element of all learning methods. Education by way of personalised learning is a result of living and working, an exercisable democratic right. It occurs continuously and dynamically and so requires instructional design rules that gather individual learning experiences and actuates them through learner-selected learning communities.

<b>Pedagogy</b>	<b>Andragogy</b>	<b>Mobigogy</b>
compulsory	voluntary	continuous
teacher-centred	learner-orientated	learner-directed
minimal control by the learner	education as freedom	education as democracy
training for life	assimilation of learning with life experience	life experience is learning
encourages convergent thinking	encourages divergent thinking	enables network thinking
rote learning	active learning	dynamic learning
dependency on educator's learning	learning and teaching roles are blurred	supported in learning communities
imparting of information	opens vistas for continuing learning and peer learning  uncertainty about the outcome, whatever the curriculum content	seeking knowledge from shared life events acknowledging living as learning  object oriented recognition

Information in this table on Pedagogy and Andragogy comes from:  
[http://www.trainer.org.uk/members/theory/process/pedagogy\\_andragogy.htm](http://www.trainer.org.uk/members/theory/process/pedagogy_andragogy.htm))

Information in this table on Mobigogy comes from a draft paper, "New learning paradigms" by Janet McMillan, Senior Instructor, Archer College.

# MOOP - USING M-LEARNING ENVIRONMENT IN PRIMARY SCHOOLS

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## Abstract:

Moop is an interactive m-learning environment for situations where primary school pupils take use of a mobile phone to analyze their surroundings and to communicate within groups. Through Moop, a pupil makes observations and saves and manages information in the mobile and network learning platform. The learning environment supports the process of inquiry learning, during which a pupil outlines his or her thoughts on the current topic, collects information and observations from the surroundings and reports the findings in the network-learning environment. Moop project is based on needs of schools and teachers: the traditional learning environment is broadened from classroom to observation in the surroundings. The goal is to increase interactivity and collaboration in learning with the help of a mobile phone. In the Moop environment the mobile learning is realized through tasks based on geographical location and requiring creative problem solving. Camera phone is familiar for pupils and a meaningful tool for communicating and working. The benefit of a mobile data terminal is that it goes where the learners go. Experiences with this tool have showed that inquiry learning processes can happen as part of daily school work and the tool was easy to use with students aged 10-12 years.

Moop application interface has been designed for Symbian (S60) platform technology. The application collects the media from the phones and shares it through real-time data-connection to server and www-environment. The connection used in the process is data-connection (GPRS/3G). Locating is based on GPS-technology which enables connecting observation and orientation tasks. Pupils (and teacher) communicate using push and talk (PoC) application.

Keywords: *m-learning environment, primary schools, inquiry learning, creative problem solving*

## 1. Introduction

The aim of this paper is to introduce the Moop m-learning environment and show its benefits to the primary school learning. Young people use mobile phones, SMS and other mobile services undoubtedly and without prejudice. During Moop-project has been created contents that improve the teaching opportunities and genuinely motivate the pupils. Moop is a "real" practical application for primary school use. The demand for such environment came from teacher's need to expand the traditional classroom environment to the examination of the surrounding phenomenon and problems.

The basic ideas at the background of Moop are: school curriculum and content of education, pupils as users of technology, collaboration with parents and school, cooperation between the schools, breaking the boundaries between the classrooms and developing the pedagogy. The main purpose for the school is to provide basic education and it is important to maintain it. ICT-technologies support the pupils learning process. Mobile learning environment has to adapt as a natural part of the daily schoolwork and pupils class schedule – as a part of the knowledge building model.

The purpose of this project is to create a learning platform for mobile learning situations where a pupil works in a mobile and network environment. Mobile phone is used to bring observations from nearby surroundings to the classrooms and to school teaching situations where they are handled co-operatively. Information from neighbourhood will be utilized in learning process. One goal is to create a user interface, through which a pupil is able to outline his thoughts, observations and share them with other pupils. The intention is to use the environment both at school and in leisure time. Then the application will be seen rather as a possibility, not as a necessity for study. Learning through observation occurs in real life.

This paper expresses in practise the pedagogical principles from the learning impression and from the teacher's work. The actions and qualities of the environment and the accomplished education are also described – ending up considering the direction of the continuation development.

## 2. Pedagogy

The pedagogical principles are: inquiry learning, skills for gathering information and building knowledge, creative problem solving and leading to the interactive and cooperative learning.

Information and communications technology must support the learning. Mobile learning environment supports the ICT-teaching entity by offering a wireless and transportable solution to support the pupil's thinking and actions. The bare equipment won't just do the learning – ultimately the learning still takes place in learner's own head.

School actions must be based on rational contents from the school's curriculum. The equipment or teaching method being used depends on its benefit to the learning. Teaching is aimed at developing the learner-centric classroom techniques, when the learning is seen as a process. Learning process is based on a familiar and meaningful approach, which will be used when solving the problem. In our teaching practise we use the model of knowledge building. We call it also as model for "rational actions" in a classroom. It is based on experiences noticed in a school practise.

This knowledge building model has been developed as a pedagogical guideline for working at school. Model is originated from the teacher's need to understand the entity of the teaching situation. The learning process is based on a simulation of learning situations. This model is meant for both primary school pupils' and teachers' use. With this model they know in what phase of the task solving process they are and what actions still need to be done in order to achieve the desired outcome. This model creates logically proceeding learning path, where all the phases of the learning process forms an own entity. This model isn't constant - it can freely be modified and used according to the own task.

Learning has the nature of process. Pupil forms new information to the basis of earlier created knowledge. In the first phase the pupil forms the inquiry learning problem. He sets the hypothesis to his functions and creates the mind map from processing subject. Into this map he gathers the information already has or is able to find from the study book. The next stage is to search information concerning the subject. Findings and observations from the nearby surroundings have become as distinguished part of the project as the information gathering. These observations are crucial, pupils act like content producers at the same time.

With the gathered information and knowledge the pupil classifies the subject matter and rebuilds the schoolwork. The possible consequences will be considered further through the common classroom discussion. The outcome is that pupil has solved the set problem by following the learning process model. From the pedagogical background the technology is being carried out to a natural part of functioning in classroom and working model. The crucial learning factor, even more important than information, is the learning process itself. (Roschelle & Pea, 2002)

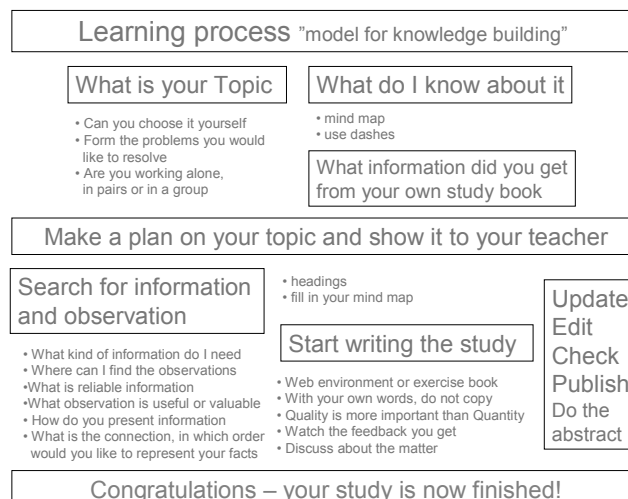


Figure 1. Model of Stages in Knowledge Building Process

### **3. Learning situation**

The aim is to create a model of a learning situation, which can be accustomed further as a support for learning and teaching. It rises from the basis of curriculum to the different school tasks. During teaching process knowledge is being built in a modern and meaningful way. Learning situations from neighbourhood are connected to the curriculum themes. The intension is not to compensate the traditional teaching, rather give more equipment and means to realise it. With real-time feedback and interchange the pupil is guided to do the observations and downstream operations that follow the idea.

#### **Pedagogical Aims by Using Moop**

1) Main principles are based on pedagogical ideas of inquiry learning and creative problem solving and the tasks led from the learning process. During process a pupil lists the previous information and opinions about the task, forms the project plan and through that seeks for more information and observations about the subject. Then the pupil composes the study on a school subject according to the process. Before it is finished it is useful to discuss the subject with others and comment on other students' work. (Edelson & al, 1996; Hakkarainen & Sintonen, 2002)

2) Location-bound task courses are based of path being constructed to the certain area. Pupils make observations in specific task points, which are bound to GPS-location technology. The information gathered from the task points are tied to school learning process and curriculum. Pupils benefit the information collected actively in classroom and share it in cooperation with peers. The knowledge is achieved and applied like in everyday situations.

3) Collaborative project learning is realised through tasks which pupils have to figure out in a group activity. There is a certain time for the task to be finished. To cope with the mission the group has to split in smaller groups, take roles and to communicate with Moop-environment and the tools on offer, for example by using the PoC function. (Dillenbourg, 1999)

To follow the learning process pupils have to analyse their subject, consider the inquiry questions and find the basic information about their subject. With the help of all the information from thinking and analysing the briefing knowledge to the searching new information and collecting fresh observations - based on gathered information - pupil's task is to create the final learning outcome to the network-learning environment. The main issue is construction of the knowledge instead of memorising the facts.

One practical example: According to the legend Mr. Taavetti Lukkarinen was hang to this tree – explore if this could be possible. To form the final answer the pupils have to rebuild the situation and different details, anchor these to education and in real life. The tree has been there so little time that the case is unlikely possible. The pupils have to philosophise to form the final answer by themselves. It is also a didactic challenge to the teacher to form problems like this which require creative problem solving and challenge genuinely the pupils thinking and learning.

The observations are collected to the Moop-environment and are used as a part of schoolwork in net-based learning environment (Riihi). Pupils are able to edit the observations to the appropriate form and construct the mind maps in relation to observations and the existing material. Pupils have a possibility to use phones also at home and do some mobile observations at their leisure time. They are interested and eager to do so and carry on their task there. Mobile phone and the Moop-learning environment are always with learners, as part of a normal life. The overall learning process is demanding. Pupils are deep inside in a subject only after many rehearsal times. Operation can be practised through single observations and examples by constructing the meaningful and motivating learning situations.

#### 4. User interface

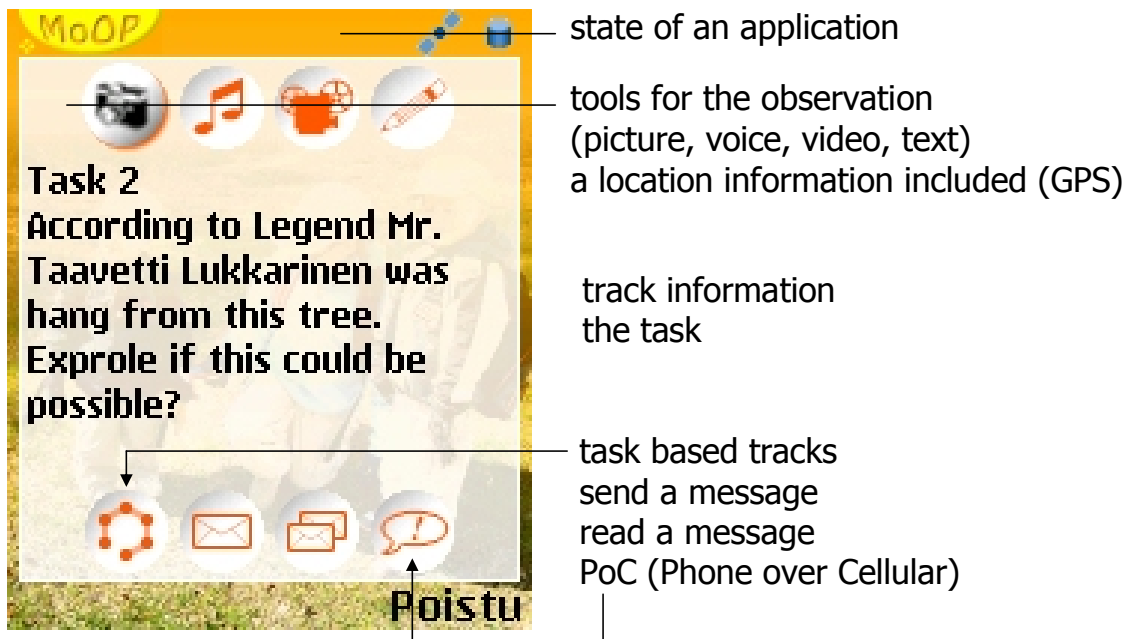


Figure 2. Moop User Interface in the Screen of a Mobile Phone

#### Mobile Phone

In the Moop-project it has been designed a user interface and application working for mobile devices in Symbian S60 operating system (for example Nokia 6630). It includes an observation gallery, an own user interface for management of users and map bases as well as some administrative tools in the Moop-network environment. Moop-observations are utilized as a part of web-based learning environment (Riihi) at the schools in the city of Oulu.

Moop learning environment is a user interface for mobile phones. It collects the teaching features inside the same application. Through Moop the pupil analyzes his/her thoughts and makes observations from the mobile device and carries on the process in network. Moop application has been planned from the basis and needs for primary school pupils. According to the experience the phone and the user interface can be adopted naturally. The user interface planned for primary school learning situations must be logical, motivational and easy to use.

The Moop-project can be described also as a learner centric technology development. The fundamental point is pupils' actions. The demands and benefits can be obtained to the pupils work through m-learning. At the same time it is possible to achieve information about the culture how the youngsters use the cell phones. With this feedback it is possible to continue the developing process and share it straight to pupils' level.

In the first phase was created a platform for collecting data from near surroundings. It enables the observation, saving and sending of phenomenon with the location information from observation point straight to the server. It enables the edition and analysis of raw data in the observation point. The created application was already more than just a tool for collecting observation. It creates the base for learning platform or mlearning environment. It is a surrounding where pupil login with his own username. The mobile terminal is in connection with a server program which transmits the information between mobile terminals, www-browser and data base. In the second phase into the environment has been developed a possibility to build task courses, which enables to form location-bound routes. The returning time and the safety area will be defined into the each route. There are tools for helping to enlarge the cooperation and interaction as PoC (Push to talk) function and features like reading and answering messages inside the Moop.

The application collects the digital data and transmits it to a certain server address by using only acceptable data connection (GPRS/3G). The media transmitted through user interface can be text, photo, video (.3gp),



a report, a record or transcription like voice message, for example an interview (.amr). The equipment used is also a phone and it can be used like a normal phone. With a phone call it is possible to clarify the subject. Pupil has also a possibility to search the task, messages and notes made by teacher or other group of pupils.

Both the teacher and the pupil have a camera phone using the Symbian operating system. The learning tasks are being transmitted through the Moop-application. The class teacher guides the action by setting questions and pupil does the observation and problem solving in a meaningful way from the surroundings. When GPS-locator is switched on the pupil is able to find his own position and the observations taken from the map base. The location information will automatically be attached to every observation and will be transferred to the class room, directly to the school teaching situation. There are more web-based tools to handle and perform the observations in the classroom. In our project we operate with a web-based learning environment called Riihi. The information stored with mobile devices is categorised and specified through logical user interface. The meaning of that information is to fulfil the information found from the study book, as a natural part of school's learning process and curriculum.

### **Moop Network Environment**

Pupils have also Moop-network environment in their use. They sign in with the same username as to their mobile device. The observations made by camera phone are transferred to the network, where those are available to the pupils in their computer or laptop. The pupils operate by using tools on a Moop-network environment or the used web-based learning environment. The observations are listed according to observation group or shooting date. Writing notes can be added as well. The meaning of these messages is to analyse pupils work and thoughts when writing the final outcome. All the observations are presentable and the included text editable in the Moop-environment.

The teacher has also administrative tools. These tools give the teacher wider opportunities, such as run and edit tasks. Admin user has a right to create maps and the location points needed for the GPS-locating. Admin user can plan routes and tasks to the pupils and for their mobile devices. Teacher works as an intermediate between closed and open surroundings. Teacher can remove the pointless observations and also publish good quality works or pupils' material which will be moved to sort of a media bank, from where it can be utilized by the others. Teacher can also transfer the photo straight to the web-based learning environment.

### **The Key Elements in the Moop-Application**

\* Tools for observation: Moop is based on the idea where the application collects the useful features from mobile phone inside the one user interface. Though Moop application user can control a camera, a video camera and a voice recorder features. When GPS-locator is connected the location information will follow observation automatically. The additional information like the shooting time, date, place and the photographer is being recorded. Before the application sends the observation further it must be named or classified by typing. The function is for the analysing the observation purposes straight from the shooting point. It guides to consider more closely the circumstances in the place the observation is made. This information is useful when the learner is building the final study in the classroom situation.

\* GPS-location technology: Maps are located at the server and are downloadable to the user's mobile phone via data connection and GPS-positioning system. A variety of electrical maps, for example guide maps, orientation maps or aerial photo maps, can be used. Before utilization the map has to be transformed into a suitable form and scale. A GPS-locator device can be used in the teaching situation. A location-bound task course is created with the help of a GPS-locator and a user can easily proceed on course to reach the set goals. The defined boundaries limit access to safe and permitted routes only. If a pupil leaves the defined safety area, both the pupils' and teachers' mobile phone notifies them with a voice signal. Planning the route with Moop's map view gives the possibility to plan a variety of learning situations and study plans. With the teacher application it is possible to plan the route directly live on course in the nature and in the observation place. The benefit of geographical location technology has been used in school learning situation when the teacher have planned routes but also when pupils have made roots for themselves and to smaller pupils. (Vygotsky, 1978) Using the maps in primary school learning we can get a great deal of useful information to benefit the teaching.

\* Push to talk – function (PoC, Phone over Cellular): PoC enables a direct voice communication between teacher and / or pupils in a closed environment. The PoC connection is opened with a push of a key (tangent), just like in the old radio phones. Pupils have also noticed the benefit in leisure time or in hobbies when forming closed groups or one to one connections when demand. This feature has turned to be useful in education. PoC connection establishes security. In remote learning situation the teacher or peer group can be activated by pressing just one button. By using the PoC connection it is easy to direct group movements and to give extra information which can be helpful when seeking the solution to a task. It is also realistic to give all introductions through Push to talk connection. This direct call over data connection improves the usage of environment by giving remarkable additional feature to interaction and cooperation tools in the Moop. As an individual application made by the Nokia the PoC-feature was adapted as part of Moop-user-interface easily. The interaction between learners can be also supported by the tools for send and read messages. It is possible to send message bases from one phone to another or form one group to another according the task.

## **5. Utilization of an Experiences and Results**

The operational environment for Moop-project is the primary and secondary school classroom (1<sup>st</sup> to 9<sup>th</sup> grade), which is led and guided by the teacher. The actions occur in real school day situations in three primary schools in City of Oulu, in three classes. The pedagogical developing process is participated three teachers. There are average 20 pupils in a class. The environment and the equipments are in constant use of 60 primary school pupils at the age of 10-12 years (3<sup>rd</sup> to 5<sup>th</sup> grade). During the spring 2005 the environment was used and tested by a thousand novice pupils. Mobile phones are used as much as it is rational from the point of view of learning. Moop-environment and the use of terminals are part of ICT-didactic use in teaching.

The main mission to the teacher is to connect the teaching into practise, branch of study, study material and to the observation of surroundings. This action is put into practice by the utilization of developed learning platform. The new features are being planned according to the need of the environment and contents. Those will also be tested in practise. The existing environment will be developed through the interaction between the school learning, software design technology and the desired user descriptions.

The pupils have been aware of the process and the learning model used. The aim concerning the learning is to define phenomenon, not just to remember pure facts. The attitudes and functions among girls or boys have been quite similar. There have been no significant differences. Pupils have had a possibility to operate the device during evenings and weekends. At the piloting session the amount of phones has been limited and eagerness to run those, also at home, has been considerable.

Based on the experiences on the mobile leaning environment and the knowledge building model, the users have found them to be motivating, encouraging – and in their own language, "cool". They thought that the best outcome was that the only solution didn't find out just by reading the school book, but it was possible to do research, seek and test the best solution by them. At the same time it was possible to learn how to use equipment and how to transfer data of your own picture, voice or text to the network and process them there.

The first pilot was carried out in Korvensuora Primary School (17.-25.5.2004) and contained one school class with 25 pupils. During the piloting project it was taken around 362 mobile observations with image, voice, or video data. The amount of the observations taken was considerable concerning the time and equipments used. Also the quality of data and how significant it was towards leaning was positive and encourage continuing the trial. After the first piloting session the surrounding was developed and supplied with new features, which have been described earlier. During this spring term 2005 there has been stored up to 2 GB observations taken mainly three school classes. The accuracy of observations has improved significantly along the phone models, when an observation can be average 500 kb. The standard of observations rise remarkably when the observer learn by experience and when the observation situation is designed in advance. The utilization of these observations in the school situations does not depend on the quality of a digital data. The observations in the server are originating from school day, home environment, big events, pets, festivals or to the school task. There are so many observations that the classification and searching tools will be emphasized in the continuation development.

The observations are especially valuable, because those are pupils' own. When considering closer the use of Moop-environment and knowledge building process it is noticeable that traditional school teaching will change. Study books made by publishers and photos included in paragraphs are no longer the only source of information – those are an important source among the others instead. Pupils own working process and importance of their own observations are being emphasized – pupils take an active part as content producers. They are not only learning the information nuggets but also the learning process itself which will be useful afterwards in equivalent situations. Pupils' activity and their own working process are emphasized and the role of the teacher is becoming more and more as a mentor of a class, group of pupils or single pupils. The teacher shares the basic information of knowledge management and media education. These skills are important when doing the projects. The value of the information that the pupil gathers from peers and peer groups is more crucial. (Vygotsky, 1978) This depend more communication and interaction skills. Moop-environment includes the tools supporting the process. It is very important to analyse and develop this technology further when there is more evidence of utilization in school practise. Overall the function teaches responsibility and ethicality how to use this kind of system. It can be described as a sort of mobile etiquette which will be practised in a closed group.

In the future the effort is to increase the work with mobile terminal. It leads the learning process in distance. The stages will be integrated to network learning environment working, your own study process and a class schedule. Bidirectional data transmission is part of the process and the environment is working as a tool for knowledge building. Practically this means that the learner analyzes the observation before it is made and learner can benefit from this information when and where ever. With this information the learner can edit the working plan and affect the course of process. The possibility to suggest comments to the work and observations by others is improved and that will affect directly to the own working process.

When the pupils are familiar with the surrounding, it is possible to establish cooperation between classrooms and teamwork between the teachers. Pupils are able to do larger projects and those can benefit from other pupils at the same or completely other circumstances, for example in the natural science projects. The learning process and utilization of ICT-technology in the teaching educate to the information gathering and managing process. This forms an important base for future learning and missions of life. In addition to the learning the thinking and the view of life is expanding and becoming as part of everyday life.

## **6. Conclusions**

Through Moop mlearning environment it is possible to reform the culture of openness, based on sharing the information and cooperative learning. Open discussions held with interactions between peers are leading towards the group shared knowledge and at the same time the standard of knowledge of an individual learner is rising. By using the right learning environment it is possible to support the knowledge building process in a way we can achieve the understandable and profound learning results. The benefit from using the learning environment is to practice the information and abilities which can be useful to the citizen of tomorrow's information society. Pupils are operating rationally and responsibly with mobile phones, by given instructions. Experiences with these mobile terminals have shown that it is a meaningful tool for primary school pupils and part of learning process. The tool has been motivating and easy to use and it benefits the situation in practice by supporting the learning process and helping the classroom functions.

Moop affords a useful opportunity to do problem based observations from nearby surroundings. According to a pattern of working model the teacher can create learning situations that the pupil can solve through own planning, actions and reasoning. The pupil reached a unique learning experience that is not dependent on any school books. Through given tasks the pupil makes observations from neighbourhood, for example the recycling process at home, respond the matter and influence the decision and way of action at home. By following that mode of action the pupil can directly affect the decisions and actions in surroundings. The noteworthy observations can be taken from the same position at a different time or different angle by different pupils according to task. The remarkable observations are as well the unique observations which will appear suddenly and are valuable to record for further examination. Through Moop-environment and a camera phone pupil can look at the living surroundings by open eyes.

The solutions used in Moop-environment efforts to increase security. A task course is created with the help of locating technology and a user can easily proceed on the course to reach the set goals. The defined

boundaries limit access to safe and permitted routes only. Teacher is all the time aware of the pupils' location, their progress and the time used on the task course. If a pupil leaves the defined safety area, both the pupils' and teachers' mobile phones notify them with a voice signal. The teacher and pupils can communicate real-time through the mobile phone's PoC connection while outdoors and make focusing questions. Regardless of task based routes it is possible to do Moop observations from normal surrounding in every day school situations and on a way to school, at home or in hobby. Mobile phone is generally part of everyday life.

One of the main aims is by working together to find new innovations in teaching and the pedagogical teacher work. From the experience learned in this project mlearning and Moop-environment are suitable ways to benefit in different learning objects and fit to as part of primary school everyday learning process. Before the cell phone is considered as a prohibit tool for classroom, although for children it's quite natural tool for communicate. This Moop-project has been start from the idea, if it is possible to find real, true and useful subjects of benefit the camera phone in school and as part of learning process. The children don't accept to do things in a one certain way. It is allowed to do mistakes in school learning and the activities are being prepared in closed surrounding.

## Basic education "model for knowledge building"

future information society skills

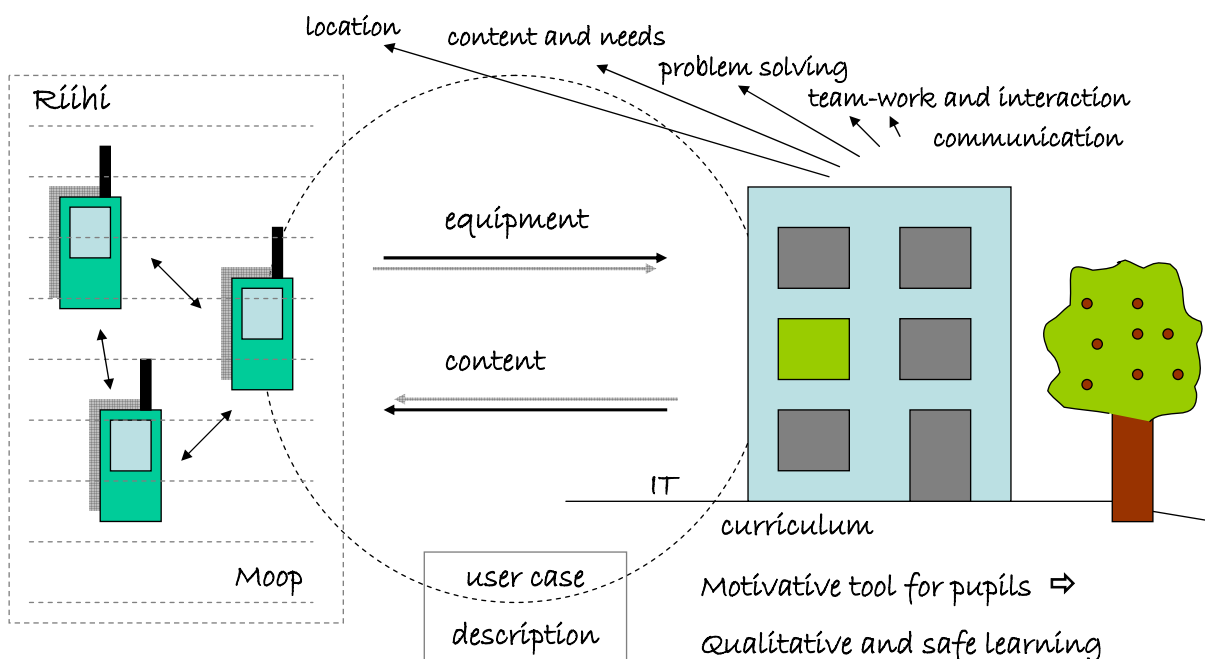


Figure 3. Developing Aims

Moop is used as a certain learning model in the classroom. When you look at the outcome of the learning results and pupils work you realize how much essential matter about teaching subject those include – mind maps, mobile observations, concept explanations and the text pupils can form through the whole model. The observations pupils make are saved to the server, to the digital data storage which is growing gradually and will be in use of all the pupils using Moop. Little by little all the mobile services become merged in school system. It develops and brings its own benefit to the existing learning solutions. The idea is to build own learning portfolio which goes together to the following school level. The building tools during the project are possibly opening the channel to make cooperation between parents and school. School with the information get nearer to pupils home and for parents it's easier to stay in contact with the school – when the one natural goal for learning starting point will be the problems raising from own neighbourhood.

## **7. Future research**

Moop mlearning project is in a way of "expedition" journey during which we are building something new and as far as concerning about user's learning process – we have to let space to do some experiments. There are no certainty towards we are heading. Progress takes place little by little through the feedback we can get from users and by following and reporting the function and advance. In the educational matter the user interface set up large pedagogical challenges, which will be interested to consider by doing research and practical teaching in normal school day.

## **8. Acknowledgements**

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## TAKING THE DISTANCE OUT OF DISTANCE EDUCATION THROUGH THE MEANS OF MLEARNING

Keywords: Distance Education, short message system (sms), learner support

### Abstract

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 by Lusunzi (1998: 1) 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" (Dhanarajan: 1996).

The aim of this article is to determine if learner support through the means of 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" (Lusunzi, 1998: 7). As these students struggle 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 (Molefi: 1999).

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

## **Introduction**

Beep! Beep! - This all too familiar sound that resonates in malls, on city streets and even during movies. It is the sound of billions of Sms's that criss-cross the globe each year, carrying with them the hopes, dreams, ambitions and emotions of billions of people that are flexing their thumbs to send these text messages.

Why can't we as educators use this to start our own "flirt net" or a "cupid learning net"?

In doing so we might enhance the learning experience for all, but especially the distance learner.

How would you react when you receive a *short message system* (sms) from the university where you are enrolled? You would probably feel excited to be part this new adventure called learning, which is described by Lusunzi (1998: 1) 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".

Enrolling at a distance education institution is much more than just studying and "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" (Dhanarajan: 1996).

"Right in the middle of every distance education system is the student. It is for this person that we, collectively, come together to conceive and create course materials, scheme out ways and means of having it delivered, prepare challenges to test if learning outcomes are being met and finally celebrate the success of the students as well as the teaching/learning venture" Dhanarajan (1996: 1).

Accessible support emerge here as one of the key factors. The better support there is for learners and the easier they can have access to it the less likely they will consider dropping out. "Those unhappy on either count were almost three times as likely to think of leaving" (Richards: 2005).

As the distance education student struggles to cope with all this information, as well as the demands of distance learning, he or she comes to realize that they need help, to the extent that, without intervention, they may well drop out of studying (Molefi: 1999).

## **Student support can counteract the feeling of alienation**

The student's success and the success of the institution depend not only on the quality of the learning package that was sent to this student, but also on the quality and scope of the support that the student is given.

Academics can make a huge difference. "Mature and first-generation students often lack academic confidence, so feedback is essential." Students become frustrated if they feel alienated and "those who had not made new friends were more than twice likely to consider dropping out" (Richards: 2005).

Students receive study packages that are sometimes well designed and sometimes not very well designed. The lecturer simply does not always know how they (the students) react to these materials. Where does the learning begin? During enrolment very little is done to prepare students for the interaction with their study packages. As a result, once they have received their study packages in the post, students are on their own. Molefi (1999: 2) says that the student faces different kinds of isolation or distance. These are

- social
- psychological
- economic
- cultural (context of learning and way of life)
- geographical
- communicative (feedback is delayed)
- distance created by differences in knowledge:
  - knowledge the learners have
  - difference levels of knowledge between tutors and learners
  - different levels of knowledge held by the institution itself - that is, about what services it provides and the knowledge learners have about the services available to them.

### **Interactive study packages take the distance out of learning**

Distance education should therefore also be designed to resolve this problem of alienation. "Providing correspondence education with minimal support is not a way to help..." (Knox: 1999). As a result, some distance education institutions have established departments specifically for this function.

One of the most effective tools is the development of high-quality interactive study packages for students. Packages that take the distance out of learning through activities which bring the lecturer and the learner closer together where there could be a 'meeting of minds' (Lusunzi, 1998: 7).



To facilitate learning in such a way that students will reach the goals they set their minds to, a distance education institution, according to Molefi (1999: 3), should:

- help its students by minimizing the effect of isolation
- minimize the dropout rate
- help students deal with the institution and augment the package of course materials
- improve the students' learning experience
- provide extra assistance for weaker students
- provide counseling for those with personal difficulties

The *Institute for Curriculum and Learning Development* (ICLD) at the University of South Africa (Unisa) is involved, on a daily basis, in developing study materials/study guides. They think that the following principles are important when a study guide is being designed:

#### □ **A curriculum relevant to the student's needs**

A curriculum is more than legislation. It is more than a descriptive way of packaging learning content. It should be in touch with the student's world: his/her beliefs, interests, culture, individual differences, goals, where the student lives and the experiences he or she has. Relevance means using examples relevant to the world of the students and, for example, not telling them about Heathrow Airport if an example of their own taxi-rank is adequate and is something they understand. Relevance therefore means: "for the intended target group".

#### □ **Competency-based student-centered learning materials**

If the student becomes the most important person in a learning experience, then he or she should not be a 'dumping ground' for content. Authentic tasks should be designed in order for students to illustrate their competencies. Here they should be able to demonstrate their problem solving skills that are based on the real world in which they live.

#### □ **Accessible language usage**

Language usage that is easily understood does not mean a lower level of language usage. It only means another register - where these diverse second language students understand all the words that are being used.

#### □ **Interactive study material**

SAIDE (1999) says: "Appropriate use of activities in learning situations encourages learning by **doing** as opposed to the memorisation of facts. Activities provide immediate feedback on the students' learning progress....In addition, they allow for the sharing of students' prior experience and interpretation of issues being

learnt". These activities can be questions, short exercises, review questions and assignments.

#### **□Communication between many stakeholders**

Communication among all the parties involved becomes even more important in a distance education situation than in a face-to face institution. To minimize the student's feeling of isolation (already discussed) it is very important that there are good communication channels not only between the lecturer and student, but also between the student and tutor and the student and his or her peers.

Du Plessis & Van der Merwe (Undated) states that the first principle for good undergraduate education is student-lecturer contact. Rixon (1985) says that "telephone tutoring led to increased interest in the subject studied". These days we can also use e-mails, text messages, discussion classes, discussion forums, chatrooms and many others. We need to explore text messages to help us here as 82% of Unisa's students have cell phones and 100% have access to a mobile phone.

Properly trained tutors and counsellors, who are thoroughly familiar with the study material, can help these students studying at a distance not only to survive, but also to complete their studies successfully. Interactivity between these two parties also means that an institution should provide sufficient student centres where students can study, get access to technology and those practical requirements asked for in the study package. Lusunzi (1999) says: "distance teaching should be an innovative and stimulating process in which the learner and the tutor are equal and symbiotic partners".

Learning also takes place by discussing the learning materials with one's peers. Study groups, paring of students that live close by, and even exchanging cell phone numbers, supports the learning process immensely, not only because of the interaction and distribution of ideas and opinions, but also because it benchmarks the learning content between the group and individual learners (Rixon: 1985).

#### **□Throughput rate**

Many tertiary students find distance education as a method of studying very difficult indeed. According to Rixon (1985), dropout rates can be as high as 50 percent after 12 months and as many as 10 % may never submit an assignment. At Unisa it takes the average student nine years to complete a degree and only about 15 % persevere to the end.

#### **□Turnaround time**

Prompt acknowledgments of students' admission and enrolment, prompt material delivery and easy access to resources, as well as fast responses to queries, fast assignment turnarounds with positive, supportive feedback are all directly linked to

students' throughput rate (SAIDE, 1999: 3). Holmberg (Rixon: 1985) notes "that there is a distinct correlation between turnaround time...and course completion". Text messages might prove to be a valuable tool in future to use in this regard.

### **Mobile technologies and learning**

When we look at the very diverse distance education learners in the South African, or per se within the African, context we wonder what these learners have in common. The answer is a mobile phone. This is the one handheld device that can be used successfully to reach some of the most distant and disadvantaged learners. According to Attewell (2005: 2) "There are estimated to be 1.5 billion mobile phones in the world today. This is more than three times the number of personal computers". This is also the easiest of all the mobile devices to master. According to Attewell, about 62 % learners are enthusiastic about mobile learning and they are keen to take part in future learning, after they have tried mobile learning. Many of these learners might never be able to afford a personal computer but they are very likely to own a mobile phone which will become their "digital life" (Attewell, 2005: 2).

"It is within this context that m-learning can contribute to the quality of education. It offers opportunities for the optimization of interaction between lecturers and learners and among members of communities of practice" (Brown: 2004).

Using a cell phone to enhance learning is practical because almost all learners have access to one, to either send or receive a text message. It is also a relatively cheap method. At Unisa it costs about twenty two cents to reach a learner by sms through the University's Learning Management System (LMS).

The Technology Enhanced Learning Research Centre in the United Kingdom (Attewell, 2005: 13 & 14) made the following key observations:

#### **Key observations**

✓ **Mobile learning helps learners to improve literacy and numeracy skills**

Even though the learners were only involved in mobile learning for a short time, the research centre reported improvements in their reading, writing and arithmetic skills.

✓ **Mobile learning can be used for independent and collaborative learning experiences**

Some of the learners preferred to work independently, as they felt under no pressure, and could do it in private, where with a computer; everyone could see

what you were doing. Others welcomed the opportunity to work in a group because they could assist each other with the mastering of the technology of the devices.

✓ **Mobile learning helps learners to identify where they need assistance and support**

The research centre reported that as a result of participation in the m-learning projects the learners have not only developed greater confidence in current reading and writing abilities but have also sought help to improve mathematical skills from local Adult Basic Education Centres.

✓ **Mobile learning helps to overcome the digital divide**

The research centre further reported that a number of learners within the group who had previously avoided using a computer where now keen to try, and as their confidence grew their skills were also enhanced to such an extent that they helped their peers.

✓ **Mobile learning helps to make learning informal**

Because familiar games such as **PlayStation** and **GameBoys** were used the learners felt comfortable to engage with each other and it also kept their interest levels high.

✓ **Mobile learning helps learners to be more focused for longer periods**

The learners were observed to be very calm and focused during the sessions when they were given the devices to use.

✓ **Mobile learning helps to raise self-esteem and self-confidence**

Allowing learners to personally take responsibility for the care of the devices made them feel trusted and it helped to build their self-esteem. Another boost for their self-esteem where when they realised that as experienced users of mobile phones they possessed useful skills which were perceived as important. It was also observed by the research centre that there were changes in the learners' level of general self-confidence and it improved their skills in working with others. They were willing to take risks and they tried new things.

### **Implementing mobile devices in the learning experiences**

In Africa the wireless future might not be as spectacular in the learning context as it is in the business world, because of student's funds and access to available resources. This does not mean that educators should not start to get the ball rolling.

**They should:**

- Develop materials specifically designed for cell phones and learning and should not try to re-use materials designed for computers.

- Registration forms should be revised to capture all relevant information such as cell phone numbers, and if the students are prepared to have their privacy invaded by text messages from the institution.
- Mobile learning should already be included in materials at the curriculum phase and not added on in the end.

If sms's seems to be too tedious as it takes longer to type and only a couple of characters can be used, then other methods should be researched. Options such as the "voice-in-demand" option used in Israel for certain religious groups who are not allowed some technological devices.

### **The way forward**

It is important for mentors and facilitators to stay involved and to be enthusiastic at all times to ensure successful mobile learning. Institutions need to make time for training. A training needs analysis is very important for these mentors and facilitators, as mobile literacy and confidence varies.

Training as well as ongoing access to advice and proactive support in the beginning will be helpful for mentors. Fast responses to the students' problems are crucial to avoid disillusionment with the mobile devices used. Proactive support encourages the mentors to also be more proactive and it will help to identify issues before they become serious problems (Attewell, 2005: 17).

### **Conclusion**

"Most institutions concur that distance education students need proper support structures to give them confidence and enable them to work properly" (SAIDE: 1999). Through support learners' throughput rates might be improved and study packages opened earlier so that the learning experience can start sooner. Active learners might immerse where previously inactive studying took place.

The aim of this article was to determine if learner support through the means of 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, not only by sending a sms as a reminder or as encouragement but also for lecturers to invite learners to send a sms summarizing their reflection on the learning experience.

Richards (2005: 1) says: "We need to build strategies into our institutions that better fit the students we have, to support their retention and success".

Mobile devices in the hands of the distance education learner can be used, now and even more so in the near future, to engage the learner in the learning activities

that might "change their attitudes to learning and thereby contribute to improving their skills, opportunities and their lives" (M-learning: 2005).

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# WE NEED AN EDUCATIONALLY RELEVANT DEFINITION OF MOBILE LEARNING

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## Abstract

In this paper we challenge current definitions of mobile learning and suggest that the direction of progress, both in theoretical/applied research as well as its role as a tool that serves social transformation and development, will be determined and even dictated by the availability of an adequate definition. A new framework for the definition of mobile learning is proposed, one that considers a repertoire of domains, and which embraces not only technical, methodological and educational aspects, but also considers social and philosophical dimensions.

**Keywords:** mobile learning, definition, theory, philosophy, pedagogy, mental development, social responsibility, literacy divide, digital divide.

## Introduction

Why has the term “mobile learning” suddenly become so fashionable? Sometimes, we become witnesses of re-organized scientific communities appealing for a niche role in mainstream science with catchy terminology in an attempt to attract interest and funds. Usually such attempts turn out to be nothing more than a re-packaging of existing concepts that do not add to our scientific understanding. Is mobile learning such an example of science trying to sell us a new discipline? Doesn't mobile learning simply mean “learning on the move”? In other words, doesn't the new term simply attempt to differentiate between learning that takes place in a formal context, such as a classroom, from learning that takes place anytime, anywhere while we are moving in our environment? If this is the case, then what is the nuance? Haven't we invented audiotapes with pre-recorded language lessons to carry with us while driving or jogging several decades ago? Hasn't learning always been mobile since the “creation” of man (or even before), thanks to the fact that we (as well as other animals) carry in our skulls a supercomputer we call brain? Don't we really learn at all times, wherever we are, whatever we do, simply because the learning machine is always “on”, even during sleep when we re-organize and sort out experiences and knowledge acquired during the day? If mobile learning is not really a new concept, why then bother with a new definition?

We ran a Google search in January 2005 using [“mobile learning” +definition] and received 1,240 items. We ran the same search at end of June 2005 and it resulted to 22,700 items. Running it on scholar.google.com we received 231 items. A quick consideration revealed that depending on who is asking, and what the context is, different people mean different things when they use the term mobile learning. In the mean time, the interest in mobile learning is growing exponentially. A search with [“mobile learning” + conference] gave us 45,100! Traxler (2005) has provided an excellent documentation not only of the most important international conferences, but also of the most influential projects of the past couple of years. We suggest taking a helicopter view of the



various definitions of mobile learning proposed so far and check whether we have a consensus, a redundancy and/or an overlap. Most researchers and educators probably view mobile learning as the immediate descendant of e-learning. Pinkwart, et al. (2003) for example, defines e-learning as ‘learning supported by digital “electronic” tools and media’, and by analogy, mobile learning as ‘e-learning that uses mobile devices and wireless transmission’. Quinn (2000) defined it earlier, as simply learning that takes place with the help of mobile devices. In line with this definition, several authors (e.g., Turunen, *et al.* 2003) view mobile devices as a pervasive medium that may assist us in combining work, study and leisure time in meaningful ways. Polsani (2003) considered these definitions “restrictive” and proposed instead the term ‘network learning’ (or ‘nlearning’). He therefore defines mobile learning as ‘a form of education whose site of production, circulation, and consumption is the network’. More recently, Traxler (2005) defined it as “any educational provision where the sole or dominant technologies are handheld or palmtop devices”, but a few paragraphs later he admitted that this definition might be rather technocentric and argues that we might need to look at mobile learning from the learner’s and user’s perspective. Sharples (2005) took a different approach. He described learning “as a process of *coming to know*, by which learners in cooperation with their peers and teachers, construct transiently stable interpretations of their world.” This definition gives mobile technologies a special role, because they dramatically increase our possibilities of communication and *conversation*. According to him, this radical constructivism (von Glaserfeld, 1984) extends the notion of learning as a constructive process beyond the individual to describe how organizations, communities and cultures learn and develop. All these definitions highlight differences in both perceptions and expectations. We cannot claim a consensus, but we can concede these noticeable differences call for a new definition. The way we define mobile learning inevitably emphasizes certain aspects and favors certain perceptions about it. Where there seems to be some consensus, however, is that mobile learning is something that needs to be re-considered in the context of the appearance of electronic mobile devices. Yet, even if we decide to define mobile learning in this context, we still have to consider two issues. First, the term mobile learning is composed of two words; the word “learning” demands at least as equal attention as the word “mobile”. In other words, defining mobile learning only in the context of mobile phones leaves out half of the story. The second issue is that the mere appearance of mobile devices, calls for the re-definition of many other terms and concepts as well. For example, concepts like “space” and “being-there” or the “learning environment” need to be revisited. Even more general concepts such as that of the digital divide (see Discussion section for an analysis of Nyiri’s 2005 thesis), our understanding of religion (see Laouris argumentation in Laouris 2006; draft available at request), or philosophy might need to be revised. In conclusion, the situation is in fact much more complicated than a superficial, helicopter-view consideration reveals. We therefore need to approach the issue of defining mobile learning in both a *systematic* and a *systemic* way. The requirement “systematic” will translate into considering each term (“mobile”, “learning”) in isolation as well as in concert (i.e., “mobile learning”). The requirement “systemic” will translate into considering the whole environment in which mobile learning unfolds, i.e., the inter-relations and interactions between technology, the learning environment, the philosophy, the pedagogy, etc. In the following sections, we will attempt to develop a comprehensive framework to embrace definition of the term “mobile learning” by considering its various facets and aspects both in isolation and in concert.

## **Preliminary considerations**

### **The term “mobile”**

Many authors use the term mobile as synonym to mobile phone. This amounts to an over simplification that misses the whole concept, because viewing a telephone as a device which operates wirelessly reveals only a very thin aspect of what today’s mobile technologies can offer. Indeed, the authors proposed the thesis that the appearance of the mobile phone has signaled the

launching of a major revolution in human evolution. While the computer constitutes the first human construction that aspired to amplify mental rather than physical human powers (in contrast to all previous human constructs; for an elaboration of this argument see Laouris 1998, 2004, 2005c), the mobile phone goes one step further. It marks the appearance of a new “organ” in the evolutionary time line; one that extends the human language system, both on the receiving (i.e., hearing) and the sending (i.e., speech) end (we refer to this as the third hear-and-talk organ). It can claim the role of an “organ”, because it indeed “integrates” directly with the brain (for a thesis on how innovations in technology may serve human evolution see Laouris 1996, 2005c). It thus demolishes distance, it demolishes boundaries (private or public), it will soon even demolish the very concept of what it means to be here or there. For the physically disadvantaged, the mobile phone (and more generally, the virtual identity that may accompany it) makes their *problem* disappear (no one can tell on the phone how you look, i.e., if you are paralyzed or if you are ugly) by lending them an “invisible” body. According to Nyiri (2002, 2005) the “... mobile phone is evolving towards the dominant medium. It is becoming the natural interface through which people conduct their shopping, banking, booking of flights, etc. Moreover, it is turning into the single unique instrument of mediating communication not just between people, but also between people and institutions or more generally between people and the world of inanimate objects”. The mobile phone is also joining the sphere of mass media. In the next few years the mobile phone will be the primary source for radio and television signals, as well as the link to up-to-the-minute information. We conclude this section by underscoring that not only the concept of mobility, but also that the concept of the *third hear-and-talk organ* triggers changes far beyond those imagined by its two billion users.

### **From e-learning to m-learning; Learning in focus**

Many authors (e.g., Mostakhdemin-Hosseini and Tuimala, 2005) view mobile learning simply as the natural evolution of e-learning, which completes a missing component of the solution (i.e. adding the wireless feature), or as a new stage of distance and e-learning (e.g., Georgiev, et al. 2004), one that describes it as occupying a sub-space within the e-learning space (which in its turn occupies a sub-space within the d-learning space). The transition from the e-learning to the m-learning revolution is characterized also by a change of terminology. For example, the dominant terms in the e-learning era were: multimedia, interactive, hyperlinked, media-rich environment, etc. In the m-learning era terms like spontaneous, intimate, situated, connected, informal, lightweight, private, personal etc. are used to characterize the context. Table 1 contrasts the choice of terminology with underlying characteristics of the two types of learning environments, while Table 2 illustrates their differences in the context of pedagogy and environment. While e-learning was still compatible with the classroom paradigm, m-learning calls for environment- and time independent pedagogy.

Table 1. Terminology comparisons between e- and m-learning

<b>e-learning</b>	<b>m-learning</b>
Computer	Mobile
Bandwidth	GPRS, G3, Bluetooth
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Collaborative	Networked
Media-rich	Lightweight
Distance learning	Situated learning
More formal	Informal
Simulated situation	Realistic situation
Hyperlearning	Constructivism, situationism, collaborative

Table 2: Pedagogical differences between e- and m-Learning environments  
(Modified from Sharma & Kitchens 2004)

Pedagogical Changes	More text- and graphics based instructions	More voice, graphics and animation based instructions
	Lecture in classroom or in internet labs	Learning occurring in the field or while mobile

The mere use of terms like *when I want*, *wherever I want*, and *however I want*, indeed impose new requirements not only to the technological and educational frameworks, but also to the way in which all actors interact and communicate. Table 3 summarizes differences in these communication pathways. Finally our possibilities for assessment and evaluation are different for the two paradigms (Table 4).

Table 3: Differences between e- and m-Learning environments with respect to modes of communication between actors (Modified from Sharma & Kitchens 2004)

Instructor to Student Communication	Time-delayed (students need to check e-mails or web sites)	Instant delivery of e-mail or SMS
	Passive communication	Instant communication
	Asynchronous	Synchronous
	Scheduled	Spontaneous
Student to Student Communication	Face-to-Face	Flexible
	Audio-teleconference common	Audio- and video-teleconference possible
	e-mail-to-e-mail	24/7 instantaneous
	Private Location	No geographic boundaries
	Travel time to reach to internet site	No travel time since wireless connectivity
	Dedicated time for group meetings	Flexible timings on 24/7 basis
Poor communication due to group consciousness	Rich communication due to one-to-one communication, reduced inhibitions	

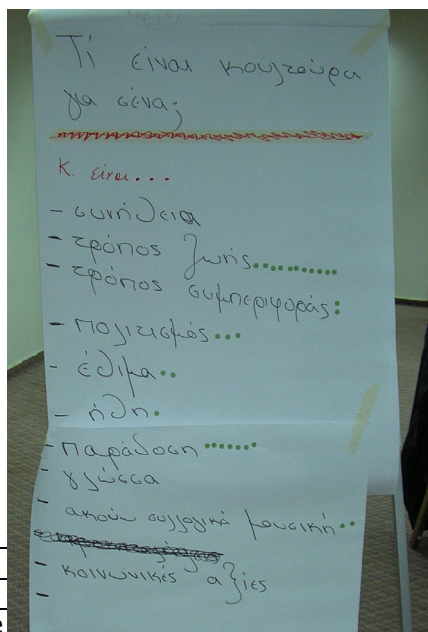
Table 4: Differences between e- and m-Learning environments with respect to methods of evaluation (Modified from Sharma & Kitchens 2004)

Feedback to Students	1-to-1 basis possible	1-to-1 basis possible
	Asynchronous and at times delayed	Both asynchronous and synchronous
	Mass/standardized instruction	Customized instruction
	Benchmark-based grading	Performance & improvement-based grading
	Simulations & lab-based experiments	Real-life cases and on the site experiments
	Paper based	Less paper, less printing, lower cost

The above tables may guide us to define mobile learning in ways, which not only take into account the various aspects that change, but also take advantage of the emerging possibilities.

### Mobile learning and the universality of culture

What is culture? In a series of four youth (ages 12-16 years) workshops we proposed this as our triggering question for a brainstorming session among 20 individuals (in each workshop). Not surprisingly, all groups came up with more or less the same definitions (confirming the correctness of the “collective wisdom” concept), an example from one case shown in Fig. 1.



Assignments & Tests

In-class or on computer	
Dedicated time	
Restricted amount of time	able
Standard test	Individualized tests
Usually delayed feedback	Instant feedback possible
Fixed-length tests	Flexible-length/number of questions

Presentations, Exams & Assignments

Theoretical and text based	Practical oriented exams direct on site, hands-on based
Observe and monitoring in lab	Observe in the field and monitoring from remote location
Class-based presentations	1-to-1 presentations with much richer communication
Usually use of one language	Automatic translation for delivery of instructions in many languages (possible)
Mostly individualized, component-based group work	Simultaneous collaborative group work
Paper-based assignment delivery	Electronic-based assignment delivery
Hand-delivery of assignments at a particular place and time	E-delivery of assignments at any place and time
Instructor's time used to deliver lectures	Instructor's time used to offer individualized instructions and help

Fig. 1 Pictures of wall charts taken during the workshop (for details refer to text)

A careful look at the various facets of the definition of culture and civilization reveals that “things we learn” are in the basis of most of them. As “learning” becomes more standardized (technology imposes this requirement), and more accessible to all (and thus more global) the shared knowledge

base (i.e., the overlap of knowledge across people who are geographically or nationally divided) expands. But if we accept that aspects of our culture and our civilization (and by extrapolation our learning base) contribute towards distinguishing countries and nations, aren't we then moving towards a global culture?

These thoughts illustrate how the wide penetration of mobile learning might even affect our very concepts of culture and civilization, thus contributing towards the emergence of a universal culture. The notion of the universality of culture is not new. Indeed, more than 23 centuries ago after leaping from Greece to conquer most of the known world, Alexander the Great envisioned such a world and attempted to create it by founding more than 70 cities all called "Alexandria". Before Alexander, there was little contact between different cultures (for example there is only indirect mentioning of the existence of Jews in Greek literature). Along with the characteristics of an emperor and dictator, he also promoted cultural diversity, openness and integration. Today, the unprecedented rate of globalization makes the mixing of civilisations, without the need for forced reinforcement, a reality. This mixing is supported by virtual (i.e., through mobile devices and internet) and physical (i.e., through traveling) communication, as well as by decreasing variability in what people "learn" and experience". In all these aspects, the mobile phone (with its various appendices such as video cameras) and the revisited concept of (mobile) learning, plays a prevailing role. But, what happens if the current status quo and power-relations among the nations and cultures is added to the picture? Will advances in telecommunications and wonderful opportunities such as of mobile learning simply become the tools in the hands of imperialist attitudes to impose and reinforce their own beliefs, stereotypes and educational models on the rest of the world? Therefore, we may conclude by saying that the mobile phone, and the concept of engaging in learning with it, does not come or exist or in a vacuum. On the contrary, it is part of a gigantic picture that extends to all angles of life and calls for careful and comprehensive examination. The way we define it will disclose the depth of our understanding of the magnitude and importance of all inter-relationships, as well as our commitment to apply it in the service of all humanity.

The discussion in the previous paragraphs illustrates how the definition of mobile learning might change as a function of time, but also as a function of our (biased) perspective. From the point of view that learning takes place in our heads, it has always been *mobile*. Yet, in the era of e-learning, a definition would focus on issues of accessibility to knowledge through (portable) computers and the internet, while a contemporary definition would have to take into account the various liberalizing- and concept-transforming attitudes of modern telecommunications. In the next sections we attempt to elaborate on how considering the various facets of mobile learning not only affects the definition, but moreover, it affects our assumptions, our expectations, and even our world-views.

### **Defining mobile learning in the context of devices**

Both Quinn (2000) and Pinkwart, et al. (2003) defined m-learning as "e-learning that uses mobile devices". Also, the majority of authors, actively or passively, apply a definition that views mobile learning as learning connected to a mobile device (and most of them imply a regular mobile phone or in the best case a PDA). Is it necessary to make the definition of mobile learning dependent on mobile devices (i.e., mobile phones), or can we envision a device-independent definition? Indeed, we would like to propose the thesis that not only should we not constrain our definition of mobile learning to *learning through mobiles*, but we must shift focus from device to human. We suggest taking a broader view that accounts for a learner freely moving in his physical (and virtual) environment. Tomorrow's learners will have access to a dynamically changing repertoire of devices and services that will differ in speed, processing power, monitor (and other output) characteristics, etc. As our engagement with technology changes with time, mobile learning

becomes a function not only of time, but also of the momentarily available and dynamically changing technology. The various mobile devices, embedded in our virtual environment, need to be considered not only in concert and in context with their inter-relationships and inter-dependencies to different types of content and content delivery. They must also be considered as functions to time-varying levels of attention, interest, preferences and motivation of the learner. The momentary access to the learner's private learning environment (which is constrained by the mobile device at hand) imposes requirements as to what type of learning might be advisable, possible or appropriate. We thus deduct that a socially and educationally responsible definition must view the learner as the one being mobile and not his/her devices! What needs to move with the learner is not the device, but his/her whole learning environment.

In closing this discussion about devices, we would like to point out that our approach, of shifting attention away from the device, also has political and philosophical implications. It is for example to the interest of the industrialized world to promote definitions that emphasize on devices, rather than on complex interactions and theory, because they maintain absolute superiority in the design and mass production of such electronic devices. Such a focus facilitates the opening of new markets to distribute their products, and at the same time serves to maintain the economic and digital divide.

### Defining mobile learning in the context of the learning environment and learning experiences

Learners do not learn in a vacuum. They learn together with their peers and their teachers, they learn while competing and collaborating, they learn by example, they learn by doing and they learn by correcting misconceptions they have from previous "learning activities". Furthermore, they learn within a well-defined learning environment. In the past, this was constrained within walls and the teacher was the main source of knowledge. With the advent of computers, the teacher was put in a position in which the information within the walls was competing with information outside the classroom and beyond his/her control, thus calling for changes (Koschmann, 2001, Bransford, et al. 1999). The concept of mobility (as we understand it in the context of mobile phones) invites us to revisit what learning actually means and what are its ingredients (graphical summary in Fig. 2).

Table 5: Components of the learning environment

1	Learner with paper and pen.
2	Teacher or other facilitator/coach.
3	Access to knowledge and books.
4	Structured curriculum with pre-defined tasks and targets as well as methods of interaction.
5	Learner is member of a learning community within which s/he competes in tests, cooperates in logistics and learning and

For example, to what extent is learning restricted to acquisition of new knowledge and to what extent does it encompasses the logistics related to the process of learning. What are the minimal ingredients of the learning environment. We propose these to be those summarized in Table 5.



Fig 2. The mobile learning environment.

The learner may have access to a multitude of different hand devices. S/he is also embedded within a physical and digital medium in which antennas, repeaters, servers and other technical equipment may continuously change. A multitude of managing-, negotiation-, monitoring-, and maintenance processes run in parallel. Much of

these logistics directly affect the quality and efficiency of learning. They must, therefore, be treated as an integral part of the learning process. What moves with the student must no longer be the device, but the learning environment. What remains distributed will be the various knowledge applications and of course the raw data.

Mobility is about increasing a learner's capability to physically move their own learning environment as they move (Barbosa and Geyer, 2005). The mobile context permits not only constructivist approaches to be employed, but also contextual learning. Indeed, it is now possible to take the learning process out of the classroom into authentic environments (Michie, et al., 1998). Learning while interacting with many peers has the potential to develop collective cognitive responsibility (Dolan 2005; see also Bransford, et al. 1999; Churchill, et al., 2001; Dillenbourg, 1999; Zurita, et al. 2003; Zurita & Nussbaum, 2004), because it offers possibilities for immediate and radical conceptual changes and correction of misconceptions. Activity theory and Vygotsky might need to be revisited in many ways, not only from the point of view of mobility, but also in view of the era of globalization and our changing concepts about cognitive neuroscience. Engstroem (2000) for example has added social context and cultural aspects.

### Defining mobile learning as a function of its facets

From the analysis of the proceeding sections, it becomes obvious that a systematically correct and systemically complete definition of mobile learning must take into account many parameters and also ways in which they interact and influence each other. In order to be able to visualize, conceptualize, and hopefully later, study in greater detail such parameters and their inter-relations, we propose the following abstract formulation for the definition.

$$(1) \quad \text{MLearn} = f \{ t, s, \text{LE}, c, \text{IT}, \text{MM}, m \}$$

t = time	Whereas t was discontinuous and discrete for previous paradigms of learning (e.g. mainly whenever in classroom), for m-learning time during which mobile learning can take place may be continuous.
s = space	In the classroom paradigm, space was simply defined as the classroom and to some extent the learners' home. Now space is not constrained at all and it may even incorporate virtual spaces.
LE = l-environm	The learning environemnt consists of at least those elements summarized in Table 5.
c = content	The curriculum, the specific educational themes and chosen topics covered are now structured in a completely different fashion and follow different rules and priorities. The learner usually shifts from topic to topic and from discipline to discipline, in what might appear as a chaotic pattern.
IT = technology	This parameter is quite complex. It encompasses all technological aspects and momentary characteristics of both the hand-held device and the surrounding environment (i.e., services available, antennas, repeaters, external devices within reach etc.).
MM = mental	This parameter contains as a conglomerate of the learner's mental abilities, prior knowledge, preferences, motivation, momentary attention etc.
m = method	The "method" is a conglomerate of all parameters related to delivery of and interaction with content. These may include pedagogy, philosophy as well as technical and logistical aspects such as method of presentation (or assessment).

(2)  $s = f \{ MM \}$  The spaces which the learner may wish to visit or wander (theoretically) depend on his/her free will and preferences, and to some extent to time (i.e., during the night, mobile learning activities might not be possible).

(3)  $c = f \{ MM, soc, edu \}$

- edu = educationally relevant
- soc = socially responsible

The chosen educational themes must be the result of a *negotiation* between the learner's agent (in which his/her MM is coded) and what we as society wisely have decided that it is socially responsible.

(4)  $LE = f \{ IT, S, C \}$

- S = available services (agents, facilitators, access to knowledge)
- C = learning community

The learning environment is not only defined by the available technology but also by the presence of and access to available services such as agents, facilitators/coach, knowledge bases, tracking systems as well as other learners who are part of a learning community.

(5.1)  $IT = f \{ s \}$  The IT available depends on the technologies that are available in the concrete space (physical or virtual in which the learner is working).

(5.2)  $IT = f \{ s, m \}$  We propose IT to also be a function of m; this imposes new requirements for design because it implies that if the interaction with a specific type of knowledge requires some m that is currently not available, IT must be in a position to ubiquitously negotiate the addition of the necessary service.

(6)  $MM = f \{ MA, k, p, \alpha \}$

- MA = mental attributes
- k = prior knowledge
- p = preferences
- $\alpha$  = attention

We suggest that m is a function of the learner's mental abilities, prior knowledge, preferences, motivation, momentary attention etc. This imposes new requirements for the design of educational environments and choice of pedagogy, because it requires knowledge of these parameters. The authors have a parallel project in which they attempt to model MA. Parameter k, can theoretically be available (in the future) if we assume that all learning activities of the individual are negotiated by his/her (permanently available and accessible) agent. Parameter p can be dynamically modified by the learner. The inclusion of the parameter  $\alpha$  opens up a whole new area for research, because it will require real-time methods of monitoring and keeping track of the learner's changing attention.

(7)  $m = f \{ PM, Ph \}$

- PM = Pedagogical Model
- Ph = Philosophical paradigm

The choice of the methods to be applied during the learning interactions is a function of a pedagogical model (or sub-unit of it) appropriate for the type of learning experiences at hand, as well as a philosophical approach suited for the particular moment (i.e., location, learner's preferences, etc.). Research in the design, standardization, delivery, etc. of learning objects, as well as research related to modeling and managing user preferences, is of great importance for the concretization of these relations.



This is probably the first attempt to develop a model of mobile learning that inspires to include the full spectrum of actors in both a systematically correct and systemically complete way. As such it probably contains inaccuracies and inconsistencies. The author will be thankful to contributions and criticism. The original ideas for this approach stem from the KnowledgePacket<sup>®</sup> concept which the authors have applied while developing in the early 1990's, a 6-year long curriculum (referred to as Cyber Kids Method) used in the Cyber Kids experiment to introduce IT in the lives of young children (see Laouris 2005 paper presented in the same conference).

## **Conclusions and Discussion**

In an epoch where humanistic values are decrementing and vision towards social progress is disintegrating, our need to promote responsible education and learning is more crucial than ever. Within this context we suggest that sensitive definitions as those related to learning must take into account the role that learning (and education in general) must have within the framework of socially responsible education (Laouris 2003).

Most definitions focus on the devices. The most elaborate one added “.. learning supported by mobile devices, ubiquitous communications and intelligent user interfaces” (Sharma & Kitchens, 2004). The only definition that views mobile learning from a more general perspective is the one proposed by Nyiri (2002). He defined it “as learning that arises in the course of person-to-person mobile communication.” This definition stimulates a philosophical consideration of the role of mobile phones, because as he pointed out, “mobile communication is enhanced everyday communication; and just as our everyday conversation is indifferent towards disciplinary boundaries, so, too, is m-learning. Situation-dependent knowledge, the knowledge at which m-learning aims, by its nature transcends disciplines; its organizing principles arise from practical tasks; its contents are multisensorial; its elements are linked to each other not just by texts, but also by diagrams, pictures, and maps.” However, this definition leaves out our responsibility to define revolutionary concepts and devices in ways that best serve our humanistic values.

The analysis in this paper has hopefully convinced, for the multi-dimensional and extensive effects that mobile phones increasingly exert influence not only on learning paradigms, but also on a repertoire of actors and parameters related to learning as well as to the spheres of philosophy, politics and even religion. The advent of mobile phones presents a great opportunity and offers a timely challenge to re-define and transform our educational paradigms. As wine fans claim “we cannot pour fresh wine in old bottles”, likewise, mobile learning too requires a new philosophical framework and new educational paradigms if it is to flourish. Only then will it become ubiquitous. Learning will occur not only with less effort, but also without us being conscious that we are learning (as indeed is the case for most of the knowledge we acquire in life!). To achieve this goal we will need to turn to the science of bionics and mimic processes evolution has optimized over millions of years like, for example, in our hypothalamus (which acts like our private secretary and librarian and is active even when we sleep, sorting out and “filing” information). Recent research with “virtual agents,” user preferences management and definitions of mental attributes is relevant in this line of thought (for example see Barbosa and Geyer 2005). We may envision an m-learning environment in which agents take over most of the logistics. Some may argue that logistics are not part of the learning process. When we sleep and our hypothalamus organizes our knowledge, is that part of learning or not? I maintain the thesis that it is. It is not surprising that ISTAG priorities include memory enhancer tools to help us access to our own knowledge (like an artificial hypothalamus?). Access to intelligent parts of our mind that help us remember where to find knowledge we acquired, review and re-visit it, share it with others, re-use it, adapt it and restructure it for a new situation. Within this context we might need to open up our definition of our learning mind to include the *third hear-and-talk organ* and also all external in agreement with the recently proposed extended mind theory (Clark and Chalmers 1998).

In conclusion, and in appreciation to the theme of the conference, we must ask ourselves whether and to what extents mobile learning is a potential actor in the digital divide debate. The author has dedicated another paper to this issue as he and his colleagues have accumulated ten years of experience on how technology can not only contribute toward bridging the digital divide, but also towards accelerating economic and social development in less developed countries. Nyiri insists that the digital divide is a myth. He claimed “ ... give a kid a keyboard and a screen, and illiteracy becomes a thing of the past. Provide a disadvantaged, barely literate person, with access to the Internet, and soon s/he will run a small virtual business enterprise.” With all the respect we have to this great man who has and is contributing enormously to the establishment and development of the field, we feel that such over-enthusiastic statements must not be read literally, but in merit of their constructive intentions. It’s a bit like arguing about the potential of a specific genetic code saying, “ ... give this sperm an egg to penetrate and the great man who is coded in its DNA will change the world.” Unfortunately, we all know that there is considerable distance between a “potential” and its “materialization.” Our ten-year-long experiments in social intervention and change have scientifically documented that technology alone cannot serve our purpose. It needs to be accompanied by vision, strategy, scientific theory and methodology, and a great deal of commitment.

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# THE INTRODUCTION OF *IT* IN THE LIVES OF CHILDREN AS A SERVICE TO GLOBAL PEACE: EXPERIENCES FROM A NATION-WIDE EXPERIMENT 15 YEARS AFTER

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## Abstract

In 1992, we launched a nation-wide experiment based on a concept we then called the “*profitable dream*.” We envisioned that introducing advanced computer technology in the lives of a critical number of young children using an educationally relevant and socially responsible, peace-enhancing curriculum would allow us to “transcend” the country’s educational and political life and move the new generation a decade ahead. The project was founded on a well-defined vision statement: “... *to re-define the tools, methods and purpose of education, in light of relevant social change*.” The vehicle chosen to disseminate the impact of the project and its vision was the profit-making concept of franchising. Within the first five years (1992-1997) 26 computer-learning centers were launched with average of 50-150 students enrolled in each location. By 1999, the number of children who benefited from the Cyber Kids curriculum exceeded 15,000, which is approximately equal to 20% of the country’s youth population (ages 6-15). During the same period, the organization trained and employed 186 young and talented university graduates, thus combating brain drain while simultaneously spreading the Cyber Kids philosophy and knowledge to many more spheres of social life. This paper attempts, fifteen years later, a critical examination of the project, and an evaluation of whether the experience gained in employing IT in connection with innovative education can serve to bridge the digital divide in terms of high-tech literacy and economic development contributing to the world’s top priority, fostering and strengthening a global culture of peace. A brief overview of the award winning cyber method is also provided.

**Keywords:** computer education, pedagogy, curriculum, constructivism, leadership, user-centered, social entrepreneur, “agent of change”, vision, peace, development, transformation, literacy-, economic- and digital divide.

## Introduction

In 1990, we embarked upon an ambitious visionary project aimed to transform education and technological infrastructures on the ethnically separated island of Cyprus; a small country with less than one million citizens. Our motivation stemmed on one hand from the concession that educational systems all over the world seemed to be failing to meet contemporary needs and expectations, and on the other hand, from the advent of promising computer-based technologies which were signaling fundamental changes in social development and human evolution. The aim of the project was to test the hypothesis that by acquainting the young with the most up-to-date tools and knowledge of tomorrow’s world, we could accelerate social transformation and better prepare future citizens for the emerging competitive world in terms of a culture of global peace, tolerance and creative cooperation.

The first author (at the time a Research Assistant Professor) together with a committed (at the time, graduate student) friend, both at the University of Arizona, came up with the plan to test the above hypothesis in their homeland. They envisioned that introducing advanced computer technology into the lives of a critical number of young children, using an educationally relevant and socially responsible curriculum, would allow them to “transcend” the socio-cultural and political limitations of their country and move their society forward a decade. The project was driven by a few concrete and

powerful philosophical principles, which served as the inspiration and the glue to build a team of committed agents of change and entrepreneurs. The concept of the “profitable dream” attracted highly educated and extremely talented social entrepreneurs, who formed the core group, then called a *high-performance group*. The philosophical and political foundation of this effort incorporated the idea that “heroes” of the next millennium need not be defined by adversarial nationalisms and deadly conflict with others around the world. Rather, the new concept proposed the creation of a social-economic and educational space within which IT-based education would open up opportunities for humanistic oriented learning, fostering mutual understanding, cooperation and reaching out to the rest of the world, while at the same time having the right and the opportunity to participate in a “profitable” business venture.

The vision statement “... to re-define the tools, methods and purpose of education, in light of relevant social change” proved to be a very powerful one. It illustrated and explained the various facets of the accompanying curriculum, philosophy and pedagogy of the Cyber Kids project. Every word in this vision statement carried significant, well thought out meanings with profound implications. The term *re-define* revealed a revolutionary disposition. From a dialectic point of view, it implied that the conventional educational systems required exhaustive upgrading and transformation to meet the needs and challenges of the new millennium. It needed to be completely re-visited and re-defined. The term *tools*, referred to and called for the need to integrate emerging technologies into the educational context. For the 1990’s, *tools* referred to computers and the Internet. Today, it would also refer to mobile devices and associated services. The term *methods*, highlighted the urgent need for new methodologies, new pedagogies and new theories to guide learning activities. The term *purpose*, disclosed the requirement to question the very purpose of conventional education, and to open up discussion and inquiry as to why and for what end children should spend half their lives in schools. It further denoted the exploration and development of novel approaches to learning and acquisition of new knowledge in light of globalizing conditions and the consequent need for a global culture of peace and cooperative symbiosis. The central concept of the vision statement envisioned a society in which people not only engage in learning activities voluntarily and with enthusiasm, but also with high respect for knowledge, wisdom and human values relevant for global co-existence. Finally, the phrase “... *in light of relevant social change*,” suggested that the above vision, stated within the context of a dynamically changing world, will be ever changing to accommodate evolving needs.

## **The Cyber Kids Method**

### ***Initial investment and foundations***

The founders of the project did not have any financial strength, as the families of both became refugees in 1974, following the Turkish invasion in Cyprus. The initial funds mainly came from the following sources: (a) \$ 5,000 from the International Program Development Fund and from a Provost Teaching Award of the University of Arizona (awarded to the first author), (b) \$ 20,000 from the third member of the team, Maria Symeonides, who quit her job at Apple Cupertino to join the dream from the very beginning; (c) \$ 80,000 in the form of a “low-interest” (as it turned out later, the compound interest and repayment conditions were similar to those of any bank) government loan for the unemployed; (d) \$ 10,000 in the form of a bank overdraft which required as securities five guarantors and a 250 sqm plot (value over \$ 50,000), which was the only asset of the sister of one of the team members; (e) never-returned loans by the father, Chris and wife Joulietta of the first author who still remain firm believers of the power that early education has to change the future world of children. These details are provided not to obstruct, but to inspire and enhearten potential social entrepreneurs to dare to follow their dreams even with modest resources available.

### ***Launching***

The project was launched in three cities simultaneously. Almost all the money was used to purchase 28 Apple LC computers, a few high-power computers for the management team, printers, scanners and

software. The furniture, air-conditioning and other appliances were purchased a year later through leasing. In the Headquarters Office, the furniture was “virtual,” i.e., chalk drawings on the floor along with cushions (an innovation that added to enthusiasm and self-esteem). The absence of an adequate business plan in connection with the unprecedented determination for success did not leave space for putting money aside to pay employees their salaries for a few months. (Note: The unconditional sacrifices in the name of the dream had a detrimental effect on enthusiasm and gradually lead to fatigue).

### ***Legal framework and expansion strategy***

We used the concept of franchising to accelerate expansion and to counter-balance the reality of not having our own adequate funds. At the time, Cyprus was ethnically divided and characterized by a closed and protected economy. As franchising was unknown, there was no adequate legal framework for the concept of franchising, nor for securing trade names, patents and copyrights. For example, although Cyber Kids invested considerably in fees paid to the Company Registrar and to top attorneys to secure trademarks, including the accompanying terms (e.g., cyber kids, -teens, -minors, cyber camps, -radio, -institutes, -café, -network, -advertising, -centers, etc.), the Registrar shamelessly approved the trade name “cybernet” for a group of Cyber Kids franchisees who did not wish to pay their royalties any longer. The action of the Registrar thus furnished the breakaway franchisees with the necessary “legal” grounds to appropriate not only Cyber Kids intellectual assets, but also physical ones, as was the case when they added stickers with the term “net” to cover the term “kids” on the Cyber Kids trademark, thus utilizing stolen posters, signs, banners, etc. Only a few years later, when the US forcefully demanded all countries to sign the international treaty for the protection of intellectual property and when Cyprus adopted the relevant EU regulations, could such matters theoretically be sorted out in courts. Of course, for Cyber Kids, it was already too late and the above anomaly cost the company close to one million dollars. Despite the absolute absence of legal protection from the government (indeed the official government may be among the enemies of the project; see discussion), Cyber Kids managed to expand very quickly and very successfully. To make its visions and its project known to the wider public, Cyber Kids applied what was then called *total marketing*. This involved the printing of 100,000 leaflets every summer, distributing them in a country of 600,000 living in the free zone of the Greek Cypriot south. This approach translated into one leaflet per household, delivered from door-to-door, irrespective of whether Cyber Kids could serve every region. In addition, it placed about one hundred, 4-meter long, banners at all major road crossings every summer before the beginning of the school year. The aim of this campaign was to communicate our ideas and intentions to people and to attract franchisees. Not surprisingly, nearly all newspapers and magazines and many radio and TV stations dedicated wide coverage of Cyber Kids ideas and our successes (links to be available on line under [www.cyber-kids.org](http://www.cyber-kids.org)), thus adding to the legitimization and appreciation of our work. The resulting expansion was almost exponential.

### ***Training the trainers***

Training constitutes the cornerstone of initiating and sustaining the expansion of Cyber Kids whether at the branch or on a national level. The function of training is to prepare the personnel of any new center to assimilate and put into effective action the Cyber Kids philosophy and practice, by becoming versed in the various aspects of its operation, ranging from developing an appreciation and understanding of the core values of the philosophy, to teaching methodologies and pedagogical approaches, to management and marketing. Training also aims to equip the new member of the Cyber Kids community with all the tools, knowledge and aspiration to serve as an agent of social change.

### ***Research & Development at CNTI***

The Cyber Kids success is based on continuous R&D performed in collaboration with the Cyprus Neuroscience & Technology Institute. This arrangement enables the organization to attract an additional number of young scientists who offer their services in scientific skills and activities in exchange for an exciting visions for positive change, the joy of research, participation in conferences and scientific publications and the accumulation of experience that supports their regular career.



### ***Cyber Kids philosophy and curriculum manuals***

The Cyber Kids philosophy is the heart and soul of Cyber Kids and its description extends over hundreds of pages. Following the decision of the company to make these ideas and methodologies available to the wider public, the authors are committed to gradually releasing them in the form of scientific publications; a process that has already begun (for examples see references). The philosophy and pedagogy are applied to support a 6-year long curriculum. Parts of these ideas will be made available in the public zone of the [www.cyber-kids.com](http://www.cyber-kids.com) web site early next year.

Since the actual details of the philosophy and curriculum are extensive and proprietary, we describe briefly in the following paragraphs some of the key elements of the theory, to serve as an initial resource for those social entrepreneurs who might wish to apply the concept in their countries (Note: The authors invite interested parties to contact them. They will be delighted to support those who share the dream).

*Classroom organization.* At the time of launching, most schools universally adopted the hierarchical model of classroom organization, i.e., all chairs facing the teacher and the blackboard. We chose to place working spaces close to the walls with computer monitors facing towards the center of the room. (Note: Our innovation hit against walls of government bureaucracy as most of our centers were not granted, by the Ministry of Education, permission to operate because the windows, blackboard and chairs were *not* in the right places!). This organization allows students to move freely (stretching their muscles), collaborate in front of each other's monitor, or to quickly re-arrange their sitting arrangement turning their rotate-able chairs inwards to engage in ad-hoc conversations. It furthermore allows the teacher to easily track how each student is progressing by enabling visual access to all students' monitors without disturbing them (since they have their backs turned to him/her!). We provide students with personal mailboxes to store their works, receive materials from their instructors or drop tasks to their peers. We also give them access to a plethora of additional equipment such as printers, scanners, audio editing, digital cameras and TV monitors. Advanced students were given permission to use the most sophisticated computers.

*KnowledgePacket<sup>®</sup>.* The core recipe for the development of all our lessons is based on a proprietary concept we named KnowledgePacket<sup>®</sup>. The innovation of our approach (which was honored by 7 international awards) lies in the way we manage to intermingle curricula with incompatible structure and goals to produce a developmentally ordered and well-structured curriculum, which is completely learner-centered and project-oriented. The concept of the KnowledgePacket<sup>®</sup> is applied to each lesson (i.e., project) and extends the value of the learning activity by combining within one and the same project the following attributes: (a) Educational theme and value; (b) Mental and psycho-emotional development; (c) Computer skills; (d) Social awareness and linking to real-life and society; (e) Detailed instructions to teacher; (f) Proposed software. The KnowledgePacket<sup>®</sup> can be viewed today as a predecessor of Learning Objects (LOs). Indeed our recent contributions in the global efforts for standardization of LOs are using concepts from the original KnowledgePacket<sup>®</sup> in an attempt to add to the educational, mental and social dimensions in the LO standards (Laouris, 2005 a,b).

*Philosophy adapted to age and prior experiences.* The curriculum philosophy comes in different versions and variations depending on age, prior knowledge, special needs and culture of the recipients. For the first levels (Minors A & B, children under 9) the emphasis is in the development of their psycho-emotional world and selected mental abilities as well as development of passion and love toward exploring the world of knowledge and technology. The next two levels (Juniors A & B) focus on the development of problem solving skills and acquisition of advanced technical expertise. The Seniors levels aim at talent exploration and working in teams on complex real-world projects that require exploitation of their acquired communication and negotiation skills. The Cyber Kids philosophy utilizes a new definition of the learning mind; one, which aspires to



identify, assess, monitor and develop mental abilities (we call them mental attributes) that are important for learning. The authors are engaged extensively in related research and have developed a framework to describe the learning brain using this concept and apply it in a computerized system that assesses a number of mental attributes (Laouris, 2003, 2005). The system was recently validated in 30 schools and proved very useful for the screening and diagnosis of learning disabilities.

*Student-centered, role reversal, shifting control.* All projects follow the principle that *control* is not with the instructor, but with the student and his/her peers (whose role is both to encourage and to monitor). This shift of control is achieved through a process of role reversal by which the responsibility to choose, design and implement a project is passed to the students. This applies to both assuming initiative to perform an activity and exploring knowledge bases to discover and acquire the know-how and skills necessary to fulfill self-defined tasks.

*The “God gave you 5 min” teaching method.* The method capitalizes on whole-life experiences of an instructor, who is asked to imagine that God gave him/her 5 minutes to offer an animated and vivid explanation of a concept or a process to a group of students in a way they will understand and remember it forever. Transcending into such hypothetical scenarios reconciles one’s relations to the extraordinary and the world of the “impossible” thus stimulating creativity and imagination (Laouris, 2006, in preparation; draft available).

*Project-oriented; Creators, not consumers.* All educational activities are project-oriented. This means that whatever the educational theme we wish to teach, the mental attributes we aspire to develop, the computer skills we plan to drill, the social relevance we assume to convey, children will go through a process of defining their own project (or team project for senior levels), planning its implementation and successfully delivering (i.e., publishing, printing, presenting to the group, etc.) their product. There is an incredible amount of theory behind these concepts, but for the purpose of this paper let us restrain ourselves to discussing: (a) the importance of cultivating the attitude of a creator rather than a passive user or one who follows instructions and (b) the power of becoming accustomed to delivering a final product within an agreed deadline and in compliance to promised specifications.

*Development of communication-, negotiation- and leadership skills along with social values and ethics.* A very important facet of the Cyber Kids curriculum is its focus on the development of personal values, qualities and skills. Embedded within the instructions of lesson plans that address the needs of team projects, are instructions on how to stimulate discussion, encourage debates, negotiate the differences and finally, to reach a consensus that will allow them to collaborate and complete their project. Usually leadership emerges out of such small working groups and it is the role of the facilitator to nurture and guide students to develop in healthy and ethical ways. During this process the instructor is also trained to bring-up and offer for discussion issues that relate to human values.

*The extracurricular dimension.* Schooling is a rather recent invention of our world and has served the needs and constrains of its times. Building on our prediction that, in the next 20-30 years, education will incrementally be moving out of classrooms, we included in our educational scheme a strong extracurricular dimension. There is a distinctive difference between formal classroom education and education that takes place in a context and is situated in a relevant environment. The first paradigm provides the learner with a third-person perspective, i.e., s/he “sees” the world and is expected to extract knowledge and derive wisdom through the eyes of others. Taking students out of the classroom and placing them in context allows them to “see” the world with their own eyes and develop their own point of view. Having with them recording instruments (i.e., digital cameras, scanners, voice- and sound recorders, etc.) provides them with additional possibilities, which go far beyond what a superficial understanding of extracurricular activities denotes. It

equips them with “eyes” which can “see” the world from different perspectives. Imagine, for example, how the world (in philosophy and cognitive science we borrow the term *Umwelt* from the German) would look like if we could experience it from the perspective of a dog. Each one of us lives in our own environment and develops our own understanding of the world. This is due to biological, cognitive and cultural constraints. Technology provides the *transducers* (i.e., machines which can record signals from the world that the normal human cannot; e.g., zooming capability) that not only can break such constraints, but when working in teams and within a context contributes towards constructing a joined cognitive and mutually acceptable model of the world. Learning becomes more experiential, and thus constructivist, and less bound to the classroom. One could almost compare it to an adventure game experience. The plethora of activities envisioned and implemented serves our aim for a socially responsible education.

Below is a summary of such activities, in which the contribution towards students’ development is briefly highlighted.

- *Links to the world of professions.* Senior groups have scheduled and planned visits to professional environments such as publishing houses, research institutions, business and accounting enterprises, etc. This enables them to interact with professionals, as well as, correct possible misconceptions, reflect on their own interests and talents, exercise their communication skills and train their ability to extract the information they wish and use it for their projects.
- *Students as creators of advanced multimedia projects.* In almost all cases, out-of-class endeavors are combined with the development of some project (mostly multimedia-based) related to the needs and operations of the place we visit. More often than not, student’ projects reach levels beyond excellence. For example, students have developed complete programs for kiosks, hotels, video stores, etc. Following a competition among our most talented children in graphics design in 1996, we even adopted a more lively, colorful and technically manageable logo (see it on the web site) revised by one of our students.
- *Engaging them in research.* Within the framework of special agreements, our students collaborate in research activities and perform joint presentations with college students as well as complete internships and apprenticeships at CNTI and other research and/or academic institutions. This acquaints them with attitudes, styles and working habits of forward thinking people. It also familiarizes them with the world of science and research, thus removing some of the stereotypes and misconceptions that many people have about such communities.
- *Presenting their innovative ideas in public forum.* In many cases, students are encouraged to come up with innovative ideas and inventions and present them in national or international competitions (such as the Innovation-Technology-Social Progress,). The brainstorming sessions preceding the process and the activities towards documenting an idea and preparing it for presentation stimulates their creativity and develops their problem-solving skills. The actual participation in a forum in which adults and representatives from the authorities, the industry and financial bodies dominate, boosts their self-esteem and confidence. (visit [www.cnti.org.cy/CNTI\\_Album/1993/1993\\_KTK\\_A/index.html](http://www.cnti.org.cy/CNTI_Album/1993/1993_KTK_A/index.html) for information).
- *Camping, sport, museums visits, exploration expeditions.* A few times a year mass events are organized, in which students from different centers in different geographical locations participate. During these events, teams work on well-specified projects that involve data collection (recordings, video-taping, interviews, data collection through questionnaires etc.) and subsequent development of multimedia projects. What is important in these activities is that the *lab* (i.e., tools such as computers, cameras, recorders, note books, etc.,) goes with the students. This contributes enormously, not only towards situated learning, but also towards preparing the citizens of tomorrow to expect technology to be able to accompany them wherever they wish to go, rather than having to visit specific and geographically fixed places in order to use it.

- *Contributions in art and culture.* At least once a year almost all students are encouraged to submit artistic creations to art competitions and exhibitions. For examples visit: [www.cyber-kids.com/album/art](http://www.cyber-kids.com/album/art). Such endeavours cultivate not only creativity, but also understanding and appreciation of the value of art and culture.
- *Interacting with video games.* Not only at the completion of their projects during each session, but also at any other time of the week they wish, students may use the center's computers to try-out and play video games. The games are chosen by the researchers to comply with certain standards. Usually students are requested to participate in small research projects which expect them to evaluate the games for various characteristics such as degree of interactivity, fun, engagement, educational value, skills that it trains, etc. By doing so, students develop a critical perspective and relationship toward video games while also drilling certain skills. The concept is that students who have been attending classes for more than a year are attracted much less to video games, which demand low cognitive effort.
- *Participation in leadership, conflict resolution and communication skills workshops.* In collaboration with peace groups and other civil society organizations, students participate in workshops offered for young people, which aim to develop their skills in communication, negotiation, leadership and conflict resolution. Such skills are applied and sharpened during the implementation phases of their team projects, as they negotiate the division of labour among themselves, debate on the specifics of their joint project, and collaborate to present it to their peers and compete for excellence.
- *Social voluntary work.* Shortly before Christmas or in parallel to national fund-raising campaigns for children with special needs, our students are encouraged to come up with ideas and a plan of action to support other children who might be at a disadvantage. Their active participation and contribution to such events develops their social responsibility and deepens their ethical values.

In summary, our extracurricular (doesn't the term appear out of place after this discussion?) dimension contributes to a procedure that takes knowledge we own and understand and converts it into wisdom through a process of interaction with the real world, analysis and synthesis of concepts, growth of expertise and practical application in context. After all, according to Gisela Labourie Vief, "wisdom is one's ability to see beyond individual uniqueness into structures that relate us in our common humanity," or as Robert Sterberg wrote, "it is a virtue which provides us a compelling guide to action." (Citations borrowed from an inspiring presentation by Traxtler, 2005).

## **Results**

### **Expansion data**

The number of operating learning centers, entrepreneurs collaborating with Cyber Kids, instructors employed and students attending the Cyber Kids curriculum is summarized in Fig. 1 (see Legend for details). Note that the actual market and community penetration of the project might be more extensive than the largest number displayed for the last year might suggest, because a Center may operate for a few years and then close (i.e., it is not included in subsequent years), or students attending during one year do not necessarily attend during subsequent years. Also, what this graph does not show is the number of parents (grandparents and relatives in Cyprus are also engaged in family matters) who become sensitized, develop a knowledge about and appreciation for the method and evolve into active and passive supporters.

## Expansion of Cyber Kids

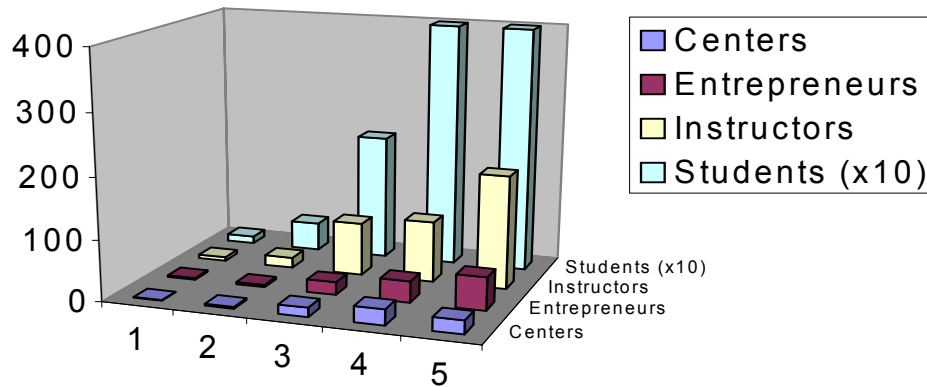


Fig. 1 Expansion data of Cyber Kids in Cyprus. The x-axis plots the data for the first year of launching (1992), the year when the first franchised centers were launched (1993), 1995, 1997 and 1999. Note that the number of students was divided by 10 so that the rest of the data would not be masked. The actual numbers of centers was 1, 3, 5, 26 and 22. The number of entrepreneurs was, 3, 4, 21, 34 and 54. The number of instructors trained and employed (i.e., those trained but not employed are not included) was 6, 17, 87, 100 and 186. The number of students is plotted as a cumulative sum, i.e., the total number of students who have benefited from the Cyber Kids curriculum has exceeded 15,000 by 1999 (note that the numbers of the last two columns for students are out of scale; the actual numbers are 1997: 6,000 and 1999: 14,700).

Of course the numbers shown here might seem small. However, taking into account the size of the country in question (i.e. 600,000 citizens; 75,000 children in the age range 6-15), the implications for social change are quite real.

### Training of Trainers

In the years between the launching and 1999, 186 young Cypriot scientists were trained to become instructors authorized to deliver the Cyber Kids curriculum. An additional number were partially trained but never employed. Also 37 multi-ethnic, highly qualified individuals of Lebanese, Greek, Israeli, Egyptian, Jordanian and Indian descent were trained to become the trainers of trainers, i.e., authorized to train new instructors. The training followed a curriculum that resembles that of a small university. It includes both theoretical and practical sessions. The theoretical part is composed of 46 short courses which cover areas like: (1) Courses introductory to Cyber Kids concepts, materials, methods etc; (2) Basic principles of business, financials and how these are applied in Cyber Kids operations; (3) Detailed training in the philosophy, method and delivery of the curriculum. This area includes courses in how to become a research associate and collaborate with the R&D of the Headquarters and/or how to become a curriculum contributor; (4) Scientific theoretical background such as the basics of various (mainly constructivist) learning theories, multisensorial approaches and multimedia, application of video-game technologies in the educational context etc.); (5) Special education courses focusing on how to deal with special needs children and when to refer them to experts; (6) Courses that illustrate the role of Cyber Kids toward social transformation as well as courses that bring the instructors up to date with the latest research findings and inventions in the IT and cognitive science fields; (7) A number of courses focusing on the specifics of the Cyber Kids Operation; (8) Special courses required for those involved with the international expansion. The practical training involves both mock sessions on all courses for which the potential instructor is expected to teach, as well as pre-agreed hours of training in real-class situation as an additional requirement for the final certification, under the supervision of experienced instructors. Potential instructors do not need to attend all classes and courses available. The head of education may offer

waivers depending on formal university qualifications, prior experience and required employment expertise. Not only are the numbers of young scientists trained impressive, moreover, the quality and type of education they receive contributes toward global change in the community in which we operate through a parallel path.

### **Research vehicle**

In the years between 1992 – 1997, more than 30 students from the University of Cyprus, the Higher Technological Institute, Philips College, the Cyprus International Institute of Marketing and various international institutions performed practical training, internships, research projects and masters theses at Cyber Kids Headquarters. About an equal number of talented and advanced Cyber Kids students performed apprenticeships at analogous institutions as well as at selected medium size enterprises.

### **Contributing to global euphoria**

The Cyber Kids evolved into an organization of thousands, if one counts also students and parents. This community of people shares an enthusiastic dream, has an appreciation for the value of education and their mind is turned towards the future. Their collective positivism adds to a culture of confidence and transmits a euphoria, which in turn contributes to the creation and amplification of a socially healthy momentum for change.

### **Relation to other organizations**

Over the years, Cyber Kids has developed strong bonds and collaborations with many other organizations, such as NGOs for peace and other civil society groupings, the Dyslexia-, the ADHD- and the Autistic Children Associations, schools of special education and for the mentally retarded, etc. These relationships were built during the various extracurricular activities, i.e., for research purposes, as part of activities related to social/voluntary work or as part of special agreements to integrate children with special needs in our regular classes (see for example Laouris, et al. 1997).

### **Refocusing on real social priorities and values**

The fact that Cyber Kids becomes an active social actor in the local communities assists towards re-focusing the interests of laymen by enriching everyday conversations with more important issues. The numerous events organized, media coverage, press releases, videoconferences, etc. facilitate the dissemination of the dream. They reinforce a change of the communal mental framework from an indifferent, partly corrupted society, which is mostly manipulated by its political leaders (in the case of Cyprus, the manipulation aims to keep the group interest focused on the *Cyprus Problem*) to a society that is more critical, and capable of ranking its priorities and goals.

### **Contribution to the national economy**

The contribution to the economy of the country, and of course indirectly to global development, was one of the major goals when the project was originally launched. Fig. 2 compares the cumulative income from all centers with the cumulative income achieved by the Headquarters over the years 1992-1999.

## Cumulative income from Branches vs. Headquarters

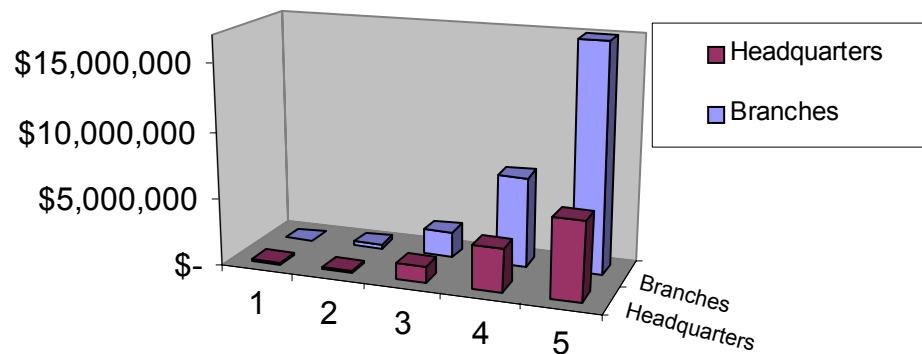


Fig. 2 Cumulative income for Cyber Kids in Cyprus. The x-axis plots the data for years of launching 1992, 1993, 1995, 1997 and 1999. The cumulative income for the Headquarter rises from about \$100,000 during the first year of operation to over 5 million in 1999. In the same period the cumulative income from all franchises explodes to 17 million. At about 1995, the income accumulated by branches exceeds by far the income (and consequently the financial strength) of the Headquarters.

The Industrialist and Employers Association recognized the significant contribution to the Cyprus economy through the application of this most innovative approach by awarding Cyber Kids their most prestigious Prize in 1996. By that time Cyber Kids had already accumulated 5 international awards. During the ceremony, the person standing next to the President of the Republic who traditionally delivers the award, US Ambassador Richard Bautcher said "... we are glad Mr. President that Cyprus honors innovation and leadership the way we do." implying the support and recognition that Cyber Kids was already enjoying from international institutions.

## Discussion

This paper reviews an innovative application of IT in a nation-wide experiment fifteen years after. Although it is generally accepted that the possible educational outcomes of new methodologies are very difficult to measure and evaluate, the authors propose that the experiment had a traceable impact for the reasons outlined in the next few paragraphs.

By recruiting and utilizing through its various activities, not only students, but also parents, instructors, social partners and the public at large, the experiment has initiated a nation-wide discussion and inquiry concerning the need for educational-, social-, and even political transforms. This thesis is not based only on the positive impact that the well-defined, -structured and –communicated vision, philosophy and pedagogical approach might have had. It is also based on the extent to which these ideas achieved to penetrate society. The results section has revealed that, percentage-wise, the number of children reached by the organization amounted to almost 20% of all children living on the island. What is not considered in the present paper are indirect contributions made via other learning centers, such as those that opened after being motivated through Cyber Kids' enthusiasm, impact and successes; as Cyber Kids break-away franchises; or as a natural development of the emerging IT era. Such centers, following Cyber Kids and benefiting from its leading role, not only in terms of opening the market, but moreover in being able to attract public attention, have in effect partially served the Cyber Kids dream. The number of instructors trained and employed by the organization might not seem large, but the fact that they were equipped with knowledge, skills and

clear vision converted them into powerful agents of change who operated within the society at large. The thousands of enthusiastic parents and grandparents may have supported their contributions.

*Cyber Kids as an agent of change.* Cyber Kids' research activities and scientific contributions, in special education and dyslexia in particular, have contributed to parallel developments in a wider context. For example, during the same years as Cyber Kids was initiating its research activities, the following developments took place: (1) Fulbright (which has always been a great supporter of Cyber Kids) provided more than a dozen short-term and year-long scholarships to teachers with interest in special education to study in the US. The majority of the recipients were public teachers, who were already collaborating, either as part-time instructors, or as research associates with Cyber Kids. Ten years later, these special educators, today hold sensitive positions in the public educational system. Even the head of the public special education department is the person in charge of the Cyber Kids' Dyslexia Group over the last 12 years. Together with his daughter, he is also owner of a successful Cyber Kids franchise. (2) The Cyprus Dyslexia Association (CDA) is founded months after the Cyber Kids' Dyslexia Group began its activities. The latter has organized more than 7 "Computers and Dyslexia" conferences, between 1993-2002, in which more than 200 educators, psychologists, speech therapists and IT specialists participate (proceedings available at [www.cnti.org.cy](http://www.cnti.org.cy)). The Cyber Kids research group has collaborated with the CDA from the very beginning. Developed, IT-based research products, were validated in public schools partly under the supervision of the CDA. (3) Cyber Kids contributed enormously toward the establishment of the first citizens' peace movement in Cyprus, both with human resources as well as by providing meeting space, communication facilities and financial support (Anastasiou, 2002; Laouris, 2004). The authors were members of a core group of trainers<sup>1</sup>, which introduced concepts of conflict resolution and peace to more than a few thousand people from both sides of the island<sup>2</sup>. The activities of the Cyprus peace movement gradually culminated in the drafting of the first comprehensive plan, known as the Annan Plan, for a sustainable solution of the long-standing Cyprus problem. The fact that the Cypriot (especially the Greek) society did not see the opportunity, and its political leadership did not embrace the initiative is a matter of greater debate and it is outside the scope of the present review.

*Cyber Kids' educational paradigm.* Cyber Kids has introduced not only a theoretically sound new educational paradigm, but also one that can be practically implemented even in hostile environments. It calls educators to move away from the stereotype that wants the teacher to be an all-knowing mystic individual who has all the answers. It encourages us to abandon once and for all the middle ages model of education, which is an implementation of the polymath, who wanders around in the countryside with his cart and carries with him tools that can solve all possible problems of contemporary civilization. With the explosion of knowledge, human technologies and constructions, as well as the widening of our interests' horizons, this becomes impossible. The new paradigm proposes shifting our mental framework to those models, which treat learning as knowledge and wisdom rather than as information. As T.S. Eliot said "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?" The proposed approach is a practical implementation of these theories, which has been tried out in the youth population of a whole country. Furthermore, it has introduced a number of new dimensions that have implications for the design of future educational environments. The KnowledgePacket<sup>®</sup> concept proposes, on one hand, new domains as an integral part of any educational project (i.e., educational and social relevance of what is taught, mental attributes of attempted child development), and on the other hand it lays out a new coding scheme, which can be of service in the design of LOs. A word about the role video games can play in mobile learning is probably also appropriate. Cyber Kids has been able to integrate them into the educational paradigm and its research has demonstrated that children can develop critical attitudes towards them. We lost valuable years to convince educators and bureaucrats that e-learning should not have declared war on the world of video games, but on the contrary it should have embraced them in their

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<sup>1</sup> [http://www.cnti.org.cy/TFP\\_Album/HistoricDocuments/slides/TrainersLetterToUN.html](http://www.cnti.org.cy/TFP_Album/HistoricDocuments/slides/TrainersLetterToUN.html)

<sup>2</sup> [http://www.cnti.org.cy/TFP\\_Album/Posters/slides/BicomHistoryMap97.html](http://www.cnti.org.cy/TFP_Album/Posters/slides/BicomHistoryMap97.html)



pedagogical paradigms (Vakanas, et al. 1996, Laouris, 1998). Video games (and video game consoles) have secured their space in the lives of our children and are here to stay. We must begin studying these environments scientifically, embracing them within paradigms of mobile learning and taking advantage of their magnetism (Bonano, 2005). According to Kambouri (2003), our first goal might be to "... expand the usability dialog into the area of mobile educational games," thus highlighting and defining the differences between conventional game design and educational game design. We may then proceed to re-define usability criteria to fit our educational aims and goals.

*Cyber Kids fosters economic development.* The graphs in the results section demonstrate the contribution of the project towards economic development. What cannot not be derived, however, from graphs and analysis are indirect effects on the economy. Those include the extent to which the project has contributed to reversal of brain drain or the extent to which other young entrepreneurs were inspired and encouraged to follow their own dreams and aspirations and take risk by starting their own business, thus further contributing to economic development.

*Cyber Kids strengths and weaknesses; supporters and enemies.* Looking at the Cyber Kids project from a meta-position, one could conclude that it was not an easy project to implement in Cyprus. Not only the complete absence of an appropriate legal framework, but also many other factors and circumstances opposed its development and expansion. In an effort to highlight and possibly rank the few most negative experiences, obstacles and intractable parameters we would isolate the following: (1) Limited funds at launching. Although the project has succeeded to develop, expand and flourish, the fact that funds were limited at start-up chased its founders throughout, and influenced many important decisions. (2) Authorities count among the greatest enemies. Although, Cyber Kids seemed from the outset to be working and collaborating with top officials, ministries and financial bodies (such as the Development Bank which by becoming share holder mislead the company to detrimental and loss-making ventures), people in positions of power often treated the project antagonistically, and placed obstacles to its activities. (3) The status quo and the traditional economic powers in Cyprus saw the project as something disrupting the status quo and long-standing and -accepted hierarchies among people and organizations. The project was not only promoting ideas for educational and social transformation, but it was also introducing in Cyprus the new economy. (4) Cyber Kids has also encountered some of the most negative attitudes and characteristics of the Cypriot mentality, like those associated with a small size, closed society, the village mentality, arrogance, and a laziness combined with a tendency to steal and copy rather than to create, which they probably inherit from the Ottomans.

In summary, however, as the actual numbers demonstrate, the "supporters" by far outnumbered the "enemies." Furthermore, the mere fact that the supporters were very enthusiastic, driven by their hearts, were usually younger in biological and mental age and usually more educated, overwhelmed the "enemies" who were driven mainly by their own misconceptions, fears, conservatism and absence of vision and confidence. Cyber Kids students are now graduating from universities from all over the world and they will be the ones who are expected to put to work the concepts and principles learned. The spin offs of this experiment are multi-dimensional. We believe that the Cyber Kids concept has the potential to initiate and mobilize changes in many domains of life, in such a way that no formal institution or status quo can resist. We conclude this discussion with a word of encouragement and invitation to attempt to use this and/or similar models in the third world countries toward accelerating development, thus contributing to the closure of the literacy-, economic-, and digital divide.

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became shareware. The revised mission inspires to make ideas, methodologies and experiences available to other people and countries. In this spirit we invite those interested to participate, collaborate and contribute in research activities, towards building bridges of communication and international scientific missions to contact us and explore possible collaborations.

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## Title: Meta learning: Experiences from the inclusion of mlearning in a standards-based and corporate-wide learning content management policy.

### Abstract

'Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow' (Pollard 1996).

At the Lisbon Summit in March 2000, European heads of state and government set a new goal for the European Union - to become the most competitive knowledge-based society in the world by 2010. However, one of the major obstacles facing individuals and organizations as they strive to retain and grow their competitiveness is that of acquiring relevant knowledge from the mass of information available today to anybody with an internet connection.

A large multinational like Ericsson is no exception to the problem of managing the information at its disposal for competitive advantage and for the benefit of its customers. In response, Ericsson Education, the training division of Ericsson, has championed the use of global standards and reference models in its learning content management policy. The goal of this learning content management policy is to ensure reusability of learning objects as well as appropriateness of learning objects to the target audience.

Mlearning, as a new and innovative delivery mechanism, is included in the policy framework of learning content management at Ericsson Education. In this regard it is treated as another viable form of content delivery as part of a blended learning strategy, much the same as standard elearning, synchronous elearning (virtual classroom training) and instructor-led training. This paper explores the background and development of Ericsson's content management policy with specific reference to mlearning and meta-tagging structures based on global reference models (SCORM 1.2).

### Keywords

*Metadata, mlearning, content management.*

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# Meta learning: Experiences from the inclusion of mlearning in a standards-based and corporate-wide learning content management policy

## 1. Introduction

'Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow' (Pollard 1996).

At the Lisbon Summit in March 2000, European heads of state and government set a new goal for the European Union - to become the most competitive knowledge-based society in the world by 2010. However, one of the major obstacles facing individuals and organizations as they strive to retain and grow their competitiveness is that of acquiring relevant knowledge from the mass of information available today to anybody with an internet connection.

A large multinational company such as Ericsson is no exception. This paper describes the experiences gained by Ericsson as it strives to make sense of the mass of information at hand, to put order on this information and to optimize it for delivery as learning content. The emphasis of the paper is on mlearning and particularly the experiences Ericsson has had in this domain over the past five years.

### 1.1 Ericsson Education

Ericsson Education is amongst the largest global suppliers of IT and Telecommunications training. Ericsson Education is a key organization with Ericsson's Global Services division. This division provides services to the IT and telecommunications industry, primarily to Ericsson's extensive installed customer base. Global Services, in turn, is a key Business Unit within the overall Ericsson organisation. The following illustration visualizes the overall structure of Ericsson:

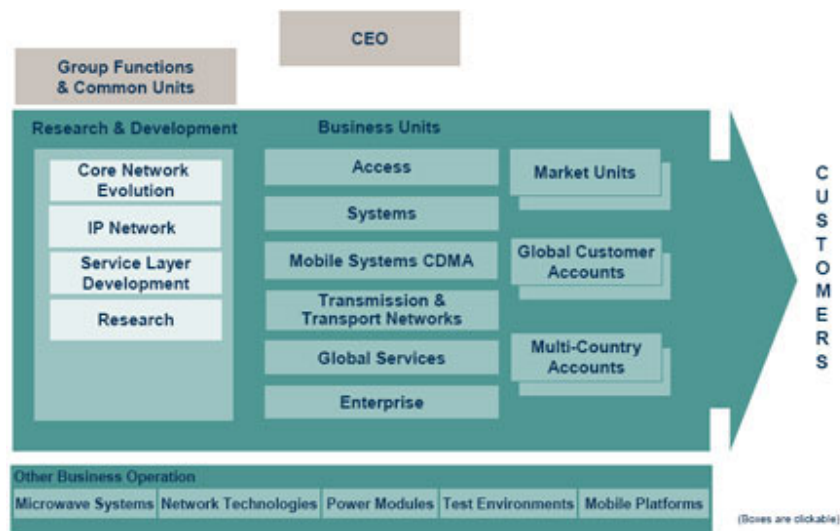


Figure 1: Structure of Ericsson

Today, Ericsson is the largest supplier of mobile systems in the world and supports all major standards for wireless communication. The world's 10 largest mobile operators are among our customers and some 40% of all mobile calls are made through our systems. We have been active worldwide since 1876 and we are today present in more than 140 countries. Our headquarters are located in Stockholm, Sweden.

Ericsson Education has trained more than 800 000 students since year 2000. Our portfolio is divided into two overall product lines; Training Programs and Learning Solutions.

Through Training Programs Ericsson offers globally standardized training flows to customers. This service includes pre-defined training flows according to job categories. The course participants can attend these training flows at their own site through the Remote Training Lab service, via Virtual Classrooms and web portals, or at one of the 26 Education Centers spread worldwide. The Training Programs portfolio includes more than 500 course titles, covers all of Ericsson's technical solutions and are based on years of experience working together with customers. The portfolio covers major job categories including network operations, field maintenance, system administration, network development, application development and business management

Learning Solutions on the other hand is a coherent end-to-end service designed to optimize the operator's competence development investments with a clear line of sight to the bottom line. Such solutions focus a lot on visualization of return on investment where meaningful Key Performance Indicators are used to measure the impact of the total solution.

For a more thorough review of Ericsson Education's complete portfolio please visit [www.ericsson.com/learning](http://www.ericsson.com/learning)

## 1.2 Ericsson Education and mlearning

Both Training Programs and Learning Solutions make use of both traditional course delivery techniques as well as state-of-the-art delivery techniques. Mlearning naturally fits into the latter and Ericsson Education has experimented for more than 5 years now with mlearning content development and delivery.

Ericsson Education's first major involvement with mlearning came about in 2000 when we initiated a joint research program with a pan-European consortium to research the boundaries of mlearning. The project ambition was stated as follows:

*The project sets in place the first stage in the creation of a global provision of training on the wireless internet. It sets in place the first building block for the next generation of learning: the move from distance learning (d-Learning) and electronic learning (e-Learning) to mobile learning (m-Learning) (Keegan 2000)*

The project received part funding from the European Union (Leonardo da Vinci program) and the consortium was made up of Ericsson Education (Dublin), NKI (Norway), FernUniversität (Germany), University of Roma Tre (Italy) and DEI (Ireland).

The project concluded in late 2002 with a conference in Dublin entitled mlearning: The Cutting Edge. The participants at the conference were able to see innovative courses designed for PDAs, perhaps the first training courses in the world on mobile phones as well as insightful presentations and information sharing on the techniques, didactics and technical challenges of presenting training material on wireless handheld devices.

This information is still available on the web today:

[http://learning.ericsson.net/mlearning2/project\\_one/index.html](http://learning.ericsson.net/mlearning2/project_one/index.html)

Included below is a sample screenshot of the mlearning courseware produced at this time. As you can see the device used is an Ericsson R380, one of the first 'smart phones' on the market. The large screen-size gave it a distinct advantage against standard phones for mlearning purposes. This was borne out in trials conducted with students during this project.

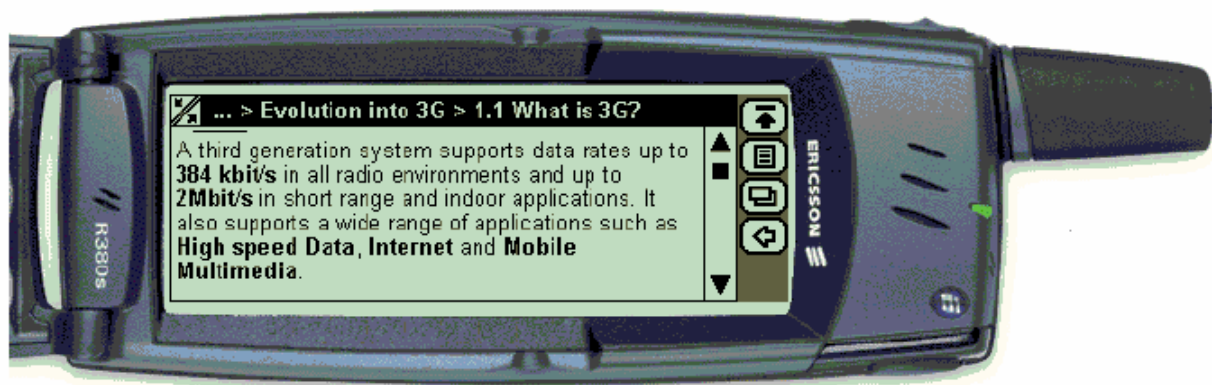


Figure 2: mlearning on an R380 smartphone (2001)

Despite the technology limitations of 2000 to 2002 the results of the project were quite positive as summarized by Keegan: 'The mixing of distance learning with mobile telephony to produce mLearning will provide the future of learning' (Keegan 2002).

After the conclusion of this project Ericsson Education continued to experiment with mlearning and in late 2003 a new research project was initiated with a similar consortium to the 2000 project. This project had the following aim:

*To develop and trial mobile learning (mlearning) courses for current and new mobile handsets where mobile learning is defined as the provision of training courses via wireless devices – PDAs (Personal Digital Assistants), smartphones and mobile telephones. These courses will be developed as part of a fully functional mobile Learning Management System (mLMS) and the courses will be trialed and evaluated and the results widely disseminated. (Landers 2003)*

The final results of this project were presented in Dublin on Sept 9<sup>th</sup> 2005 at the 'mlearning- the Future of Mobile?' conference. A summary comparison of the results on display between 2002 and 2005 indicate a huge jump in the functionality and capability of hand-held mobile devices when it comes to mlearning. The figure below indicates the huge improvement in functionality (screen resolution, color etc). However, some of the same issues remain such as how best to optimize the limited screen space and what learning model and business model works best for mlearning.

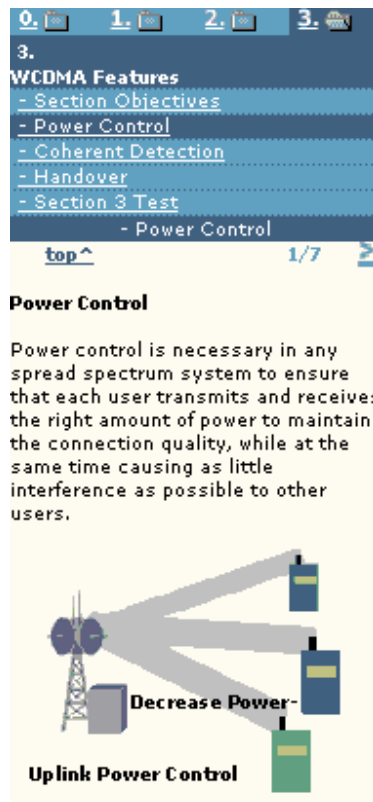


Figure 3: mlearning on a P900 smartphone (2005)

In summary, Ericsson's research in the world of mlearning has taught us a lot, not least how to manage the training content we produce in such a way that it is 'future-proofed' for delivery via hand-held mobile devices.

## 2. Development of a Learning Content Management Policy

The nature of the IT and telecommunications training market has changed over the past 5 years. This has partly been caused by the downturn in the industry, which happily now seems to be firmly behind us.

Corporate training budgets were not immune to the general cutbacks experienced in the IT and Telecommunications industry in recent years. Lower budgets, but not necessarily lower training requirements, meant that both suppliers and receivers of training had to manage their costs in a more efficient way. One outcome was the general requirement that an individual only takes the minimum training necessary that he/she requires in order to proficiently carry out their role and associated responsibilities. This put new requirements on a training supplier such as Ericsson Education. Whereas before a customer might be quite happy to enroll a group of students on the best-fitting off-the-shelf course from Ericsson, the requirement had now changed to where the general requirement is just for those parts of a training course or courses that match exactly a particular competence gap at that time. In other words a generic, global training course was not accepted unless it fitted the customer requirements 100%. If it did, well and good but if it didn't then the course required a specific customization for that particular customer.

Customization of training material can be expensive, especially if the structure and nature of the material is not designed in such a way that it can be easily customized. At Ericsson we found that while we had a very efficient and comprehensive course development process we weren't always able to customize the material in a cost-efficient and timely manner. Thus we initiated a review of our entire course development

process for all delivery formats (elearning including synchronous training, instructor-led training, and mlearning).

The outcome of this review indicated that we should develop a more modular based structure to our courses. However, developing such a structure is not as easy as it first sounds and there are many considerations that must be taken on board before a modular based structure can be launched across a global corporation. The results of this process have resulted in Ericsson's new Learning Content Management process and some of the principles behind this policy are shared with you here, particularly where they concern mlearning.

## 2.1 Learning Content Management Basics

First of all, any comprehensive learning content management policy must take into account all possible delivery formats of the material. At Ericsson, the majority of our material is delivered in the traditional manner as Instructor-led training. However we have a growing elearning sector and we are positive towards the use of mlearning as a viable delivery method. Therefore it was essential that whatever structure we put in place could handle all delivery formats.

Other initial considerations were that we would most likely need a new software support system to manage and administrate the new structure on our content. A feasibility study into the use of our existing system indicated that it would not measure up to the new requirements we were developing. This we initiated a vendor selection and approval process to test the marketplace to select the most appropriate learning content management system.

Of most concern though was the consensus that the most important criteria had to be that we future-proof the content. In other words we required all the content developed according to new principles to be reusable in the short, medium and long term. Therefore we avoided any kind of bespoke solutions and concentrated on the growing global development and acceptance of standards and reference models for learning content. Although these are primarily developed with elearning in mind (e.g. SCORM) we conducted a feasibility study into which standards and reference models that we could use for all of our content including mlearning.

## 2.2 Frameworks for Learning Content Management

The result of this feasibility study pointed towards the use of SCORM as a baseline requirement. In other words we would apply SCORM standards to our content, regardless of delivery format, and we would only consider content management systems that supported the required standards.

We also made the decision to produce modules of learning rather than complete courses. We defined criteria for a module as follows:

- A module is a self-contained part of a course covering a specific topic and/or a reusable chunk of information.
- A module is an indivisible, independent unit of training.
- A module is built upon one or several Main Learning Objectives. Each Main Learning Objective is based on Detailed Learning Objectives.
- A Module should have a recommended duration of 3 hours up to 1 day (ILT), and 1 hour (elearning) and 30 minutes (mlearning)
- A module will have metadata attached to it, making it possible to uniquely define and describe the module.

Of course we did not want to fall into the trap of developing different modules for different delivery formats. However we did have to take account of our current situation where the majority of the content is developed for Instructor-led training use. To avoid falling into this trap we included within the meta-date

model the primary delivery method for each module as well as secondary delivery methods. We also knew that the ability to be able to publish content to different formats depended a lot on the capabilities of the content management system that we would choose.

In this new content management scenario we apply a SCORM framework that enables us to manage the content in a much more systematic way than before. Firstly, for every piece of content that we develop, regardless of delivery format, we apply a SCORM supported meta-date model. This model is very comprehensive and the following illustration indicates the kind of meta-data that we record per module. The model we developed is in conformance with SCORM 1.2.

<b>Information</b>	<b>Informal description</b>	<b>SCORM metadata category and element used</b>	<b>Multiplicity</b>	<b>Type</b>	<b>Sample/ vocabulary</b>
Title	Title of the module	General/title	1	Lang string	"How to install base station XYZ"
Identity	A unique identifier	General/identifier Catalog = "Ericsson Education" Entry	1	Char string (Ericsson principle to be defined)	Entry="LZM123 456"
Description	A description of the contents (to be used in course description)	General/description	1	Lang string (Ericsson guidelines to be defined)	"This modules describes how to install base station XYZ, maintenance and configuration"
Author	Responsible author of the module	Lifecycle/contribute Role = "author"	1-*	Role Entity Date	Entity = "Karl Karlsson, HQ 123" Date = "2004-08-09"
Owner	The owner of the module	Lifecycle/contribute Role = "publisher"	1-*	Role Entity Date	Entity = "Jim Boss, HQ 456" Date = "2004-08-06"
Language	The language(s) of the	Educational/language	1-*	ISO639:1988 string	Language = "en-GB" This field



	module content			("en-GB", "en-US" etc)	should not be visible to end-users.
Version	The version of the module	Lifecycle/version	1	Lang string	Version = "R1A"

This is only a sample of the meta-data used for one individual module. The total number of fields used is currently 31. We develop one such meta-data master file for every module in our portfolio. The flexibility to customize the model to our own specific needs whilst retaining the integrity of the data over time was a big factor in choosing the SCORM model for Ericsson's content management strategy.

### 3. Application of a Learning Content Management Policy

Once we had agreement on the meta-data framework the next step in the process was to finalize a contract with a provider of a learning content management system. Perhaps the key requirement was that the preferred content management system would support SCORM 1.2 in full. This was crucial as our meta-data model was so completely derived from SCORM. In synchronization with this vendor selection process we have had to undergo a large change-management process and this process is still very much on-going.

#### 3.1 Tools and systems

An analysis of the leading learning content management systems on the global marketplace threw up some surprises for us. Firstly, most did not support SCORM 1.2 to the level of detail required by us. We hadn't expected this as an earlier preliminary feasibility indicated widespread support for SCORM amongst all LMS and LCMS providers. But we quickly learned that there is widespread support for part of SCORM, perhaps a number of key meta-data fields, but there is very little support for all of the possible fields. We quickly narrowed the list of potential suppliers down to three and we are in final negotiations to purchase one of these. We have conducted detailed 'sand box' trials with one vendor and the indications are very positive for the validity of our approach.

#### 3.2 Learning content management and mlearning

As part of the on-going work at Ericsson we are applying the SCORM-based meta-data model to our mlearning courses. We have a sample course publicly available today at this address:

[http://learning.ericsson.net/leonardo\\_courses/stand\\_alone\\_version/WCDMA\\_RAN\\_Overview/index\\_WCDMA\\_RAN\\_Overview2.html](http://learning.ericsson.net/leonardo_courses/stand_alone_version/WCDMA_RAN_Overview/index_WCDMA_RAN_Overview2.html)

This course is optimized for delivery to mobile devices such as the Sony Ericsson P900. However it is accessible by any mobile device with a web browser. A sample screenshot of this course is included here:

0. 1. 2. 3.

**1.**  
**Introduction to WCDMA RAN**  
 - Section Objectives  
 - Introduction  
 - WCDMA RAN Architecture  
 - Section 1 Test

- WCDMA RAN Architecture  
[top](#) 1/3

WCDMA system is a third generation network built on a horizontal layered structure consisting of the:

- Service layer
- Control layer
- Connectivity layer

The focus of this course is on the **WCDMA Radio Access Network of the connectivity layer.**

- **Service layer**

■ - Application  
■ - Service Capability Servers  
 - - - - control

- **Control layer**

From the point of view of content management this course is considered to be a single module as it matches the criteria that it is considered to be an indivisible, independent unit of training. Some of the meta-data for this course/module appears as follows:

<b>Information</b>	<b>Informal description</b>	<b>Sample/ vocabulary</b>
Title	Title of the module	WCDMA RAN Overview
Identity	A unique identifier	Entry="LZM 123 457"
Description	A description of the contents (to be used in course description)	"This modules describes the radio access network for WCDMA"
Author	Responsible author of the module	Entity = "Sean Smith" Date = "2005-02-09"
Owner	The owner of the module	Entity = "Paul Landers" Date = "2005-02-09"
Language	The language(s) of the module content	Language = "en-GB"
Version	The version of the module	Version = "R1A"
<b>Primary Delivery Format</b>	<b>The recommended delivery format</b>	"mlearn"
<b>Secondary Delivery Format</b>	<b>Other viable delivery formats</b>	"elearn"

As you can see I have highlighted the delivery format fields. There are some distinct advantages in having our content so finely described and tagged. Firstly, it is possible for our learning architects to quickly search for content to fit a specific purpose. They can search on any of the meta-data fields. If they require learning content on the subject of WCDMA that is preformatted for mlearning then they just have to use the two search criteria 'mlearn' and 'WCDMA RAN overview' in the relevant search fields. They will immediately get a hit on this course and any other courses and modules that match these search criteria. They can then browse this content to confirm that it is suitable and include it in customized courses and/or curriculums for our customers. Obviously this is a much more efficient way of managing the vast information we have at our disposal.

#### 4. The Future

So where does this work with SCORM, modules, meta-data standards etc leave Ericsson and its work with mlearning? The answer is quite simple. We have been working on this meta-data model for 12 months and through trial and error we have refined it to suit our specific needs whilst still ensuring the longevity of learning content developed in accordance with its principles. We are now entering the next phase of the endeavor which is to begin to create all new content according to structures in our meta-data model. We also plan to convert specific old content to the new model, particularly content that is foreseen to have a medium to long-term lifespan.

Specifically regarding mlearning, Ericsson Education is currently working to refine the content development process for mlearning. We have evolved from the production of basic mlearning content specifically for WAP 1.1 enabled handsets in 2000 to the use of much more evolved technologies such as Flash and specifically Flash Lite. More importantly, mlearning is considered as a viable delivery format, hence its inclusion in the learning content management framework as demonstrated earlier.

However that is not to say that the future is clear and well understood for mlearning. There are still obstacles to be overcome and questions to be answered. For example, what is the business model behind mlearning? What is the optimum pedagogical experience when using mobile devices? How should we handle simultaneous development of elearning content and mlearning content? Do we develop once and expect content management systems to render according to the device requirements? Or do we develop content in parallel?

It will take further research and development to answer these questions. However one thing is clear; the importance of an innovative systematic approach to learning content management is crucial for a company like Ericsson to harvest the vast information at its disposal for its own benefit and for the benefit of its customers. Survival in a knowledge-based industry and a knowledge-based society demands such innovation particularly in the area of education and learning where access to the right information and knowledge at the right time (and on the right device) is crucial to success.

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# **THE INCORPORATION OF MOBILE LEARNING INTO MAINSTREAM EDUCATION AND TRAINING**

by

**Desmond Keegan  
Dublin, Ireland**

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- 2. A definition of mobile learning**
- 3. A subset of distance education**
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- 8.1 University of Pretoria**
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- 8.4 Ericsson Education Ireland**
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- 10. Conclusions**

### **1. The basis of mobile learning**

What are the bases for mobile learning? It is important when introducing a new sector of education and training provision to have solid foundations on which to build the new sector.

From my own personal point of view, when I came into mobile learning for the first time in 1999, there were three bases for mobile learning:

- The future is wireless
- Irritation with the published scenarios for mobile devices of Ericsson and Nokia
- A 'law' of distance education research.

1. *The future is wireless*

In 1999, when I started working in this field, it was already clear that the future was wireless.

M-commerce was already replacing e-commerce, there were wireless applications for banking, stock exchanges, business and the home – the move to wirelessness in telephony and computing was irreversible.

The move to 3G, already rolled out in some countries and soon to be rolled out in many more, will enhance this transition to wirelessness. The humorous version of what 3G will bring and what 3G means is Girls, Games and Gambling, but the establishment of 3G will consolidate the move to wirelessness in telecommunications.

2. *Irritation with the published wireless scenarios of Ericsson and Nokia*

Irritation is not a good basis for the foundation of a new sector of education and training provision.

But in 1999 Ericsson and Nokia had already published their plans for the development of wireless applications. Reading these one could only marvel at what was being proposed. There was, however, a glaring lacuna: there was no mention of applications for education or for training or for learning.

Sadly, this scenario is little changed today. Mobile learning remains on the periphery of the planning of the wireless telecommunications operators.

A few days ago I was talking to a senior executive of Sony Ericsson about the new handsets they were planning for production for the market of 2006. He confirmed that, as it was in 1999, mobile learning was of little interest to their market. This is of serious importance for everyone attending this conference and for all who are interested in mobile learning.

3. *A 'law' of distance education research*

The justification of mobile learning and a solid foundation for this new sector of provision comes from the 'law' of distance research which states that 'It is not technologies with inherent pedagogical qualities that are successful in distance education, but technologies that are generally available to citizens'.

A typical example is the 12" laser discs of the early 1990s. These laser discs had excellent pedagogical possibilities and excellent courses were developed for them especially in the field of ESL (English as a Second Language), but they were not successful because not enough people owned one.

Never in the history of the use of technology in education has there been a technology that was as available to citizens as mobile telephony. The statistics are stunning: Ericsson and Nokia tell us there are 1.500.000.000 of them in the world today for a world population of just over 6 billion. Nokia forecasts further sales of 700,000,000 in 2005. In China alone there are 358.000.000 mobile subscriptions and this grows by 160.000 a day.

Sales will continue as ownership of the latest model becomes of social importance and multi-ownership is already an important phenomenon.

## 2. Definition of mobile learning

At other conferences I have heard John Traxler and others proposing complex definitions of mobile learning. Here I would like to propose quite a simple one.

In defining mobile learning one confronts tensions between functionality and mobility. There is a continuum from the point of view of functionality in the devices used for e-learning and m-learning. This continuum goes from desktop computers to laptop computers to PDAs or handhelds or palmtops to smartphones to mobile phones. There are many, especially in the United States of America, who include laptop computers in their definition of mobile learning.

I disagree. I feel that in the definition of *mobile* learning the focus should be on mobility. Mobile learning should be restricted to learning on devices which a lady can carry in her handbag or a gentleman can carry in his pocket. I therefore define mobile learning as 'the provision of education and training on PDAs/palmtops/handhelds, smartphones and mobile phones.'

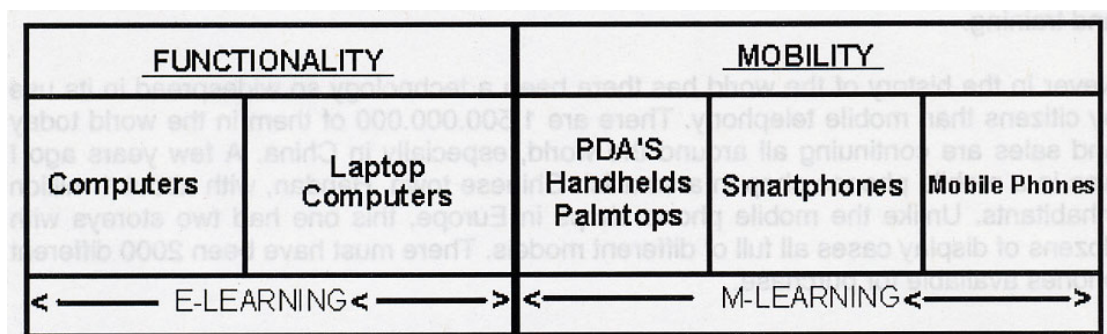


Figure 1. Functionality and mobility in a definition of mobile learning

One of the characteristics of mobile learning is that it uses devices which

- citizens are used to carrying everywhere with them,
- which they regard as friendly and personal devices,
- which are cheap and easy to use,
- which they use constantly in all walks of life and in a variety of different settings,

except education.

### **3. A subset of distance education**

#### *Conventional education and distance education*

Mobile learning is best seen as a subset of distance education.

This is because the world of education and training is divided into two halves known as conventional education and distance education.

Conventional education is also known as traditional education, or face-to-face education, or ILT (instructor-led-training). It takes place in schools, colleges and universities, training centres, laboratories and workshops.

The characteristics of conventional education are that the education transaction takes place

- within the learning group
- by interpersonal communication
- between the teacher and the taught.

What the first distance educators did was that they broke with the 2000 year history of education taking place in the learning group, by interpersonal communication, between the teacher and the taught and they replaced it with

- a largely individualized form of interaction
- based on an apersonal form of communication
- that was mediated by technology

and claimed that the education transaction in which learning from teaching occurs was maintained intact.



### *The benefits of distance education*

Distance learning brought great benefits to society.

It freed up learners so that they could study at any time and in any place and in structures suited to their employment and family commitments.

Most of the goals that today characterise just-in-time learning, or life-long learning, were anticipated by distance learning.

Above all it freed up learners from the learning group in a university or training centre: the obligation to join a learning group, at a fixed time, at a fixed place, for a fixed period of time, in order to learn.

It made possible:

- Training when it is needed
- Training at any time
- Training at any place
- Learner-centered content
- Avoidance of re-entry to work problems
- Training for taxpayers, and those fully occupied during university lectures and sessions at training centres
- The industrialisation of teaching and learning.

### *History of distance education*

In spite of these benefits that distance education brought to society the first 100 years of distance training were marked by criticism.

The correspondence image was disliked, governments largely ignored distance training, university professors scoffed at it, corporate trainers focused on ILT.

It is best to see the history of distance education in two phases:

- From 1870-1970
- From 1970 to the present day.

A major breakthrough in both the quality and quantity of provision came in the 1970s with the foundation of the European open universities, notably the Open University of the United Kingdom at Milton Keynes, the Universidad Nacional de

Educación a Distancia at Madrid, and the FernUniversität in Hagen, Germany, which were followed by other open universities all over the world.

Although the course materials of these open universities attracted much attention it was the student support services that they provided which enabled these universities to spearhead the change in status of distance education. They brought it about that nationally and internationally-recognised university degrees, college diplomas and training certification could be won at a distance.

### *Distance education today*

Today distance education is a rich form of provision with five main subdivisions as follows:

- Distance education – the provision of education and training at a distance by Open Universities, distance education institutions and distance education departments of conventional institutions
- E-learning – e-learning is the provision of education and training via the WWW for students who study mainly as individuals using LMSs (or VLEs) like WebCT and Blackboard. Since its beginnings in 1995, it has rapidly become a world-wide multi-billion dollar or euro training industry.
- I find in Europe a great lack of knowledge of and use of the synchronous e-learning systems, which are widely used, especially in corporate training, in the USA – these are the provision of education and training on the WWW to students who study in groups using LMSs like Centra or Horizon Wimba
- The use of the WWW for the provision of education and training on university and college campuses as a supplement to lectures and ILT given on campus or, alternatively, as a substitute for lectures when the courseware is provided on the WWW in the institution in place of lectures
- Mobile learning – the provision of education and training on PDAs (including palmtops and handhelds), smartphones and mobile phones.

### *Parallels between distance education and mobile learning*

One can see many parallels between the history of distance education and the history of mobile learning. Mobile learning is still in the period of criticism, of lack of acceptance, of lack of status, of lack of certification for its degrees, diplomas and training certificates that characterised the first 100 years of distance education.

When compared with the field of electronic learning or e-learning the scene is quite different. The hard work of the period 1870-1970 in distance education has been largely absent from the field of elearning.

Its ten years of life since the commencement of the WWW have seen the quick acceptance of electronic learning, the rapid achievement of status both at

university level and at corporate level, the swift recognition of degrees, diplomas and training certification, whether wholly or partially awarded for study by elearning and the rapid emergence of elearning as a multi-billion dollar industry, for which many observers forecast exponential growth in the immediate future.

Perhaps the hard work for acceptance done in the field of distance education has rubbed off on electronic learning and will also affect the field of mobile learning.

#### 4. Mobile learning projects

An important dimension of an analysis of the incorporation of mobile learning into mainstream education and training is the study of major mobile learning. There have been many mobile learning projects in various parts of the world. Here we will focus on mobile learning projects funded by the European Commission in Brussels.

There are four major projects in mobile learning funded by the European Commission in Brussels. These are:

Programme	Project leader	Title
Leonardo da Vinci	Ericsson Education Dublin	From e-learning to m-learning
Leonardo da Vinci	Ericsson Education Dublin	Mobile learning: The next generation of learning
IST FP5	LSDA UK	The m-learning project
IST FP5	Giunti Ricerca Italy	The MOBILearn project

Brief descriptions of these projects are:

- The Leonardo da Vinci project *From e-learning to m-learning* led by Ericsson Education Dublin referred to above.

The *From e-learning to m-learning* project addressed the development of courseware for mobile phones, smartphones and PDAs.

What was important about this project was that the main pedagogical problems of developing mobile learning for PDAs were solved in the project *From e-learning to m-learning*, in which a comfortable didactic environment was created by using Microsoft Reader Works, providing each student with Microsoft Reader software to display the content and which was adjudged highly satisfactory by surveys of students who had studied a full course by mobile learning on a PDA. As the major objection raised against mobile learning is screen size, it was important that this problem was solved and bypassed at the outset.

The full course of text and readings measured 1000 A4 pages and was easily held by the memory of a standard PDA like the HP Compaq iPaq 5000 series.

The project also had success in developing courseware for phones and incorporated surveys of student satisfaction with mobile learning for students from Ireland, Norway, Germany and Italy.

- The Leonardo da Vinci project *Mobile learning: the next generation of learning* led by Ericsson Education Dublin.

The main activities to achieve the products of acceptable courseware for smartphones in the *Mobile learning: the next generation of learning project* are installing a web-authoring tool like Macromedia Dreamweaver MX Version 1.0, installing a desk-top browser e.g. Opera 6.31 that has page rendering characteristics similar to a mobile phone, using XHTML 1.0 Transitional to code the web pages, using Cascading Style Sheets (CSS) to separate presentation style from document content, arranging each course page as a vertical column of content of at most 208 pixels, designing the user interface so that the limited screen space available is utilised as efficiently as possible, designing concise neat diagrams to fit the small screen, using Adobe Photoshop to produce light weight GIFs for mobile devices.

The next generation of mobile learning course development is based on Flash Lite. This development is motivated by the fact that there are thousands of developers who have used Flash to develop elearning content and that there is a lot of elearning content available in Flash, so that – for the first time in the history of mlearning – you can reuse the pedagogical and technical skills of the developers and the content can be reused too.

Progress was also made in the development of courseware for PDAs with one of the partners, NKI from Bekkestua, Norway announcing that by developing server-side code for their system, they had produced mobile learning versions of all 400 of their e-learning courses and were offering them to their mainline students.

- The IST project *M-Learning* led by the United Kingdom government Learning and Skills Development Agency (LSDA)

This €4.500.000 project had an important social dimension. It recognised that there were in the United Kingdom many 16 to 20 year old youths who were unemployed and had urgent needs for additional training, but who refused to attend a training centre or college. They were unemployable and refused to attend training. They all had, however, a mobile phone which they used constantly. The project, therefore, set out to develop courses for them on their mobile phones in the fields of literacy, numeracy and social skills. The focus of the project was on mobile phones, as this type of student did not possess either smartphones or PDAs.

- The IST project *MOBILearn* led by Giunti Ricerca of Genoa, Italy.

This was a very large project led from Italy and counting a wide range of at least 20 European universities among its members with funding of €8.000.000. The objectives of this project are: The definition of theoretically-

supported and empirically-validated models for: Effective learning/teaching/tutoring in a mobile environment; Instructional design and eLearning content development for mobile learning.

This project ended in early 2005 and the mobile learning world is waiting for the release of results from it.

## **5. The failure of mobile learning**

When one is discussing the question of the incorporation of mobile learning into mainstream education and training it is important to realise that these projects were *projects*. That is, they were research undertakings to set out the first building blocks of a new sector of education and training provision.

It is now time for mobile learning to emerge from its project status and enter into mainstream education and training. Excellent work has been done by the projects listed above but until mobile learning enters the mainstream it remains a fragile and research-based undertaking.

The trouble with *projects* is that they tend to collapse and disappear when the project funding is discontinued.

Why has mobile learning not yet emerged from its project status and not yet taken its place in mainstream provision? Why does it remain at the research project level and not emerge into a serious form of provision?

The problem is that wireless applications are being developed for wireless devices for all walks of life. Learning and training do not figure in these developments. Learning and training do not seem to be high on the list of applications that are receiving attention today.

It is essential for mobile learning that developments in education keep pace with developments in other fields. It is important that mobile learning should not be left behind. As relayed by innovation experts, new ideas and inventions only become innovations when the ideas and inventions are adopted and utilised by the market.

Isn't it strange that all students enrolled in higher and further education institutions today have frequent needs for information from their institutions about timetable changes, assessment deadlines, feedback from tutors and other urgent administrative details? Nearly all of these students carry a sophisticated communications device which they use constantly in all walks of life except in their education or training programme.

Isn't it strange that all higher and further education institutions today have frequent needs for providing information to their students about timetable changes, assessment deadlines, feedback from tutors and other urgent administrative details? Nearly all of these students carry a sophisticated communications device which they use constantly in all walks of life except in their education or training programme.

The answer to these questions that I have been posing about why mobile learning has not moved from project status into the mainstream is well known. It is that mobile learning is not seen as a satisfactory revenue stream for the telecommunications operators. The urgent need for mobile learning is to emerge from its fragile project status and convince the telecommunications operators that it represents a viable and valuable revenue stream.

## **6. Towards a solution: a matrix for mainstream provision**

We have posed the problem of the status and acceptance of mobile learning – we must now look for solutions to the problem.

One can develop a nine-point matrix for the use of mobile learning in mainstream education and training. One axis is made up of the three types of devices that make up mobile learning provision:

- PDAs
- Smartphones
- Mobile phones.

The other axis is the types of education provision that can reasonably be provided by mobile learning:

- Mobile learning academic administration SMSs. This provides universities and other institutions with structures to send SMSs to all their students, or all students in a particular grouping about timetable changes, examination deadlines, assignment results, changes of procedure that all institutions need to immediately communicate to their students. This can also be used for students who need information from the institution in the form of FAQs, or answers contained in databanks.
- Mobile learning academic summaries. These are 4 to 5 screen academic summaries of content, examination hints, assessment questions for course revision, guidelines for particularly difficult parts of a course or counselling provision for students in need.
- Full modules by mobile learning. This is the presentation of full courses, or full modules of courses, on mobile devices.

This gives the following nine possibilities:

Mobile learning for academic administration on PDAs  
Mobile learning for academic administration on smartphones  
Mobile learning for academic administration on mobile phones  
Mobile learning academic summaries for PDAs  
Mobile learning academic summaries for smartphones  
Mobile learning academic summaries for mobile phones  
Full modules by mobile learning for PDAs  
Full modules by mobile learning for smartphones  
Full modules by mobile learning for mobile phones.

As I have indicated in my analysis of the European Union-funded projects, many of these have already been achieved; a few remain to be achieved.

## **7. Towards a solution: criteria for inclusion in the mainstream**

We need criteria for the inclusion of mobile learning courses in the mainstream. When can they be said to have achieved mainstream status? And when must it be said that more work remains to be done? The following criteria were established by analysing the parallels with the fields of distance learning and of e-learning.

There are four criteria for the inclusion of mobile learning in mainstream education and training. These are:

*Enrolment of mobile learning students in courses on the institution's official prospectus.* This is essential for incorporating mobile learning into the mainstream. If the mobile learning course is not included in the institution's prospectus and listed as available for student enrolment it remains peripheral with the status of a research project in an isolated university department and cannot be considered as part of mainstream provision.

*Enrolment of mobile learning students into fee-paying courses.* This is essential for incorporating mobile learning into the mainstream. This is applicable to countries in which fees are payable for enrolment in further and higher education courses. If the mobile learning course is not included in the institution's fee-paying courses and is listed as available for paid student enrolment it remains peripheral with the status of a research project and cannot be considered as part of mainstream provision.

*Enrolment of mobile learning students into assessed courses.* This is essential for incorporating mobile learning into the mainstream. If the mobile learning course is not assessed with the same rigour and procedures as other courses offered by the institution it remains peripheral with the status of a research project and cannot be considered as part of mainstream provision.

*Enrolment of mobile learning students into accredited courses.* This is essential for incorporating mobile learning into the mainstream. As happened in the field of distance education and then in e-learning, the achievement of accreditation for mobile learning is an indication that the sector has entered into the mainstream. The awarding of assessment at university level in distance education was a lengthy process lasting nearly 100 years and was not fully accepted until the foundation of the Open Universities in the 1970s; in e-learning it was achieved much more quickly.

## **8. Towards a solution: institutions already operating in the mainstream**

The goal for any presentation on 'Incorporating mobile learning into the mainstream' is to be able to state that mobile learning has arrived and is now operating in the mainstream. This is far from being the case with mobile learning. Like the fields of distance education and e-learning before it, mobile learning needs to achieve acceptance and then status and then certification, eventually at university degree level. Mobile learning is just setting out along that path.

There are, however, some institutions which have already travelled extensively along the path, and it may be claimed that they are already operating in the mainstream. In this presentation I want to refer to four examples:

- The University of Pretoria, South Africa
- NKI, Bekkestua, Norway
- Athabasca University, Alberta, Canada
- Our own new project at Ericsson, Dublin, Ireland

#### *The University of Pretoria*

The importance of the work being done at the University of Pretoria is that it deals with mainline students who are studying mainline university courses.

The University of Pretoria started using mobile phone support during 2002 in three paper-based distance education programmes because more than 99% of the "rural students" had mobile phones. This is still the case. Currently nearly 98% of these students have mobile phones.

The profile of these students in 2002 was as follows:

- The majority live in rural areas
- 100% are full-time employees (teaching)
- 77.4% are English second language speakers
- 83.8% are between the age of 31 and 50
- 66.4% are women
- 0.4% have access to e-mail
- 99.4% have a mobile phone

The majority of these learners live in deep rural areas with little or no fixed line telecom infrastructure.

Mobile phone support to these rural distance learning students entails 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.

#### *NKI, Bekkestua*

NKI has been for many decades one of Europe's leading providers of distance education courses. In more recent times it has become probably the largest European provider of e-learning courses for paid enrolment and has today a portfolio of over 400 e-learning courses.

It is a partner with Ericsson in the *Mobile learning: the next generation of learning* project. During the course of this project is announced that it had developed mobile learning versions of all 400 of its e-learning courses and was offering them for paid enrolment. This represents a massive transfer of mobile learning into the mainstream.

#### *Athabasca University, Alberta, Canada*

Athabasca University has announced that their School of Computing and Information Systems has offered their course *Introduction to Computing in XML* for delivery to wireless mobile devices. Students are using a variety of mobile devices including HP iPAQ Pocket PC, Samsung A 860 clamshell mobile phone, Palm One Treo 650 smartphone and Samsung A 540 clamshell mobile phone. They are also trialling next generation devices for mobile learning including ultra notebook computers like Vaio VGN-U71P (about the size of a paperback book), Psion Notebook (larger than a PDA), OQO 1.0 (larger than a PDA) and Toshiba Libretto (a mini-laptop).

#### *Ericsson Education Ireland*

I am happy to be able to announce that Ericsson Education Ireland in Dublin has again been successful in winning a grant for mobile learning from the European Commission. Again the grant is small (€350.000) and the programme is very demanding:

- Development of a Mobile Learning Development Kit for the use of mainstream institutions to enable them to introduce mobile learning. A hands-on, how-to-do-it guide.
- A Mobile Learning Academic Administration kit. A hands-on, how-to-do-it guide for mainstream institutions on how to contact all, or groups, of students by mobile learning (on the model of the University of Pretoria)
- Production of 20 academic course guides, 4-5 screens long.
- Production of 10 modules for use as mainstream courses.

- Teaching and evaluation of 20 course guides and 10 full modules with mainstream students.
- Production of a Book on Mobile Learning and an International Conference.

You can see here a transition from a concentration on institution-specific development within a single institution to a focus on the provision of materials for the field as a whole, with the purpose of moving mobile learning into mainstream education and training.

## 9. Towards a solution – the literature

The development of the literature of mobile learning has high importance in the move of mobile learning into the mainstream. Mobile learning will never emerge from its present fragile project-based status and take its place in mainstream education and training unless it has a vibrant literature. Deans of Faculties at universities throughout the world will never accept the introduction of mobile learning into their courseware unless they can verify the claims of mobile learning by consulting the research literature.

In some ways the status of mobile learning today is similar to the status of distance education at the start of the 1980s. Distance education, it is true, was characterised by extensive offerings from institutions around the world and the foundation of the Open Universities in the United Kingdom, in Spain and in Germany were beginning to give it new status, but its literature was unacceptably weak.

For this reason *Distance education: international perspectives* was published by me in 1983 to provide a collection of contributions to the literature of distance education from the 1970s, my *Foundations of distance education* was first published in 1986 to give an overview of the field, *Theoretical principles of distance education* followed in 1993 to give a theoretical analysis of the field and *Distance education: new perspectives* was also published in 1993 to give a collection of the contributions to the literature during the 1980s. The international journal *Distance Education* was founded in 1980 and is now in its 25th year.

Similar initiatives are necessary for the literature of mobile learning if it is to convince academics in universities worldwide that it is a viable form of educational provision.

In this context it is excellent to be able to welcome the first book on mobile learning to be published by a major international publisher which will appear in mid-November 2005 from Routledge in London and New York.



## Mobile Learning

A Handbook for Educators and Trainers

Edited by: Agnes Kukulska-Hulme, John Traxler



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Routledge

**ISBN:** 0415357403  
**Pub Date:** 17 AUG 2005  
**Type:** Paperback Book  
**Price:** £24.99  
**Extent:** 192 pages  
(Dimensions 234X156 mm)

This timely introduction to the emerging field of mobile learning explains the technologies involved, their applications and the multiple effects on pedagogical and social practice.

Mobile devices include handheld computers, smartphones and PDAs, and this handbook will emphasize the issues of usability, accessibility, evaluation and effectiveness, drawing from case studies written by researchers and practitioners, all experts in the field.

This is a cutting-edge subject in open and flexible learning, with e-learning a key issue in the UK Government's strategy to increase the number of people going in to higher education.

The title is *Mobile Learning: a Handbook for Educators and Trainers* and it is edited by Agnes Kukulska-Hulme of the Open University of the United Kingdom and John Traxler of the University of Wolverhampton both of whom will be known to many in today's audience.

It is described thus:

This timely introduction to the emerging field of mobile learning uses case studies written by experts in the field to explain the technologies involved, their applications and the multiple effects on pedagogical and social practice.

Moobile devices include handheld computers, smartphones and PDAs, and this handbook will emphasise the issues of usability, accessibility, evaluation and effectiveness, drawing from case studies written by researchers and practitioners, all experts in the field.

The paperback version of *Mobile Learning: a Handbook for Educators and Trainers* costs £22.99 and its ISBN number is 0-415-35740-3.

## **10. Conclusion**

Finally, the problem of the incorporation of mobile learning into mainstream education and training has been addressed in this presentation. The answer to the question 'Why has mobile learning *not* moved from project status to the mainstream?' has been identified. It is that mobile learning is not seen as a satisfactory revenue stream by the telecommunications operators.

Solutions have been proposed for this problem. Firstly, there are thousands of universities and further and higher education colleges all over the world. If they can all be convinced to accept mobile learning as their normal means of communication with all their students on changes of timetable, submission deadlines, enrolment procedures and other administrative necessities, a massive mobile learning revenue stream will already be set up.

Secondly, the production of a mobile learning development kit for distribution to universities and colleges to enable them to introduce mobile learning will set up another revenue stream.

Thirdly, the production of course guides, course summaries, examination reminders, helps with difficult parts of a course, will set up another revenue stream.

Fourthly, the production of full course modules for PDAs, handhelds, palmtops, and also for smartphones and eventually for mobile phones, will set up another revenue stream.

Finally, the literature of the field needs to be developed, books on mobile learning need to be written, conferences like this one need to be organised.

The challenge to all of you attending this conference is to go away from here convinced of the need to establish mobile learning as a viable and valuable revenue stream for the telecommunications industry.



# Streaming mLearning Objects via Data Resolution and Web Services to Mobile Devices: Design Guidelines and System Architecture Model

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## 1 Abstract

Mobile technologies—PDAs, cellular/smart phones, PC tablets, hand-held computers, wearable computer devices, etc.—allow for connection to both internet-based learning/training resources, as well as other people. Users of mobile technology can manage the administration of their learning via personal journals and interaction with virtual learning environments. The ability to instantly download performance support resources and instantly publish ones behaviors/actions, observation, and data will empower users to become investigators and active learners that are responsible for their own knowledge acquisition and decision making. Further investigation that results in the design and implementation of guidelines is needed in order to successfully and effectively employ mobile technologies for education/training and performance support within blended learning environments, across various communities of practice, composed of learners having various skill levels. Moreover, existing technical specifications and standards such as—wireless network technology, web services, Sharable Content Object Reference Model (SCORM) 2004, Content Object Repository Discovery and Registration Architecture (CORDRA), and S1000D (technical data publication standards)—require investigation in their application to technically make available instruction and performance support resources via mobile technologies. Specifically, this paper will offer guidelines as well as a system architecture model that could potentially identify both SCORM conformant and technical publication objects via a content/data resolution server using web services to deliver objects for mLearning and performance support via mobile technology devices. Additionally, a prototype will be developed to demonstrate the capability to stream SCORM 2004 conformant objects from data repositories—using web services—to various mobile technology devices.

## 2 Mobile Technologies to Support mLearning

Both mobile and game technologies are increasingly topics of research for the development of resources that can remotely support learning and training. This increase is partly fueled by the realization that Generation-Xers (Gen-Xers) and Generation-Ys (Gen-Ys or Millennials) live in a digital world whose culture is constantly being shaped by mobile and game technologies, just as much, if not more than PC applications. Many education and training settings are trying to implement such technology to reach and engage this digital population in real time with meaningful performance-based learning/training. Other influences for this increased research activity are the need for immediate training and performance support on the spot and just in time. Examples include but are not limited to:

- Mobile devices that are used by a disaster recovery team to display just in time information and data capture that is relevant to disaster recovery.
- Ubiquitous collaborative learning via cell phones or PC tablets that allow the learner to play an active role in both the knowledge building process and decision making anywhere, anytime.
- PDA's are used as an essential device in dental education and clinical practice for knowledge capture and decision making.
- Experiential learning through mobile gaming or mobile simulations.
- Mobile technologies can provide situated learning by extending the learning/training environment beyond the classroom into authentic and appropriate contexts of use.
- Learning and performance support that provides information and training onsite and just in time.

The challenge of mobile technologies is to understand and explore how best they can be used to support learning, training, and performance support. The use of mobile technologies should not be viewed as isolated activities; instead, they should be viewed as richly ubiquitous, networked, and effective collaborative devices having a presence in the classroom, during a maintenance activity aboard ship, or helping to diagnose and triage victims during a disaster recovery effort.

## **2.1 Moving Forward with Mobile Technologies**

Empirical based findings, best practices, and lessons learned regarding mLearning and their respective instructional strategies offer a foundation to investigate mobile technologies and appropriate instructional strategies for knowledge capture and adaptive decision making that result in performance based outcomes. Though mobile and gaming technology research and its application to learning and training is in its infancy, the existing research increasingly shows its potential to offer the learner empowering opportunities not only to learn by doing, but to develop meta-level reflections on strategies for learning and decision making (see, Kirriemuir & McFarlane 2003; Squire 2003; Gee 2003).

## **3 Support for Blended Data Systems**

### **3.1 Standards and Specifications Overview**

#### **3.1.1 SCORM 2004**

“The Advanced Distributed Learning’s Sharable Content Object Reference Model (SCORM) aims to foster creation of reusable learning content as “instructional objects” within a common technical framework for computer-based and Web-based learning. SCORM describes that technical framework by providing a harmonized set of guidelines, specifications, and standards based on the work of several distinct e-learning specifications and standards bodies” (ADL, 2004).

#### **3.1.2 AECEMA S1000D**

S1000D is an International Specification for Technical Publications utilizing a Common Source Data Base (CSDB) and is used for the procurement and production of technical publications. These comprehensive technical publications cover all aspects of creating, maintaining and publishing a technical information data set. Web technology and graphics standards are included as well as a capability to integrate with the other standards based processes used in project procurements. Whilst the title restricts its use to technical documentation it has been demonstrated that the principles of the specification can easily be applied to non-technical documentation (i.e., the incorporation of technical data into training content). The specification adopts and profiles ISO and WWW standards. Information generated is in neutral format, which means it can be used on disparate IT systems—is interoperable. It is this feature together with the modular approach to data creation and storage that makes the specification so acceptable to the wider international community. (S1000D Brochure)

#### **3.1.3 CORDRA**

CORDRA™ (Content Object Repository Discovery and Registration Architecture) is an open model for how to build systems than can share and reuse learning content. CORDRA is just one of many international activities that are focused on the development and deployment of tools and systems that enable discovery, management and sharing of learning content. The CORDRA project has its roots in the ADL's SCORM initiative, but the model will not be restricted to SCORM content. The project is currently a collaborative activity among a number of interested organizations—to include DoD, whose draft instruction 1322.XX.00 states that all DoD components shall maintain all distributed learning content in repositories that are searchable and accessible. CORDRA facilitates object searches and accessibility.

From a community perspective, users deserve simple models and means to seamlessly find and access appropriate learning content. Keys to reaching these goals are providing the appropriate infrastructure and removing barriers (both technical and policy) that limit interoperability among systems as well as between systems and users. The various ongoing international projects address parts of the content discovery and sharing problem through their particular approaches.

### **3.2 The Delivery of Objects Via Web Services and Wireless Technologies**

Emerging technical standards and specifications such as wireless network technology, SCORM 2004, CORDRA, and S1000D can permit the 2-way interchange of reusable content objects among common-source data repositories that store both technical data and training/learning content. Learning content and technical data resource blending is both fiscally and strategically advantageous. The goal is to develop technical and training content from an integrated data environment that relies on data request and data

resolution Web Services in conjunction with XSLT processing applications to deliver technical data or training content objects to the appropriate communities of use.. (see Figure 1). This blended approach will also create potentials for the reuse of diverse data objects to enable the development and production of technical manuals and respective courseware as though from single source materials. Configuring training/learning content from the authoritative technical data will create possibilities for data aware distribution environments. These linked data environments could enable systematic, cascading notifications of recommended changes to training/learning content when critical updates are made to authoritative source data objects. Automated content data configuration systems will help insure that all data consumers will have access to the most current content data whether it is in the form of technical manuals or associated training and educational resources.

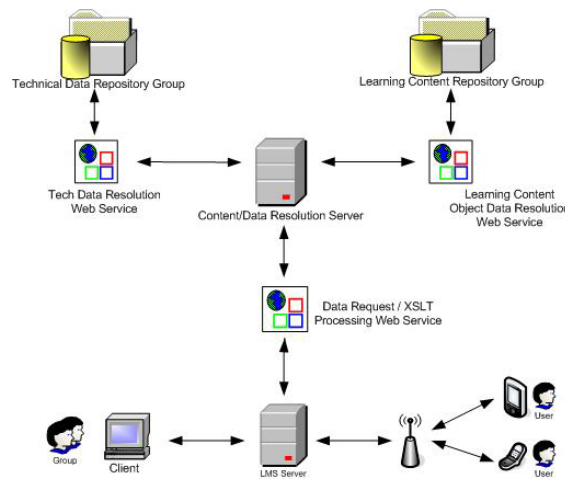


Figure 1: Data Flow and Resolution to Deliver Learning and Technical Objects to Mobile Technology End Users.

## 4 Methodology

Investigate the various types of mobile technologies: PDAs, cell/smart phones, PC tablets, hand-held computers, ultra portable computer devices, etc., and their appropriate application in various education/training and performance support environments. This investigation will include the analysis of integrating mobile technologies with emerging learning content (i.e., SCORM 2004) and technical data (i.e., S1000D) specifications to integrate into a distributed learning environment. Specifically, guidelines will be developed based on theories and applied research in the areas of cognitive sciences, learning, gaming/simulation, and learning objects as well as existing studies from mobile technologies' research and use cases. The following analysis and product development based will be structured around current mobile technology research, lessons learned, and best practices.

### 4.1 Literature Review

Review of literature was focused around the following research questions:

- What types of training and/or performance support can be effectively delivered via a PDA that are consistent with the identified learning environment?
- What are the technology and media capabilities and/or limitations within PDAs relevant to learning and performance support?
- What limitations, if any, exist for use of adult instructional strategies? Are there any that are particularly well suited for PDA use?
- How is the mobile technology training/performance support integrated within the identified learning environment, taking into consideration the identified learning environment's business rules and system architecture?



- How can training and technical data be integrated into a hybrid product for delivery via mobile technologies?
- What are the existing mobile technologies “best practices” that can be applied to the identified learning environment?
- What is the potential for importing legacy content into the mobile technologies for use in the identified learning environment?
- What existing mobile technology applications can readily integrate with the identified learning architecture to maximize the potential for content delivery via mobile technologies?
- What are the change agency issues that surround the adoption of mobile technology use within the identified learning environment?

## 4.2 Analysis

1. Investigate a cost model for infrastructure, technology, and services for integrating mobile technologies into a distributed learning environment.
2. Investigate the usability requirements of all stakeholders—both those creating the content and using the technology—involved in the development and use of mobile technologies within a distributed learning environment. Specific areas to investigate include:
  - Appropriate ISD theories for mobile technology content development
  - Appropriate design and use of mobile technologies for both education/training and performance support
  - Technological (e.g., web services, data resolution, data repositories) considerations for implementing mobile technologies within a distributed learning environment
3. Determine which mobile technologies and respective instructional strategies are best suited for which training and learning task to support mLearning.

## 5 System Architecture Design Issues

### 5.1 The Mobile SCORM LMS Issue

Limitations in current mobile technologies prohibit the standard LMS deployment of SCORM compliant content to mobile devices under the terms of the SCORM RTE Specification. Deployment of SCORM compliant content to mobile technologies will require highly specialized mobile SCORM LMS development.

The conceptualization and engineering of methodologies to cope with the deployment and rendering of SCORM compliant content on mobile devices, or any other platform, lie beyond the domain of SCORM compliant content development. Content developers are bound by elaborate yet technologically unsophisticated specifications. The SCORM 2004 Content Aggregation Model (SCORM CAM) and the SCORM 2004 Sequencing and Navigation Specification (SCORM S&N) apply more to content development concerns.

The task to deliver SCORM compliant content to mobile devices falls under the realm of LMS development. The SCORM 2004 Run Time Environment Specification (SCORM RTE) is the primary reference for LMS developers.

The SCORM RTE is a much more technologically demanding specification than the CAM or S&N specifications. It requires familiarity with Object Oriented Programming (OOP), the W3C Document Object Model (DOM), Hypertext Transfer Protocol (HTTP) and data modeling to be fully understood.

The ADL SCORM RTE assumes PC-based rendering of content objects delivered (or served) by a compliant LMS. The SCORM RTE Specification offers no support or guidelines for the implementation of the SCORM RTE within the realm of mobile technologies.

However, it is possible to demonstrate the ability to successfully render and track SCORM 2004 compliant content on mobile devices in non-standard ways. It is possible to address the limitations of individual

mobile device OS and browsers by developing integral, client-side SCORM conformant viewer applications for each mobile OS platform. Pocket SCORM is the example of this technology.

## **5.2 The SCORM RTE “As Is Situation”**

Research into SCORM RTE compliant content for mobile devices reveals a number of special circumstances that make the strict implementation of the ADL SCORM Application Programming Interface (API) on mobile devices a task fraught with barriers.

Perhaps the single greatest obstacle is the lack of uniform support for the most common technologies promoted by the SCORM RTE Specification. The strategies used by LMS developers to establish data communications between SCOs and the LMS invariably fail when deployed on mobile devices.

Lack of complete support for the foundational technologies that enable the SCORM RTE among device OS and mobile browsers currently prohibits the development of universal, cross-platform, open-source solutions to accommodate the ADL SCORM RTE. However, there are other means to accommodate SCORM compliant content on mobile devices. As mentioned, Pocket SCORM represents one such solution now available for the Pocket PC. This will be discussed later in the document.

However, enabling technologies for mobile devices and browsers are evolving by leaps and bounds. It is not unreasonable to speculate that the inhibiting issues may be overcome by the mobile OS and browser developers in the near future. The gravity of the consequences of these issues for all communities of mobile content developers makes this eventuality even more likely.

The limitations for ADL SCORM in mobile browsers fall into two basic categories:

- General Lack of support for advanced DHTML scripting and the W3C Document Object Model (DOM)
- Lack of cross platform support for Java and/or Active X Components

Perhaps the greatest handicap to the SCORM on mobile devices is the limited support for advanced DHTML in mobile browsers. As a practical matter, the SCORM API requires the use of advanced scripting and DHTML objects in HTML pages. It should also be noted that the ADL offers no support, guidelines or specification for the implementation of the API within mobile technology platforms.

### **5.2.1 An Immature Rendering Environment**

Mobile devices are a comparatively immature content rendering platform. As previously noted, the lack of standardized support for the SCORM RTE foundational technologies creates an unfriendly environment for the LMS delivery and client rendering of SCORM compliant content on mobile devices in accordance with the SCORM RTE specification. This means that it is highly unlikely that a single solution can be formulated for the delivery of SCORM compliant content across the spectrum of mobile device OS and Web browsers at this time.

Follow these links to view detailed information on the support for capabilities of the two predominant mobile browsers for Palm OS and Pocket PC:

- [http://kb.palmone.com/SRVS/CGI-BIN/WEBCGI.EXE/?St=32,E=000000000100175381,K=5710,Sxi=4,new,t=printsolution.case=obj\(31514\)](http://kb.palmone.com/SRVS/CGI-BIN/WEBCGI.EXE/?St=32,E=000000000100175381,K=5710,Sxi=4,new,t=printsolution.case=obj(31514))
- <http://msdn.microsoft.com/library/default.asp?url=/library/en-us/wcepie/html/cerefPocketInternetExplorer.asp>

Please note that our research indicates that, although not stated, the Palm browser support for DHTML is limited, as it is for Pocket IE.

### 5.2.2 Palm OS

Our research does not indicate the existence of a SCORM conformant RTE for the Palm OS. However, because Pocket SCORM architecture is built upon Web Services and platform independent protocols such as SOAP, it may be possible to devise a client-side SCORM viewer application module for Palm OS devices that can be integrated into the existing Pocket SCORM RTE server-side architecture. Creation of such an application may represent a significant development effort.

### 5.3 A Viable Alternative: Pocket SCORM

Pocket SCORM is a modular remote LMS and mobile client viewer solution. It operates through a custom Pocket SCORM RTE that mirrors the conventions of the ADL SCORM RTE. The Pocket SCORM RTE accommodates the special needs of MS Windows-based mobile devices. Although it is similar in many respects, by necessity, the Pocket SCORM RTE is not fully ADL SCORM RTE compliant.

While it may not strictly comply with the ADL SCORM RTE, Pocket SCORM is recognized and to a degree endorsed by ADL. Pocket SCORM provides a sophisticated and elegant means to deliver and track user data from SCORM 2004 compliant content

## 6 Prototypes

Applying the a) results from the analyses—guidelines for which instructional strategies best support mLearning via mobile technologies, and b) system architecture design and respective model a prototype will be developed to demonstrate the capability to deploy SCORM 2004 conformant objects from data repositories through XML Web Services to mobile devices.

## 7 Conclusions

Until the methodologies required for the instantiation of the SCORM API on mobile clients are fully supported by mobile browsers and Operating Systems, we are prevented from deploying standard SCORM LMS navigation and CMI user data functionalities in mobile environments as specified by the SCORM RTE.

This circumstance necessitates the research and development of conformant LMS adaptations of the SCORM RTE in mobile learning environments across the range of target Operating Systems.

At the same time, the lag in technology affords a great opportunity to plan the infrastructure and programming methodologies that will enhance a standardized ADL Mobile SCORM RTE when it eventually becomes a viable option—as it seems almost certain that it will.

This effort has produced a wealth of strategic information that will greatly enhance future efforts when conditions permit implementations currently rendered impractical within mobile technologies.

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## **9 Curriculum Vitas**

### **Heather A. Katz, Ph.D., Senior Instructional Technologist and Researcher**

Dr. Katz has over 13 years experience in the field of education and instructional technology with a concentration in the application of cognitive sciences to electronic learning environments. Dr. Katz has designed e-learning for K-16, government, and corporate audiences to include both technical and ISD development. Her current research endeavors involve data—technical and training—integration, content management, reusable object models, mLearning, and mobile technologies as they apply to enterprise strategies. Dr. Katz was the project lead and primary author of foundational research that was used to develop the U.S. Navy's Content Object Model. She is a contributing author for the U.S. Specification Implementation Group Training Subproject White Paper that raises issues and recommendations regarding the harmonization of the S1000D and the ADL SCROM. Dr. Katz is a member of the AICC ISD Working Group that is devising recommendations for the extension of the LOM. She is the former Department Head of the Interactive Medical Multimedia Department within the Visual Information Directorate at the U.S. Naval Medical Education and Training Command. Dr. Katz is a former adjunct professor and has designed and instructed both undergraduate and graduate level courses in the educational, instructional technology, and computer disciplines.

### **Stephen Worsham, Senior Programmer**

Mr. Worsham has over 20 years experience in the fields of computer programming and training with a concentration in the development of interoperable and open architecture development tools and data resolution systems. He has designed SCORM conformant proprietary software for the development of training courseware that delivers interoperable and open architecture source files. Mr. Worsham's current development endeavors include the design of interoperable system architectures that utilize web and data resolutions services to deliver both learning content and technical data objects to end users.

**4D Technologies: appropriating handheld  
computers to serve the needs of teachers and  
learners in rural African settings**

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## Introduction

*'Globalisation must [...] mean justice on a global scale'. (Commission for Africa, 2005, p.22)*

*How are we going to overcome poverty?... perhaps the answer lies in our ability to replicate the best elements of our society, at all levels, and among all communities' Nelson Mandela, 1999.*

*'...if applied with thought, extreme sensitivity and knowledge... [ICTs] afford the means to extend access to education and training to the knowledge-poor, the unreached, the isolated and those who have been ignored for too long' Raj Dhanarajan, 2001.*

Dongwe Combined Primary School, which has around two hundred pupils, is situated above rolling hills on the outskirts of a sizeable village, 15 kilometres from Berlin, Eastern Cape, South Africa. Across a scrubby path in a small classroom with commanding views across a valley, a meeting of teachers from a cluster group of local primary schools is working on the Inkanyezi project. Seated on low pupil benches they share battery-powered laptops with their project partner; each teacher is also working with a state of the art hand held computer. The purpose of the meeting is to evaluate their progress on the project, as well as to share ideas about pupil achievement and progress. One young teacher shares an animated bilingual intsoni (folk tale) a group of his pupils have created in the local language (Xhosa) and English to support their literacy work, whilst his colleague discusses issues of classroom organisation when using a single laptop with a large class. Teachers from a nearby school demonstrate power point presentations on local animal species, spreadsheet on animal classification, and illustrated poems produced by their pupils in literacy and science lessons.

This paper starts from the view that Africa must drive its own development, but that educators world-wide need to work in partnership to support this process if quality teaching and learning is to be achieved for all. It is addressed primarily to the international community of teachers, teacher educators and educational policy-makers who, it is argued, need to commit to joint research and creative action in respect of the challenge of Education for All (EFA).

Over 100 million children worldwide go without primary schooling. Running parallel with this momentous problem is a growing imbalance between the output of trained teachers, specifically in low-income countries, and the demand as primary provision is necessarily expanded. A third of existing teachers in sub Saharan Africa for example, are untrained. Of the thousands recruited each year, they largely have inadequate subject knowledge and little if any pedagogic preparation. It is clear that the existing institutions of teacher education are unable to cope with the scale and urgency of the demand. Creative and radical solutions to the problem of teacher education in the Global South need formulating (see for example Moon, 2000; Leach and Moon, 2002; Dladla and Moon, 2002; Moon, 2004). In this context we argue, the thoughtful use of ICT has significant potential in helping widen access to - and improving the quality of - teacher education in the developing world. A study carried out by the UK's Department for International Development (DFID, 2002, p. 4-5) concluded that 'properly deployed, ICTs have enormous potential as tools to increase information flows and empower poor people'. It recommended that governments should 'mainstream attention to the information and communication aspects of poverty and appropriate uses of ICTs in the development process'. This process should include 'providing concise, evidence-based material drawing on research and experience about what works and what does not' (p. 5).

# **The Digital Education Enhancement Project (DEEP)**

## **Aims of the project**

'Inkanyezi has raised my standards and my dignity' (Teacher, Eastern Cape)

*'DEEP is significant in that it will help shape our understanding of the challenges in rural education in South Africa in the context of poverty, inform the development of responsive strategies to the day to day realities of rural schools and communities and stimulate further research into the provision of quality rural education'. (Makano Morojele, Nelson Mandela Foundation)*

The Digital Education Enhancement Project is a research and development project, focussing upon two key questions:

- How does ICT transform the pedagogic knowledge and practice of teachers and the communities in which they live and work?
- What is the impact of ICT- enhanced strategies on pupil achievement and motivation?

The project's aim is to contribute to the growing, but as yet relatively small number of in-depth research studies that can be used to inform policy makers, educational researchers and others interested in ways in which new forms of technology can enhance teachers' capabilities and improve knowledge and professionalism in the Global South.

The first phase of the DEEP project was implemented in primary schools in Egypt and South Africa, with 48 teachers (two per school) and over 2000 pupils<sup>i</sup>. Between January 2002 and March 2003 participating teachers carried out and evaluated a sequence of curriculum focused, school based professional development activities using a range of new technologies, including hand held computers (Leach 2003; Leach, Klaas, Mngqibisa, Power, 2002). The majority of participants were new to the use of ICT. The intervention and associated research was funded by the Department for International Development (DFID) and coordinated by the Open University (UK), with the University of Fort Hare (Eastern Cape, South Africa) and the Programme, Planning and Monitoring Unit (Egypt) (Leach 2005 forthcoming).

## **Using handheld computers for teacher professional development**

The study of teachers' use of hand held computers reported in this paper is part of DEEP's wider investigation of the impact of new technologies on teachers' practices. This evaluation aims to assess the possibilities and constraints afforded by the handheld computers, as well as to examine how use of this new tool impacts upon teachers' professional practice. This aspect of the broader study focusses on the following questions:

- What are the benefits of using the hand held computer in a professional development context? What are the limitations?
- Does the use of the hand held computer change teachers' professional practices?

## **Contexts, schools, participants**

DEEP was originally working with schools serving disadvantaged communities in two very different contexts: the city of Cairo, Egypt, and the mainly rural Eastern Cape Province, South Africa. All schools in the project serve disadvantaged groups- most of the Eastern Cape schools are situated in rural settings where project participants and their local communities have never experienced ICT. It is the experiences of these rural communities that are the particular focus of this paper.

Eastern Cape Province is one of the former homelands of South Africa, where poverty remains at its most severe <sup>ii</sup>. South Africa's population overall is 45.3 million, Eastern Cape Province's share is 6.4 million. South Africa's GDP per head of \$2,500 - GDP per head in the Eastern Cape is \$432. The range, type and intake of the project schools typify Eastern Cape demography: most serve largely remote and disadvantaged locations where unemployment is high, agricultural opportunities limited and resources scarce. These schools have negligible resources, apart from a small number of books and artefacts for basic numeracy and science work saved from recycled materials such as beakers, cardboard boxes, bottles and bottle tops. Many of the classrooms have poor natural lighting and fragile furnishings. None are heated, although temperatures can fall below zero in the high ground during winter and many have no windows. Several of the schools' classrooms have dirt floors and children sometimes have to stand during lessons because there are not enough desks or chairs. In one school, floorboards from some of the classrooms have been removed by members of the community to provide firewood during a cold winter or for building materials for makeshift housing.

Most of the teachers working in DEEP are female; IsiXhosa is their mother tongue. Their experience of ICT use was limited prior to the project and none had used a handheld computer. Most of the families in the rural communities served by the DEEP schools have never touched a computer / laptop / palm top, and most have never seen or heard about any of these technologies. For many pupils the pictures they took during the project with digital cameras were the first pictures of themselves or their environment they had ever seen. The brief case study that follows gives an introduction to the typical experience of teachers within the project.

## **Case Study**

Xholisa and Elizabeth are experienced and committed teachers. Each day they travel to their school from the nearest town by local crowded taxi and then on foot (an hour's journey when the weather is good and the dirt road passable). For more than 12 years the extent of their professional toolkit has consisted largely of chalk board and chalk. They have access to a rudimentary library of books, most of which are in English (which is not the mother tongue of their pupils) and distant in content from their life experiences. The opportunities to update their subject knowledge for teaching or pedagogic practice have been as sparse as the teaching resources available to them.

During the course of the DEEP project both teachers have been enthusiastic users of the hand held computer, using it everyday at home and at school. They use the diary and address book function for personal purposes; they also make considerable use of the device to plan their teaching. Elizabeth comments 'The [hand held] gives me information. It is very helpful for preparing lessons at home, because it's easier than writing by hand. I use it for getting and making resources and when I get to school I have used it in recording project information, making notes, recording students' language practice... I take pictures and get resources for my lessons... I use the calculator a lot' Xholisa encourages her pupils to use the hand held as a learning tool, and to store their work on it. The children use the notes, memo, calculator and games functions frequently and the audio and voice recorder

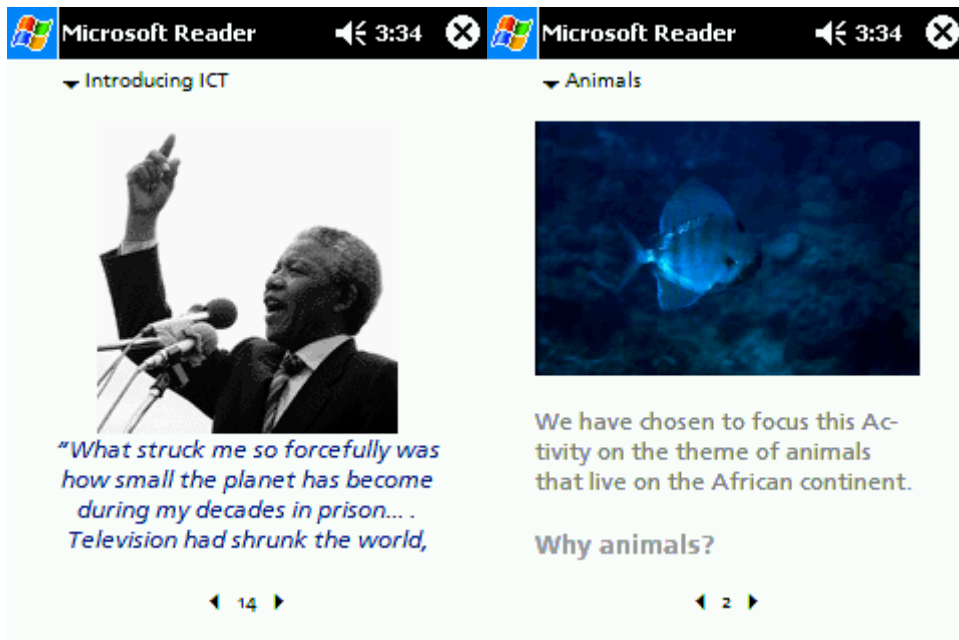


occasionally too. 'It is very educational to my learners' . 'The hand held', her project partner emphasises 'is my companion'.

### **The role of the hand held computer in DEEP**

The DEEP project team has had two grants to support handheld specific research: the first from Hewlett Packard (in 2003) and the second from the NGO, bridges.org. (in 2004). These grants have enabled DEEP teacher participant (and project coordinators) to be provided with their own hand held computer and pocket camera, together with docking station and adaptor. In the early stages of the project these devices were viewed as an additional source of support for the teachers, given their minimal ICT experience and access. The more recent study has been focusing on the potential of the handhelds as professional tools.

All the project teachers were novice users of hand held computers. A range of professional development activities and other resources, created as illustrated e-books, have been installed on the handhelds. Teachers were shown how to locate and open these, as well as to bookmark pages, make notes and access multimedia assets (i.e. audio, video and flash animations) during brief training sessions.



### **The Trojan Mouse: existing research on the use of handheld computers in educational settings**

Information and communications tools are becoming increasingly portable, flexible and powerful (Sharples, 2000) and numerous studies point to the potential of handheld technologies as learning tools (e.g. Fung, Hennessey and O'Shea, 1998; Hennessey, 2000; Soloway et al., 2001). Many studies have investigated the use of hand held computers in classroom settings but most focus on pupil learning (e.g. Fung et al. 1998; Sestokas-Filho and Bonafini 2002; Yarnell 2003). A major systematic evaluation for SRI International (Vahey and Crawford, 2002) with over 100 teachers on the educational uses of hand held technologies in schools in the US suggests that teachers are highly positive about the use of hand held computers in the classroom. They are perceived as 'effective instructional tools', with the potential to have a positive effect on pupil learning. Key benefits are seen to be increased time using technology, increased motivation and increased collaboration and communication. Soloway (2002) argues that handhelds provide an opportunity for making major changes in educational settings. He dubs this mode of technology the 'Trojan Mouse'. His research team at the University of Michigan is developing a science curriculum for pupil use and complementary professional development material intended to embed technology into the everyday experiences of students and teachers via handheld technologies. Soloway et al. (2001) and Roschelle and Pea (2002), have all proposed ways in which hand held wireless internet learning devices in particular can offer physical affordances that are vastly different from school computer labs or classrooms with five students per computer. Such affordances (Gibson, 1979) they argue, may lead to learning activities that differ significantly from conventional images of school learning.

Waycott and Kukulska-Hulme (2000) investigated the use of handhelds to support adult learners studying on an Open University course. They report that the 'anytime, anywhere' access to learning resources is an important advantage of the handheld computer, enabling adult learners to fit study time around other activities. Pownell and Bailey (2000) outline six functions for 'educational leaders' that handheld computers can offer: Organizing and Planning; Reference Information (timely access to important information); Gathering and Analyzing (supports decision making through analysis of data); Learning and Self Improvement (supports life-long learning of current information and techniques); Communicating; Teaming and Collaborating (including sharing organizational documents, data bases and schedules).

## **The use of new technologies in developing country contexts**

The advent of new information and communication technologies provides a new impetus to research the potential of computer technology in the countries of the Global South. Dhararajan (2001) points out that 'if applied with thought, extreme sensitivity and knowledge... [ICTs] afford the means to extend access to education and training to the knowledge-poor, the unreached, the isolated and those who have been ignored for too long' (p. 134). Pontefract (2001) has cautioned, however, that effective use of ICTs must be tied to the needs of developing countries and challenges the 'one size fits all' approach of many programmes. A study of computer costs and other issues in developing countries carried out for DFID by Cawthera (2001) concluded that 'the training of teachers in the use of ICT in schools is an important aspect of provision which may often be overlooked and under budgeted'.

He suggests that in contexts such as Sub-Saharan Africa, where there is simply not the capacity to train and retrain the huge numbers of teachers currently required, school based, computer supported teacher training might be 'part of the solution to this problem. Technology could make teacher training experiences better and shorter'. Moon (2000), Leach and Moon (2002), Dladla and Moon (2002) and Leach (2000) have pointed to the potential of communication technologies for transforming the models and processes of teacher development, as well as for enabling access to quality resources and professional support. Leach, Moon and Power (2002) suggest that ICT can offer teachers access to:

- scaffolding tools, that support teachers construction and understanding of new professional knowledge;
- environments and new contexts for learning, enabling teachers to experience new situations, practices and people;
- communicative tools, facilitating social participation structures between teachers and other educators (e.g. collaborative tasks);
- metacognitive tools, enabling teachers to reflect on the learning process, both at individual and group level (e.g. conferencing; joint products such as electronic self assessment).

Research (e.g. Vahey and Crawford op. cit.) suggests that hand held learning technologies overcome some of the major limitations of desktop computers, as well as providing new affordances for learning (Pea, 1993). Yet at the time of writing, extensive database searches have failed to locate research reports on the use of hand held technologies for teacher learning in sub Saharan Africa where teacher education is now so pressing. This paper suggests that these ideas need to be reviewed and evaluated, given the urgent capacity issues for teacher education in the Global South.

## **Methodology**

Our first handheld study was carried out between January 2002 and May 2003, at various locations in and around Cairo and the Eastern Cape by the DEEP project team (local coordinators and researchers, together with OU researchers). Our task has been to try and capture the way in which DEEP teachers were using the hand held computers (if indeed they were) in their daily working lives. We judged that a mixture of quantitative and qualitative methodologies was the best way to do this; qualitative methodology in particular would allow us to gain a deeper insight, and greater level of understanding. Quantitative data collection methods have allowed us to triangulate our data, as well as allowing for individual responses.

## **Research tools**

Over the lifetime of the project a wide range of data have been collected including: questionnaires (pre, interim and post project; project evaluations; hand held computer evaluation); semi-structured interviews (mid and end of project) with all teacher participants; one-to-one interviews with school principals; classroom observations (mid and end of project) in schools; feedback from pupils; electronic artefacts; laptop 'histories'; teacher and learner diaries; teacher and learner concept maps; a range of correspondence from teachers and pupils including letters, faxes, emails, message board postings; mobile text messages.

## **Findings**

Using a hand held computer was a completely new experience for every DEEP teacher. The hand helds have proved popular in both contexts, although they are used far more extensively in the rural settings. Many of the teachers use them at least once a week or more, some on a daily basis. Only one (of forty-eight) said the device is 'not useful'. A significant number use the hand helds in the classroom and many pupils were observed using the devices during classroom visits. The functions utilized as well as the purposes and constraints of use - differ in the country settings.

### **The Eastern Cape experience**

The hand held is highly popular in the Eastern Cape. Every teacher uses it at least once a week or more, several using it on a daily basis. The majority uses the device both at home and in the classroom; 5 teachers state that they use the device whilst travelling. The majority of the teachers report that the hand held has 'helped their ICT skills' and 'understanding of the language and concepts of ICT'. Overall the device is seen as 'very useful' and viewed as of 'equal value' as other computers, '[I] can do anything I may do with the other computer'. This is in a context where 56% of teachers and 75% of the school communities have had no prior experience of any form of computer technology (i.e. both hand-held and shared laptop PC were being used for the first time). The handhelds are so popular that more than half of the teachers would be willing to buy one with their own funds (if the price was affordable).

## **Limitations**

When the hand held was regularly recharged, or backed up to a computer, data was retained without problem. However, in both countries there were occasions where teachers suffered data loss due to a loss of battery power, where the data had not been synchronised with another machine. These instances were far more apparent in the rural South African context than the urban Egyptian context however. In the Eastern Cape, half of the project schools have no electricity supply and in many schools that have electricity it is not available in every classroom. At one remote rural school teachers N\_\_\_\_\_ and L\_\_\_\_\_ live almost entirely without electricity in the settlement surrounding the school. To recharge their project equipment the teachers walk a few miles down the unmade track to the local hospital. Many of the Eastern Cape teachers had used their hand held computers extensively, so those who discovered their lost data was irretrievable were particularly grieved; one teacher in a school without electricity reported being extremely upset when their data was lost. Appendix A sets out some of the technical issues in more detail – some of which have been raised by our most recent handheld study.

## **Discussion of findings from the first study**

Has use of the hand held computer changed the teaching task and teachers' professional capabilities? In this section we identify a number of key areas of change.

## **Anytime, anywhere learning**

Size and weight was viewed as being a very important aspect of the hand held (particularly in the Eastern Cape context) and this was usually linked to the sense of its portability. This view surfaced strongly in the qualitative data. 'It is useful because you can carry it everywhere you need it'. 'Since the Jornada is always in my bag it is easy to reach'. '[The] Jornada is user friendly because it is not too heavy'. The majority thought the weight and size 'just right'. It should be noted that in both contexts security is of major concern. Handhelds are easily concealed, deftly popped into pockets or handbags at the end of lessons and are not conspicuous when travelling. Teachers reported feeling safe when carrying this 'invisible' device, where they felt more conspicuous and vulnerable carrying a laptop bag. Teachers reported on the expansion of their capabilities as they used and got used to the hand held computer (Salamon and Perkins 1997); many consider that there is something quite new and unique about the opportunities provided by such a flexible device in their particular context. It has offered possibilities in terms of access to 'anytime, anywhere' professional activity. It can be used at home, in the classroom, in friends' homes, on fieldtrips or at a special event. It can be taken from classroom to classroom and within classrooms be handed from pupil to pupil, thus enabling it to be integrated with ease into the flow of daily activity, including in some instances, fieldwork outside the classroom. In this sense it is the computer that moves with the learner as directed by the teacher, to serve particular pedagogic tasks. It has not disrupted the normal layout of the classroom or required special furnishing.

## **New tools enable new learning activities**

The diary, calculator, camera and games are the most popular functions and these are used both at home and in school. Every teacher mentioned taking photographs when describing its use; 5 made use of the voice recorder 'frequently' ('Using the instrument in taking photos and in recording information'). Word is well used by a significant number of teachers, particularly for lesson preparation. Half of the teachers have used the hand held to access the DEEP professional development resources; 11 have made use of the multi-media resources.

## **Enhanced professionalism**

*"...I don't think I can teach without [ICT] again (laughs)! ... can't go back and teach differently in the future..." (Teacher participant interview, 2003)*

What of the more lasting effects of the handhelds, beyond discrete occasions of use – the impact on teachers' 'cognitive arsenal of skills, perspectives, and ways of representing the world' (Salomon, Perkins, & Globerson, 1991)?

## **Organizing and Planning**

*'Hello, I used the camera when Mark Shuttleworth visited Butterworth... You know him, the first African to go into space. I also recorded his speech while making a lecture about his journey into space. How wonderful! ... it's now that I can feel myself as a professional. Warm greetings. Bye'* (E-Mail from DEEP Participant, 2002)

In rural and resource challenged contexts where teachers have hitherto had to rely solely on notebook, chalk and chalk-board as their only means of planning and storing information 3, the hand held has modified the way teachers organize, think about, and indeed carry out aspects of their work, as well as the way in which they work with others. Highly suited to organizational tasks, data collection and planning is much easier to carry out. It is ready to hand, when any one of a range of applications are required. Project teachers were observed

using the hand held for professional purposes such as preparing lessons and making notes on pupil progress. They reported using it to: record appointments; take pictures of students; summarize some lessons; note take during lessons; take photographs for curriculum use; make calculations; set reminders for tasks; record events (e.g. Mark Shuttleworth lecture) to use as the focus of a lesson; record and photograph pupil work, presentations and music to show parents; teach peers basic ICT skills and concepts (i.e. terminology, handling the stylus, moving between programs'). The hand held has enabled effective organisation, including re-use and storing of resources.

### ***Collaboration and shared professional learning***

The use of the hand held facilitates new forms of collaboration between project partners and local cluster groups. Teachers use infrared 'beaming' to exchange resources. In the cluster sessions researchers attended, teachers were observed sharing lesson plans, photographs, recordings and presentations that they or their pupils had made. These impromptu 'show and share' sessions were times of intense interest - and laughter. This form of collaboration - shared learning and practice is difficult to achieve when teachers have no means of storing, adapting and amending their work. One of the project teachers described a sense of real frustration that, prior to the project, her main professional tool was the chalkboard. Material she wanted to present or discuss with pupils had to be laboriously written by hand on the board, often with a stub of chalk, and removed at the end of the day: in this sense, curriculum work was highly constrained and transient. Every day, lesson content had to be approached from scratch. Resources of the type most teachers in the Global North take for granted simply cannot be created. The ability to store and then share ideas, plans and resources at a later date was also a major breakthrough in project teachers experiences. When teachers from several schools exchanged materials at cluster meetings there was a sense of real excitement. The project team was also able to transfer new professional resources to the hand helds at training sessions. Such activity encouraged shared learning and the possibility for professional updating.

### ***New Classroom practices***

Pupils in the Eastern Cape were observed using the handhelds for a wide variety of activities including: literacy activities; peer tutoring; mathematical games; group work; photography; field work; language practice (recording and listening to conversation). The researchers accompanied pupils from two of the project schools on a fieldtrip focusing on the use of solar power. Pupils were observed sharing the handheld to take photos, record interviews and make notes. They were fluent users of the device. 'They are really curious to learn now. They ... most of them have changed their attitude. Yeah ... I will always have those who don't want to answer, but most of our learners have changed. We are continuing with our research on solar energy ... when I was talking to them, I said 'For this project we need to work hard.... go to the villages that are using solar energy and to find out the effect' ... You can come up with some idea and then we'll go and visit one of these areas.... use our [hand held], come back to school... and then we prepare our reports about, research about solar power'. So I mean I can see, when I said 'Use our [hand held]'. Like I could see light! They are ... really looking forward now to going and doing this research.'(Teacher interview, 2003) A\_\_\_\_\_ noted changes in her approach to teaching.

### ***Dignity and self-esteem***

Many project teachers have provided testimony to the way in which their self esteem and professionalism has been raised by the use of the handheld computer, together with the adjacent technologies within the DEEP project. Ownership of the handhelds marks a change in status and professional competence. Many teachers in the Eastern Cape used the personal pronouns 'my Jornada' or even 'my companion' when talking about the device. Several

mentioned 'we use it everywhere'. There was a strong sense of ownership; the device was not alien, appearing to be fully appropriated into daily practices. Elizabeth referred to this development of professional identity during a recent interview: 'I have changed. It has made me proud because I now know how to use ICT. At first I didn't know anything ... it has changed us really. Xholisa echoes this sentiment: 'I am proud of myself really ... the people as well ... always congratulating us. The [project] teachers are good now, I think everyone is longing to study.'

This sense of professional affirmation was not limited to project teachers alone, but extended to colleagues and parents: 'Great excitement from parents and teachers ... so there has been great enthusiasm' [School principal interview, 2002]. 'The view is that they are no longer in the shadow of the 'model school' in their town or city. There are a lot of computers in the model schools. It's appropriate technology ... Even other parents now want their children to come to our school' (Interview, 2003).

### **Conclusion: 4D technologies for teacher education**

Our small-scale studies indicate that hand held technologies may have a significant role to play in transforming the opportunities for teacher education in developing contexts. Teachers and schools in challenging environments might benefit from the many advantages that ICT is currently affording richer peers, whilst leap-frogging expensive mistakes made by more affluent countries. We have cited influential studies based in North America that demonstrate the benefits of 'anytime, anywhere' learning technologies for education and learning. (e.g. Vahey and Crawford, op. cit.), where serried ranks of unwieldy, fixed computers in school computer labs are being replaced by more user friendly, flexible technologies (e.g. Cooper 2002, Soloway 2002), used at different sites of learning, both in and out of school. A range of new educational softwares are being developed for hand helds and compelling usage scenarios being identified. Hand held devices have, to date, been largely aimed at the business market and needs of high-powered executives. Teachers in the DEEP study have been able to appropriate these devices for their own professional and curriculum purposes. Teachers have also reported that the hand held computers had positive effects on student learning, encouraging an ongoing, integrated use of technology within the flow of classroom activity. Many schools commented on the improved grades and outcomes of pupils in classes using the ICT, particularly in literacy. They also reported on increased pupil motivation and in some cases increased pupil attendance. This reporting by teachers, governors and school principals needs testing more systematically over time. However, the ease of integration of the hand helds into classrooms and its support of new classroom practices such as paired and group work is continuing to be observed by the research team, suggesting that powerful computing can become integral to learning. As a result of these observations, the research team has begun to re-conceptualise these new tools for learning: we call them 4D Technologies.

4D technologies for teacher development, like the multimedia handheld and laptop computers used in DEEP, are technologies that can support and enhance:

- **Development**
- **Democracy**
- **Deep learning**
- **Dignity**

**Development**, in the sense of the personal and professional development of teachers and their pupils, but also in the sense of supporting the achievement of the Millennium Development Goals. The entitlement to Universal Primary Education means not just getting children *into* schools, but raising the quality of education that occurs within rural schools. 4D technologies may have an important role in this. Appropriately deployed, they may also

begin to redress gender disparities and other traditional inequalities (for example, three quarters of the DEEP teachers were women, working with young children, in disadvantaged rural communities). 4D technologies are also 'developmental' in a technological sense, incorporating emerging technologies (like the handheld) and networks (like the mobile phone network) in the service of these communities.

**Democracy**, in the sense that deployment of ICTs into the hands of those who need them most (see above) can challenge existing inequalities – where ICTs are predominantly in the hands of the wealthy, urban, white, male professionals. We would argue that one computer in a rural school can have far more impact on learning than one computer in an affluent and well resourced school.

**DEEP learning**, where pupils are not learning facts dissociated from their own experience and culture, but are able to access and understand information that is part of the global corpus of knowledge, and also to capture and reflect upon aspects of their own environment and culture. 4D technologies allow teachers and learners to weave these two domains together participating in a new discourse within their classrooms, and with the wider world.

**Dignity.** The teachers on the DEEP project have often spoken about a change in their self-perception, and the way they are perceived by others in their community, which has become an organizing concept: dignity. Teachers have shown amazing commitment to their profession and their pupils, often in the most challenging circumstances. The opportunity to use professional tools in their work has raised their perception of their own professionalism, but also the esteem of teaching, and perhaps more importantly, of the school as a whole, in the eyes of the community. "It is now I feel myself as a professional" (DEEP teacher).

Further questions arose as a result of the original study, which are now being explored in a second phase:

- In what ways can hand-held tools best complement other resources, including traditional technologies, in the context of school based teacher development?
- What curriculum related developments do hand held tools best enable? What software innovations are required?
- What are the specific learning affordances offered by hand-held computers in the context of respect of teacher development, less viable by other means?
- Can hand held computers support the task of school principals and educational leaders?



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<sup>i</sup> In Phase 2 the project reach is being be upscaled to 72 schools and new countries (e.g. Tanzania and Bangladesh and the Sudan) will run pilot projects; more research is being carried out specifically on hand held use (see [www.open.ac.uk/deep/deeper](http://www.open.ac.uk/deep/deeper)) and video conferencing (see [www.open.ac.uk/deep/deepa](http://www.open.ac.uk/deep/deepa))

<sup>ii</sup> Data shows that the provincial share of the poverty gap [i.e. the combined measure of numbers in poverty and their depth below the poverty line] nationally is greatest by far in Eastern Cape. The comparative provincial data is: Gauteng 4%, Northern Province 16.5%, Kwa Zulu Natal 19.9%, Western Cape 3.4%, Northern Cape 1.9%, Free State 9.9%, Eastern Cape 24.9%

## Appendix A Technical Report

### *Background – DEEP 2001-3*

The DEEP project developed resources specifically for use on the HP Jornada 565 Pocket PC device running the Pocket PC 2002 version of the Windows-based Operating System. These resources were adapted from original print and web material into Microsoft Reader format for use on the Pocket PC. Later developments included versioning web pages for use locally on the devices, incorporating Flash and Multimedia elements. Use of a separate Jornada Cam CF interface device was also encouraged. Addition of resources and required applications involved installation onto each individual device, or for researchers to 'beam' resources/files to one another.

Technical issues raised as a result of teachers' evaluation of using the Pocket PCs, particularly in South Africa during the period of DEEP research were as follows:

- Synchronization problems – faulty interface at base of unit
- Battery issues – lack of charge stations due to fragile electricity supplies in some schools; lithium backup batteries discharging as a result and needing replacement
- Memory and backup problems – memory requiring battery backup even when device inactive. Loss of battery resulting in total data loss and loss of installed applications.

### *Development and reversioning for DEEP-ER and iPAQ H4150*

#### Preparation Issues

Initial investigations showed that Microsoft had revised the Pocket PC platform to be more standards compliant. The iPAQ H4150 runs the Pocket PC 2003 Windows Mobile operating system. All applications required for the current project needed to have updated versions installed, this has affected previous web page resources the most. Windows Media 9 appears not to have an ActiveX component (provided separately in the previous Series 8 version). This meant that despite lengthy testing and development to include XML tags and JavaScript functions, audiovisual content can no longer be embedded within web pages and needs to be provided as hyperlinked, but standalone files.

In order to provide the devices with a larger capacity- and to attempt to centralise resource provision, the project team decided to provide project content on SD Memory Cards, which might also be used as transferable personal storage for use with shared digital cameras and DEEP-ER research outputs.

Installation of additional applications requires individual synchronisation with each device, setup as a 'Guest' device with Microsoft ActiveSync. Improved batch processing of application installers was investigated, but ActiveSync itself was found to have been improved to allow a quicker method of installation onto numerous Guest devices.

#### Testing

The battery maintenance issues identified in previous research are improved on the iPAQs, but still not ideal. Both main and backup batteries are rechargeable, however on-board memory still requires battery backup to maintain data. Total battery loss can be largely equated to a 'hard-reset' of the system, so this also informed the investigations.

Given larger capacity for both on-board memory and the additional memory card, alternative fail-safe methods of storage were investigated:

- Safe store (using on-board ROM to maintain data) – available capacity very limited, but applications would always be available irrespective of additional memory.
- Storage card (within a specific folder on the external card) – large capacity available, but applications unavailable if removed e.g. for other SD interface usage.

Both destinations are supported by ActiveSync as locations in which additional applications can be installed, however they are not the 'default location', which is important to some applications. Of the additional applications provided by the project, the Flash plugin and the Keyboard driver were sufficiently small to be installed into Safe Store, and this seemed most appropriate. Unfortunately, however, the Keyboard Driver requires installation into the 'default location' in the main on-board RAM, and is not therefore protectable from battery loss nor hard reset.

Ultimately, investigations into changing the location of installed applications have proved unfruitful, as even if the applications were securely stored, the shortcuts to those applications from the 'Start' and 'Programs' menus would be removed on battery loss. The decision was then taken to install all applications into the default location in the main on-board memory, with all centrally provided resources provided on the Storage card, allowing use of remaining on-board memory for working files.

A further concern was the choice of media format for the professional development resources. Previous experience of creating Microsoft Reader files was that the file format was highly problematic in its rendering of embedded objects such as tables, charts and images. Subsequent investigations also included use of Adobe Reader and Palm Reader, with summarized findings below:

Microsoft Reader – default, stable and packaged application (not deleted on battery loss/hard reset), problematic creation process, limited embedding. Annotations possible

Adobe Reader – reasonably faithful reproduction of PDF files, allowing for comments to be read. No annotation provision. Application occasionally prone to crashing, requiring soft reset.

Palm Reader – good creation and rendering of embedded objects; annotation and highlighting provided. Application itself prone to faulty menu generation, requiring soft reset to remedy.

As a result, resources were initially provided in all 3 formats, playing to individual application strengths. Legacy content remained in Microsoft Reader format, while largely image-based resources were provided in Adobe Reader format and resources requiring a large degree of interaction were provided in Palm Reader format. An intention to investigate eBook creation using the more user-friendly eBook Studio was logged for future consideration.

#### Installation of resources and applications

Resources were developed for use on all 24 handheld iPAQ H4150 Pocket PCs. A master folder of content was assembled, to be copied to the SD Memory Cards - comprising all reader files, web pages, audiovisual assets and texts. Palm Reader in particular required files to be in a specific folder to be discovered by the application – they would not be run via the File Explorer provided as part of the Pocket PC 2003 Windows Mobile platform (no filetype association).

Despite providing correct filetypes, suitable folder hierarchy and application setup, installation proved to be non-trivial in that professional versions of some software required individual registration, individual eBooks required authentication and at one point in the file copying process, a filetype was corrupted so it could not be read without renaming.

These latter issues will of course resurface when a device suffers total data loss, as the location of the storage of such user information is unclear.

#### Training for teacher users

To support teachers in the familiarisation and orientation in using the new devices, a dedicated iPAQ skills session was provided. A wireless projection device was used to enable all participants to see the progress and visualise the procedures needed to run applications and explore the resources. This session covered the principles of the menu system, the program and settings screens and the file explorer navigation, for those unfamiliar with Windows. The remainder of the training sessions focused primarily on professional activities, using the resources provided. Technical information was introduced on a need to know basis with respect to navigation, annotation, highlighting, and related use of the Pocket Office (Word, Excel) applications. In this way, new technical knowledge was introduced in tandem with professional activity- strongly led by professional purposes. This approach was deliberate, and built on the findings of DEEP that technical expertise can be quickly developed where professional purposes are strong and motivation therefore high.

#### Teacher feedback

Once users were operating the devices themselves, another major issue quickly emerged i.e. the instability of reader software requiring frequent soft-resets. Teachers welcomed the ability to charge the iPAQ while docked in the keyboard (not available on the Jornada), though only having a mains socket charger proved a drawback. Some of the experienced handheld users consider the iPAQ less robust than the Jornada they were previously using because of the latter's screen cover.

#### Technical Recommendations

- Provision of on-board Flash-RAM as standard, with a secured area if required, rather than RAM/ROM hybrid.
- Keyboard driver should be provided as standard, so as not to be lost on battery fail/hard reset
- Syncing interface (PCB edge connector) should be more robust – both data and battery charging could be lost at same time
- Charging/synchronization lead should be powered-USB compatible as standard, including USB charger unit for mains charging.
- Alternative syncing methods could be provided – Bluetooth/WiFi

# Adaptive Heterogeneous Learning System

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## *Abstract*

*The iSign project started in 2000 as a web-based laboratory setting for students of electrical engineering. In the meantime it has broadened into a heterogeneous learning environment offering learning material, adaptive user settings and access to a simulation tool. All these offerings can be accessed via web and wireless by different clients, such as PCs, PDAs and mobile phones.*

*User adaptive systems offer unique and personalised environment for every learner and therefore are a very important aspect of modern e-learning systems. The iSign project aims to personalise the content structure based on the learner's behaviour, content pattern, policies, and system environment.*

*The second aspect of the recent research and development within this project is the generation of suitable content and presentation for different clients. This generation is based additionally on the user preferences in order to obtain the desirable presentation for a given device.*

*New, valuable features are added to the mobile application, empowering the user not only to control the simulation process with his mobile device but also to input data, view the simulation's output and evaluate the results.*

*Experiences with students have helped to improve functionality and look-and-feel whilst using the iSign system. Our goal is to provide unconstrained, continuous and personalised access to the laboratory settings and learning material everywhere and at anytime with different devices.*

*Keywords: adaptive systems, content generation, mobile learning*

## 1 Introduction

Today's network landscape consists of quite different network technologies, wide range of end-devices with large scale of capabilities and power, and immense quantity of information and data represented in different formats. A lot of efforts are being done in order to establish open, scalable and seamless integration of various technologies and content presentation for different devices. This research is an attempt to bring user-centric, personalised and adaptive user experience to the university student when performing his learning tasks.

In this perspective, our research focus on recognition of user/student preferences, needs and habits in order to design and demonstrate a solution which will make underlying technology transparent for the student and allow him to concentrate only on learning in the time he wants, on the end-device he chooses and in the format he prefers. In order to achieve that, we first had to gain an overview of the existing technologies, standards and available solutions. Second, we had to "get to know" our user/student in order to be able to develop reliable and close-to-reality learners model. At the end, we had to map those requirements and get the idea of the possible solutions.

The paper starts with introduction of the iSign project and our motivation to improve student experience when using iSign platform. It demonstrates the possible scenario of the system use. The chapter 3 gives an overview of the challenges we have faced when designing architecture of the system aimed to support different end-devices and different users. Chapter 4 goes more in detail in the adaptive aspect of the system. Conclusion and future work are covered in the last chapter.

## 2 Motivation

In year 2000, the web application for accessing laboratory settings iSign (iSign) replaced the input of data and control of simulation tool over console. The students were not anymore obliged to come to the lab and do their exercises with unfriendly UNIX console but were able do their task from any PC connected to the web, using intuitive and rich user interface that offered much more functionality. Since then a lot of improvements of the system were done: 2D visualization of the simulation results, learning content, 3D representation of the structure and calculated fields, SMS notification of the finished simulations etc. (Christ et al. 2004). Finally, since year 2003 the system has been extended to support control of the simulation over mobile devices (Mitic 2003, Mitic et al. 2004). Latter led to the burst of ideas to improve and support not only different end-

devices, that student would like to use, but also to offer more personalised use of the system that would adapt to user preferences and goals.

### 2.1 Scenario

The following scenario of the foreseen use has been designed in order to capture the nature of learners' interaction with the system. The scenario is supposed to show the most relevant challenges in designing a system, concerning device variety, content selection and presentation, user modelling, user interface design as well as use of available technologies.

*In this scenario, a student David is at home preparing to go to the University when he receives a SMS message on his mobile phone where he is reminded on submission deadline for the lab exercise. Message is also sent to other members of his group, Mary and Peter. The SMS message contains a URL link to the Web site where the detailed description of the exercise is provided.*

*On the way David reads the exercise description on the browser of his mobile phone and prepares for the calculation of simulation input using offered online learning material. In order to collaborate with other members of his group he uses SMS to set up the appointment. After arrival he heads to the PC room where he continues his reading session on the same position where he stopped on the mobile phone. Using online access to the learning material and simulation tool he calculates the structure for simulation, enters the input data, proves the structure in the 3D visualisation tool, and starts to simulate given structure. As the simulation takes too long he leaves the PC room and head to student restaurant for lunch. Mary, other member of David's group is also preparing for the lab exercises by reading online learning material. Unlike David, who prefers material with visual representations that proceed from the specific to the general, Mary prefers written and spoken explanations that go from the general to the specific. Both of them learn better with linear, orderly, in small incremental steps material, different from Peter who is a global learner. He learns better with holistic, large leaps material. The learning system adapts the presentation of content upon the user personality.*

*During lunch he receives the notification that his simulation is finished and that he could proceed with the second part of the simulation. Additionally he receives the MMS with the graphical representation of his result. As his results seems to be wrong he changes some input values using his mobile phone and starts the simulation again. The received MMS shows that this time results seem to be correct and he starts the second part of the simulation using the application on his mobile phone.*

*On the way home he receives the notification on his mobile phone that his simulation is completed together with the graphical results with the evaluation curve in which his results are compared with the results expected. Evaluation text is spoken on his mobile phone and he hears an audio report on the result analyses. After arriving home he turns on his PC and finding Mary and Peter online he discusses with them the results and all together prepare the final report for the professor.*

The main purpose of the scenario is the extraction of detailed requirements for the architecture of the system. The system discussed in this paper is compound by a combination of two-dimensional adaptive process. The first dimension addresses the different presentation devices and is discussed in the next chapter. The second dimension is concerned with the adapting of the content for the different users learning personalities and is discussed on chapter 4.

### **3 Support of Diversity**

As it is to be seen from the previous scenario student is motivated to use different devices to access the system depending on his location and preferences. Nevertheless, student experience should be the same no matter of device he uses. Change of device should be as easy and transparent as possible. On one hand, the content presentation should automatically change to fit the devices capabilities, and on the other hand, it should benefit from different device functionality. In the next sub chapters different aspects of content creation, personalisation and presentation for different devices are discussed.

#### **3.1 Device Independent Content Formats**

The number and variety of devices capable of accessing the web continues to grow. As a

result of this increasing diversity the application developers and user interface designers face number of challenges in attempt to support all different devices and capabilities (W3C, 2005). On the other hand, new devices offer additional functionality, e.g. mobile devices can offer location information, apart from using conventional display for input and output some devices can use voice, etc. Thus, content creation is directly affected by the need to support many types of target device.

The first step is to make clear separation between presentation and logic. The second is to keep the content in the format best suitable to be presented on different devices. It may be necessary to create different versions of content, particularly images, audio and other rich media, to cater for the different capabilities of various devices. Creation of alternate forms of content may also be necessary so that material can be delivered to devices that cannot support particular kinds of content (W3C, 2003). Standard solution for this is using XML format. Thus, content can be easily transformed to pure text, HTML or PDF, graphical formats like SVG or speech (VoiceXML). For example, in our scenario student David get a voice notification of his results. This is done by transforming XML into VoiceXML which is then translated with the help of a speech synthesiser (FreeTTS) into speech. This sound file can be streamed (Darwin Streaming Server) to mobile device or send as MMS or WAP-Push message to mobile phones. The voice capabilities of the mobile phone can be also used for user interaction with the system, e.g. control of the simulation.

Our research on this topic led to the conclusion that without a flexible and open platform for content generation that will decrease efforts to support existing and new coming devices and formats, we won't be able to provide such a universal access.

#### **3.2 Personalised Content Presentation**

In our system there are two different places where personalisation takes place. One is the content personalisation discussed in chapter 4 and the other the per-user-per-device personalisation. In case of more than one visual presentation available or in case of content being presented with more than one visual presentation on a device, the system has to make a decision. Because the learner has to understand the content an adequate presentation is important and his preferences has to be taken into account. The fact of a user dependent for a device presentation leads to the need that every learner has to be identified by the system. Therefore the user has to login to the system and identify himself. The



information like user name, password and last visited content are stored in the user profile. This information can be used to offer the learner the last visited content the next time he logs in. The learner is able to specify more information in such a way that the system can adapt easier to the learner. The overall goal is to present the learner a homogeneous system or at least to give him such an impression. The possible device capabilities of different end user devices have to be examined to take into account the possible visual presentation of the learning material.

### 3.3 Device Dependent Presentation

The research resulted in a three device class classification. The high-end devices are personal computers, the medium class are the PDA like devices and the low-end are mobile phones. Each class of devices is handled by a system presentation module which prepares the presentation of the data for the connected device while taking the user profile information as well as the device capabilities into account (see Figure 1). As consequence the learner has three different personalisation profiles in his user profile, for every device class respectively.

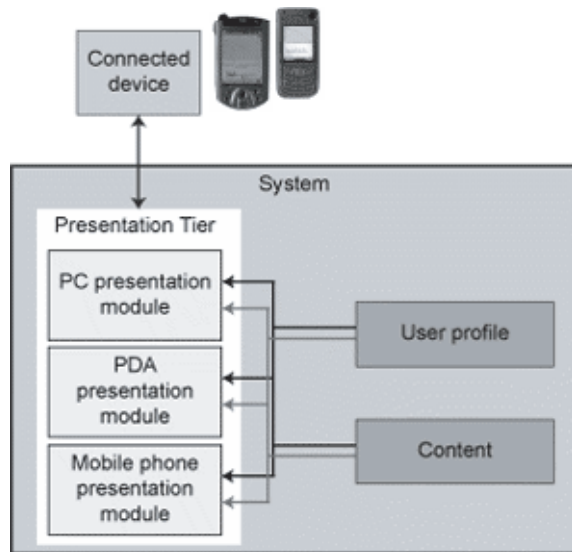


Figure 1: Device presentation modules

The easiest class according content presentation is the high-end class. There is no content visualisation which is unusable for such devices. Different learners may prefer different content presentation and therefore have the impression that a specific content form is unusable for them because they do not like it. Nevertheless all form of presentation can be used which are text, images, animation, video, speech and the combination of all. That is different with the medium and low-end class devices. For example a long text is not usable

on a small mobile phone screen. In this case it makes sense to transform the text into speech which can be listened during the travel.

The device dependent presentation is an optimisation process concerning two different aspects which are device capabilities and user dependent information. Out of this information the closest possible content presentation is chosen which is in best case the learners most preferred. Figure 2 and 3 are examples of different device presentation.



Figure 2: Example presentation on PDA



Figure 3: Example presentation on smart and mobile phone

## 4 Adaptive Learning Systems

In the scenario described in chapter 2.1 David, Mary and Peter are preparing for a laboratory. There they use the system to learn a collection of concepts. As each of them has a different learning personality and learning goals, the system adapts the content to match with their learning personalities and goals. For doing so, *content nodes* (atomic pieces of content) with common learning characteristics are grouped in clusters. During the user visit the system correlates the user situation and personality with the content clusters. Based on the result of the correlations, the system dynamically structures the *content nodes* with the most appropriated 'models of learning' and suggests the next content to be learned (dos Santos 2004).

The different models of learning influence the navigation flow. These differences are visualised in the Figure 4. There one can see, a linear navigation (PowerPoint approach), a tutorial organization with decision statements and loops, a non-structured navigation (web style), and a hybrid approach.

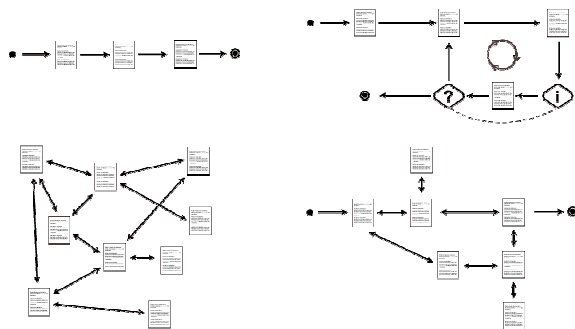


Figure 4: Navigation flow for different learning approach

An adaptive learning system able to carry out this task should switch dynamically from different learning models and content clusters, following the user characteristics and content usage. Such a system should have to own two attributes:

- Flexibility - meaning that the system has a modular structure, supports different models of learning and media types, and has a simple and standard way to store and manage the content.
- Intelligence - meaning that the system provides different environment to different learning targets, has automatic evaluation and grouping of users and content, and is able to recommend a suitable next step for different user situations.

### 4.1 Content Relationship

For the system to be able to guide the user through the content, it should store the content relationships and paths. This happens with the help of content clustering.

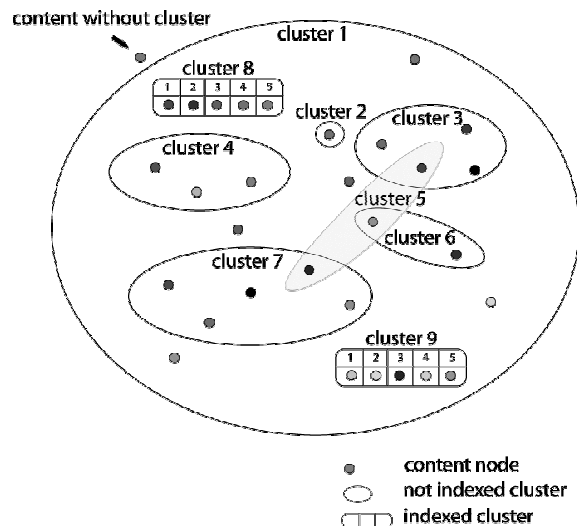


Figure 5: Clusters Structure

Cluster is an entity generated from the *content nodes*, which are in relation to each other. A *cluster* can store *content nodes* and other *clusters*.

Cluster can be generated automatically by the system or manually by the author. E.g.: The system might group a *content node* that holds the introduction for the "Microwave Lab Exercises" with nodes that contains its theoretic concepts, or the system might group two nodes that are from different chapters, but are always used together by the users.

Figure 5 introduces some possible cluster structures. Here several arrangements are represented, their meanings are explained below:

- Small circles - represent content nodes. They can be inside or outside the *cluster*.
- Ellipses – represent not indexed *clusters*.
- Squares with rounded vertex – represent an indexed *cluster*.

Each element of a cluster has a *weight*. The *weight* determines how strong the relationship between the cluster and its elements is. E.g. In a cluster that joins information about "The South America Continent" nodes that describe the whole continent will have stronger weight than nodes that describe specific characteristics of each country like "Brazilian history". A cluster can be indexed or not. Indexed cluster means

that all elements within a cluster have a unique index, due to which it is possible to pick out a specific position. This feature is especially important for an author who wants to set a fixed path.

## 4.2 Personalisation Processes

The system analyses the user's behaviour, while dealing with specific content and with the system as a whole. It also analyses the vocabulary and navigational structure of the content. User and content patterns are generated based on the result of these analyses. Subsequently those patterns are used to group content and user in clusters, and to determine how strong the connections between users and groups are. Based on the user and content clusters the system performs three types of personalization.

### Manual Ruling

Manual ruling is a personalization technique done by the author. He creates rules based on the user profile, demographic region and session history. These rules are used while varying the content.

### Collaborative filtering

Typically the collaborative filtering exploits user preferences and/or user rating to correlate his session with the sessions of the others. The result of the correlation is used to predict the content that matches with the user predilection. This kind of task requires data preparation (Mobasher et al. 2000).

### Content filtering

The content filtering matches the content visited by the user with the rest of the content that has similarity in theme or in presentation structure. (Mobasher et al. 2000).

## 5 Conclusion and Future Work

Our research on device independent content generation, personalised user experience and adaptive learning system aims to give a solution for the open learning platform that would support all this aspects.

Thus the system models nowadays teaching scenarios. The student is responsible for his learning progress which will motivate him, but never-the-less he will be restricted if he uses the system in an improper way to learn.

We have been trying to validate our research output by implementing and demonstrating some of its functionality inside of iSign project. However, the platform is still missing some important aspects like security and privacy,

possibility of federation with other learning platforms, etc.

The ability to stream sound/voice through the Darwin Streaming Server with the system is available. However voice files are produced in the moment with FreeTTS manually where in future the system has to transform the XML content automatically into VoiceXML which is then used to generate the sound file which can be streamed.

Usability tests, although done till now in an unstructured way, gave first validation and feedback from students. The team members are interviewing students to get an impression where to improve the system. This method works well up to a certain level of complexity which is reached by the system. In this situation structured and well defined usability tests have to be used in order to improve the system further more.

The three modules for the presentation on different devices are realised and are using the partly available XML information of the system.

The adaptive part of the learning system is implemented, however further tests should be performed to define the degree of learning effectiveness of the method. Besides that the present personalisation process is based on rudimentary statistics and should be subject of research. The interface between the adaptive functionalities and the user is one of the keys for the success of the tool and needs to be addressed by further research.

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# Challenges and Opportunities: Making Mobile Learning a Reality in Schools.

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## **Abstract**

This paper explores ways in which the provision of ubiquitous computing impacts on teaching and learning, through a case study of a major initiative run by a local education authority in the UK. Students and staff across 8 schools (including primary, secondary special and mainstream secondary) have been provided with handheld computers for use at home and school. Previous research suggests that mobile technologies can make a significant impact in supporting teaching and learning (Perry, 2003; Zurita & Nussbaum, 2004); this paper will examine the practical realities of achieving these objectives in diverse educational settings.

The paper considers key technical, managerial and organisational issues arising from this initiative. In particular, we explore factors contributing to or mitigating against the Initiative's aims of achieving innovative models of teaching and learning; a positive engagement with formal education; widening access to technology and changing literacy and numeracy practices. Data for the paper is drawn from interviews, questionnaires, focus groups, observation and students acting as researchers, in a spirit of collaborative enquiry.

This paper will discuss key issues arising to date, exploring ways in which handheld computers facilitate ambient teaching and learning, where teaching agendas must be set against the notion of appropriateness of tool. Initial findings reveal technical difficulties hinder the ubiquitous use of handheld computers, though enthusiasm for the Initiative remains high. Consequently, we will be asking: at what point is it reasonable for both learners and educators to make use of the technology, and at what point does use of the technology become unreasonable?

## Introduction

The U.K. Government has invested heavily in developing information and communication technology (ICT) in schools; future plans include a broadening of access to diverse forms of both ICT and learning, with the Government's e-learning strategy emphasising personalised and ubiquitous learning (DfES, 2005). This has acted as an encouragement for schools to start exploring the use of 'mobile technologies' in the classroom, but it is not yet known how these devices might be best used within education. Further, there is a current paucity of literature reviewing the use of handheld computers in education and, although several initiatives are being implemented throughout the U.K., an underlying rationale for the use of these devices in education has yet to be articulated.

Because the handheld device is so easily portable, it offers itself as an ideal conduit between school and home; this shift in sites of education means that the transfer of knowledge and skills is not limited to the school curriculum but extends into the daily lives both of those immediately involved, and their families, thus offering the potential for widening participation and allowing the actors to 'take control' of their own learning, though it seems likely that the *types* of learning with which students are engaged will differ between these sites. Yet whilst we might argue the Utopian ideal of students taking ownership of their learning, we must also be aware that teachers, who are used to taking leadership in the classroom, may insist on taking responsibility for ways in which students use these technologies. This changing locus of control is potentially problematic and requires consideration of the *nature* of control gained by students and relinquished by teachers. Indeed, Ito (2005) points out that students automatically use mobile devices in a naturalistic and selective way, yet schools are still concerned to 'teach' their use. In some senses, this teaching aims to inculcate the use of mobile technologies in a 'school way'. If this is because the hierarchical and social structuring of schools remains unchanged, then the technology is likely to prove ineffective as a teaching and learning tool.

Much is claimed for the motivational effects of ICT generally (Cox, Preston, & Cox, 1999), and if students have a personal device it might be expected that this would promote engagement with learning. In addition such ubiquitous access should support teacher innovation as the devices will be available as and when needed in the classroom. The study reported here offered an opportunity to investigate the notions of autonomy, engagement and innovation in the context of a project which aimed to increase the links between school and community based learning for school children and their families. At the same time the issues of device management, hardware and software functionality are reported, as they all played key roles in the implementation of the project and its outcomes.

## Background

Community engagement and the motivation for learning were two of the aims of The Handhelds Initiative, which was initiated by a Local Education Authority (LEA) in February 2004, and was jointly funded by the LEA and a handheld supplier. The Initiative provided personal digital assistants to students in eight schools (6 x primary schools; 1 x secondary special school; 1 x mainstream secondary school), for use at both school and home. Different schools received different types of device and some schools had a mixture of devices. This difference in provision is important because of compatibility issues between different models; additionally, the functionality of the devices varied.

Data reported here is drawn from interviews with Head Teachers of six of the participating eight schools and the Acting Deputy Head of the seventh of these schools – the eighth school declined to take part in the research. Eight teaching staff, teaching students across year groups 5, 6, (age 9-11) and 8 and 11 (age 12 and 16 approximately), were interviewed. All interviews were electronically recorded, transcribed and returned to participants for approval.

The research and evaluation exercise reported here considers the notions of:

- (i) School and community
- (ii) Attitudes to learning
- (iii) Innovation and autonomy
- (iv) Management issues arising from the implementation of handheld computers within educational settings.

## Key Findings

### (i) School and Community

The majority of staff felt that use of the handhelds had extended community access to ICT and helped in forging stronger links with parents. Indeed, the impact of the devices on the community was generally perceived positively.

*The fact that, you know, you're giving access to people who wouldn't ordinarily have it ...neighbours, people down the road. And so they do seem to be going the rounds and getting used. (Teacher, Primary School).*

There was also some evidence of positive impact on engagement with learning in the community:

*Also the fact that you've got children who as I say don't have computer access at home and they're taking something home that ... first of all appears alien to some of our parents, the technology ... and the fact that they are also encouraged to have a go and learn new skills on as well. (Teacher, Primary School).*

In some cases parents have helped to locate and share resources for the handhelds and parental feedback has been positive. It is believed that some students have 'taught' parents how to use the devices and, overall, it was felt that use of the handhelds had increased access to ICT provision outside of school.

*'It's involved certain parents who wouldn't ordinarily be involved. And that's one of the things, you know it's ... although you're giving access to a greater number of people, it's not just pupils you're giving this access to, it's going throughout their little community.'*

One school hoped that future benefits might include the ability to replace paperwork (letters to parents; sending information home etc.) with electronic versions, where parents could use the voice record function to acknowledge receipt, or respond as appropriate.

One teacher commented that a student who had visited India to meet family, used his handheld device to store digital photos and record some thoughts and feelings while he was away, which were then shared with the rest of the class on his return.

### (ii) Attitudes to learning

Teachers reported a high level of engagement by students initially, although this waned as the devices began to malfunction. Some students did report a negative impact on learning, and there were a very small number of reports of lessons that used the handhelds being contrived and making little contribution to learning. These negative comments were largely associated with frustration due to poor reliability or ease of use of the devices.

One school claimed that whilst the Project initially generated a feeling of 'a shared ethos in the class', student enthusiasm was since believed to have diminished and this was attributed, in part, at least, to decreased use of the handhelds in school. Although students still used the handhelds to beam games to each other and had the freedom to choose for themselves when to use the handhelds, the ICT co-ordinator commented:

*'... we have given up trying to format any use of them within the lessons. If a child has theirs and would like to use that in a particular lesson – great, they can go ahead. However, there are one or two children who will still use them, that are still using them considerably for playing games and things, but they're not using them for any educational purpose independently, of their own volition. English and Science have been the two main focuses of our work and they'd still use them by choice if they could in that lesson. However general instructions from me as a teacher are "We're going to*

*do this in this way on the board and we're going to record it into our books." So they don't get that opportunity. (Teacher, Primary School).*

### **(iii) Innovation and autonomy**

Although there were some expressions of desire and even intent to use the devices to innovate in the classroom there was no evidence of this actually happening. A general lack of confidence in teaching with the handhelds was apparent; this ranged from insecurity in technical know-how, to doubts as to how the devices could be used to advantage within teaching and learning. A primary school teacher felt that the handhelds needed to be embedded within the curriculum but her lack of confidence and hesitation as to how to use the devices in teaching and learning, highlighted a need for training; she felt that these issues had limited her uptake of the Project and, also, may have impacted negatively on the Project generally. Whilst training sessions were highlighted as important, they were not provided.

*'We could do with something, because we could do with seeing what everybody else is doing.'*

One teacher, who believed that the handhelds should ideally function as a research tool, was unable to proceed in this regard as it was not possible to connect them to either the intranet or Internet. Consequently, whilst this activity was seen as centrally important, it was also unattainable.

Concern was expressed as to whether using the devices complicated, rather than simplified, the teaching process:

Example 1: *'... by the time I've connected it up, I can find something else to use.'*

Example 2: *'It should be making it easier shouldn't it? Not sort of harder ...'*

The software provided on the devices was seen as inadequate by most teachers, but the reasons for this varied. Some clearly felt frustration at the inability to move practice on beyond that available with current resources: *'It's not just got to be a replacement for a book or something like that. It's got to take it further.'*

The freely available e-books were found to be inappropriate and one school wanted to be able to access reading schemes via the handhelds and to have the ability to create their own e-books. Overall, it was felt that the handhelds should provide comparable provision to that which can be found on a desktop PC, which does not suggest a vision of innovation linked to the use of the handhelds. Few expressed any desire to use the software tools available, such as the word processor, animation software etc. but, rather, wanted curriculum specific software, although one teacher commented:

*There's masses of freeware that can be loaded down for all sorts of uses. The diary uses, the notepads, the word processing. I think those are sufficient. The maths I think is a problem. And I'd like to see, like to have seen something that was more Science friendly.*

Some wanted an increase in the availability of curriculum-specific programs, together with the provision of activity and worksheet-type material. In part, this is because of the perceived advantages of moving from a paper-based approach to an electronic mode. However, a certain hesitation was noted in regard to exactly how the devices could be used to aid teaching and learning. Although students at another primary school used the devices for note taking, and the School used a mathematics application, mind mapping software and several games, lack of appropriate software was still perceived as problematic. The School would have liked the provision of revision software for core subjects, and age/interest appropriate e-books for reading. The ICT co-ordinator believed that, given a choice, because of the limited available material, students preferred to use laptops, rather than handhelds.

There was little evidence of autonomous use of the devices in class by students. In one of the schools, class teachers decided whether students should use the devices when deemed to be appropriate. However, because of the limited number available, organisation of lessons utilising handhelds was considered to be



problematic, thus restricting their usage within a class situation. Additionally, student use was always directed, and teacher-led, rather than student-initiated and driven. In order to ensure that all students had access to a handheld, the School had a rolling programme so that devices could be utilised all week and taken home over the weekend, before being returned to school for another student to take ownership. However, this did somewhat limit the possibilities for personalisation of the device and the School would have preferred to use a different model, allowing for student ownership, with a focus, for example, on individualised and personalised learning. However, even where schools stopped using the handhelds in a structured way, some of the students still used them for diarising and self-organisation. In the primary sector this was seen in a positive light but in the secondary sector the staff did not see this as particularly useful. MARGI links, which allow a handheld to be connected to a data projector, were used for presentations and this was felt to be very powerful as a teaching and learning tool.

**(iv) Management issues arising from the implementation of handheld computers within educational settings.**

Issues such as lack of teacher confidence, lack of training, and technical difficulties with the devices used, impacted negatively on their uptake and use in innovative teaching. Technical issues such as synchronising the device with a PC, or laptop, navigation and file storage, short battery life and device breakages were problematic. Similarly, paucity of appropriate software, together with uncertainty as to how the devices might best be used to enhance teaching and learning, inhibited the development of innovative models of teaching and learning, highlighting a need for the provision of training, with a particular focus on ‘teaching ideas’.

Also, concern was expressed about their design:

*But in a way they haven't been designed with school children in mind.*

Similarly, there was uncertainty as to whether the students were sufficiently careful with them:

*And the fact that you know they lose pens and covers and things. And perhaps they don't take as much care of them, as they should do in an ideal world.*

At a primary school where the handhelds were kept by the Head Teacher, the School did not suffer with breakage of the devices, but their robustness was still felt to be problematic, as was a lack of stability, sometimes resulting in data loss. Additionally, it was felt that doubling the screen size and making it generally more ‘chunky’ might improve the actual design. It was also suggested that a bigger stylus (pen sized) would more easily allow for handwriting practice.

Staff at the Mainstream Secondary School had difficulty in finding appropriate software, feeling that much of the available software was better suited to primary, rather than to secondary education, and therefore failed to provide sufficient challenge for their students. Staff would have liked dynamic geometry and mathematics software packages and simulation software for science.

Example 1: *‘... there is nothing there that would make the use of (device name) purposeful – it would be contrived. And I'm not going to do that.’*

Example 2: *‘... there's not enough that's challenging enough. And there's nothing that stretches them so they are contrived situations rather than something else we'd do.’*

The School would also have liked to access reading schemes via the handhelds and to have the ability to create their own e-books. Overall, it was felt that the handhelds should provide comparable provision to that which can be found on desktop PCs.

Whilst one of the primary schools felt that the handhelds needed to be embedded within the curriculum, the teacher also expressed a lack of confidence in her own ICT abilities and an uncertainty as to how the

devices could be used in teaching and learning, highlighting a need for training; she felt that these issues had limited her uptake of the Project and, also, may have impacted negatively on the Project generally.

*'I feel a bit sort of in the dark as to what actually we could do with it anyway you know.'*

One primary school used the handhelds for student presentations and this was felt to be helpful for developing presentation skills, though the small number of available devices complicated lesson planning. However, this school also expressed some uncertainty as to how the handhelds could be used for teaching and learning, believing that the devices were primarily used because the School had them, rather than because they met a particular teaching/learning need. Training sessions were highlighted as important, but these were not provided.

*'We could do with something, because we could do with seeing what everybody else is doing.'*

The ease of portability was seen as a positive attribute of the devices and staff of the secondary school also felt that the distribution of the handhelds had increased home access to ICT. Primary schools also perceived portability of the devices as a positive feature, which was particularly helpful when collecting, and entering data, especially on field trips. Many of the teaching staff utilised the multimedia – voice recorder, digital camera, video camera – for activities such as recording role-play, taking photographs around the school and school trips, where students take written and voice recorded notes as well as pictures. However, despite the importance of the devices' portability, activities undertaken with them were limited in some schools because not all devices had multimedia functions. This also presented problems for the secondary school, which had a range of different devices, distributed at different times, resulting in differing degrees of training. The students who had the devices the longest, and therefore received most training, had devices which were capable of less than their newer counterparts. Conversely, those students with the newest and most multimedia capable devices received less training.

However, some teaching staff expressed a concern that use of the devices was somewhat contrived, resulting in a reticence to use them as tools for teaching and learning.

*'I've enjoyed using them, the children have enjoyed using them, but we still don't think it's quite right and there's limitations with them.'* (Teacher, Primary School 5).

## **Conclusion**

Whilst the project shows some evidence of increasing access to digital technology in the wider community, and engaging students and families with formal education, there is little evidence that teachers are adopting innovative approaches to teaching and learning with the devices. This seems to be due to a lack of vision and skill with the devices or, where the teachers have a vision, lack of appropriate levels of access and software. In addition, the requests for additional software illustrate clearly that most models of practice are predicated on a mapping of the use of the devices onto the existing curriculum format and structure. The scope of the project was severely limited by the lack of technical reliability of the devices, and the long turn around time on repairs. The small number of devices available exacerbated this so that it quickly became impossible to use the devices with a whole class. The small size made sharing impractical, and it seems small group work was never seriously considered as an option. Lack of access to the Internet (either directly or through the school network) was seen as a significant drawback, and limited the options for research-based learning. Where it was available, multimedia capability was welcome and aided resource based learning.

Whilst many in education have great hopes for the use of mobile technologies in school, this project suggests that issues such as lack of teacher confidence, lack of training, and technical difficulties with the devices used, impact negatively on their uptake and use in innovative teaching. Further, there is currently no tried and tested model which schools can follow – each school embarking on the use of these devices does so largely without any map to follow, as it has yet to be drawn.

For example, whilst some teachers involved in these projects expressed both a desire and intent to use the devices to innovate in the classroom, there was sparse evidence of this actually happening. There was little evidence of autonomous use of the devices in class by students and there were examples of class teachers deciding whether students should use the devices and when this was deemed to be appropriate. Indeed, in some cases, student use of the devices was always directed, and teacher-led, rather than student-initiated and driven. This should cause no surprise in view of the continued emphasis on ‘results’ – teachers have little time, and less scope, for undertaking the ‘creative’ teaching now being espoused by government, when their main concern must remain the implementation and evaluation of state directed targets by which students, teachers and schools themselves are measured. Further, at the present time there are limited opportunities for accrediting students for that which they have achieved when using mobile technologies, but which does not form a part of the standard curriculum. This explains why, when mobile technologies are available to schools, teachers may afford them a low priority compared to the time and effort put into, for example, work on student attainment targets, and envisage their use for activities such as electronic worksheets, rather than for teaching and learning innovation.

However, for both technophobes and technophiles, teaching agendas must be set against the notion of appropriateness of tool and ‘reasonability’; that is, at what point is it reasonable for educators to make use of the technology and at what point does use of the technology become unreasonable? This question is closely linked to ways in which technical difficulties might hinder classroom appropriation of the technology. Therefore, we need to establish which contexts are relevant for the use of mobile technologies, given that the technology itself is flowing and shifting (Ito, 2005). We might also ask why mobile technologies should be used in schools at all, considering what they offer over and above other forms of technology, and reflecting upon where there may be congruence and dissimilarity with the existing curriculum and pedagogy, because if implementation of these devices within education is to succeed, cultural change is inevitable.

*I believe that if we are to have new forms of learning, we need a very different kind of theory of learning. The theories that have been developed by educational psychologists and by academic psychologists in general, are matched to a specific kind of learning. School’s kind. As long as these ways of thinking about learning remain dominant, it will be very hard to make a serious shift from the traditional form of School. (Papert, 1994, p.21)*

Given this background, there is a need to move towards a theory of Mobile Learning and, to some extent, this is linked to the policy context within which this learning takes place. The e-learning strategy, together with the Government’s Building schools for the Future Initiative (Directgov, 2005), would seem to indicate that a cohesive strategy for the overall development of education is in place, with an emphasis on the growth of ICT. However, this is somewhat in contrast to the curriculum, which, despite the rhetoric of individualized and collaborative learning, continues to demand a focus on didactic teaching and quantifiable results. As can be seen, the tension which arises from these opposing value systems and pedagogical frameworks has already been experienced by some of the schools undertaking pioneering work attempting to use mobile technologies in education.

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## ***Your employees are increasingly mobile, is your learning?***

Key issues for business leaders are often a combination of driving growth, innovation and productivity while ensuring alignment across their organizations. Yet much of the formal learning initiatives where the bulk of learning investments are made are either not aligned with strategy and/or don't take into consideration the constraints on people's time by re-engineering how they produce, deliver and encourage formal and informal learning. With a significant proportion of the workforce already mobile and the trend on the rise, the question is not *should* mobile learning be part of learning strategy but *how*. Mobile learning over the last three years has primarily focused on repurposing content and distributing it on PDAs (personal digital assistants). It's time to rethink how workers communicate, collaborate and learn—especially as growing numbers of workers now are very comfortable with and expect to use technology that enables just-in-time, just-for-me and anytime, anyplace learning. The result will be more effective learning that aligns with business processes and workflows, with much greater business impact than traditional training.

### **Three Trends Driving the Need to Utilize Mobile Learning Now** **Mobile Working**

Eilif Trondsen, Ph.D., Director of the Learning on Demand (LoD) program at SRI Consulting Business Intelligence recently articulated key trends pointing to the need and opportunity in mobile learning in Bulletin Mobile Learning Revisited. Trends in employment point to increasing mobility and the use of mobile devices on the job to accomplish tasks such as CRM (Customer Relationship Management) and increasingly for various tasks in supply chain management, such as tracking and managing production, inventory and shipping. People need to stay connected and informed while multitasking and on the move. Remote and mobile workers including frequent business travelers, mobile office workers, telecommuters, remote branch office employees, multi-site workers and non-office workers are estimated by Stat/MDR to be approximately 94 million at the start of 2005, or nearly 40% of all US employment.

### **Time Pressure and Impact on Learning: Time to Re-engineer**

The trends in corporate restructuring including outsourcing, and the demands placed on employees to get more done with less people is having an unintended impact by driving demand for traditional training courses down. Estimates are that the average number of training days completed in the US per year is down to two days. People just don't have the time to sit in epic workshops or even follow through with their commitments to attend shorter ones. Yet 75% CEO's when surveyed in 2004 by IBM, said employee education is the most critical success factor relative to other people issues. How many people cancel a few days before a workshop because they are too busy or were called onto another project? (Or they say that because they sense that they won't get enough value out to justify taking themselves off the job for even a short time). This is exasperated by outdated curriculum that hasn't taken advantage of technology to shorten training time, ensure the right people are in the right course at the right time, and to support the growing trend towards informal and workflow learning, all of which can be supported with mobile learning strategies.

### **Technology – New Developments Make Deploying Engaging Mobile Solutions Easier**

Look around these days from homes to offices to coffee shops to cars, trains and airports and what do you see? Mobile gadgets everywhere! Just scratching the surface reveals the last two years have seen an explosion of mobile devices as demonstrated by the popularity of Apple's iPod, Blackberrys used for mobile email, more cell phones in use than ever including many more with PDA functionality such as browsers, email, camera and video (although usage and uptake of these features is lower in the US than in Europe and Asia), while laptops have gotten lighter with longer battery life and now connect wirelessly to high speed networks at thousands of "hotspots" and increasingly in homes with wireless broadband. Imagine the possibilities...

Producing learning content for multiple devices that can also serve up that content based on where the learner is or what they are doing is now a built in capability for at least one 3rd

generation LCMS (Learning Content Management System) and recording and editing audio and video can now be done more easily at lower cost. Further, advancements in tools such as Macromedia's Flash enable developers around the world to build advanced games, learning and other applications for cell phones and other mobile devices.

So, the devices have gotten more powerful and ubiquitous and easier to connect to high speed networks, and building content and applications for them have advanced as well. What are we waiting for?

### **New Approaches to Reaching Your Mobile Employees Today with Connectivity and High Gain Rich Content**

Having your employees on the move and working in different locations poses a problem to keep them informed and engaged with each other in ways that would enable faster detection of both opportunities and problems while working together to develop collaborative solutions.

Many mLearning projects to date from around the world have been more focused on repurposing existing content to work on a mobile device than redesigning or building new learning processes to solve specific business driven learning needs. This is starting to change with new applications and ideas, looking beyond deploying content to increasing collaboration and real time information sharing with significant results.

Enabling employees to get the information and learning they need in the format, device and time they want while being able to collaborate and learn from each other to create and share knowledge are the keys to performance *now*, more than ever.

### **Online Communities, Moblogging and Podcasting**

Organizations have been using online communities in which workers monitor and discuss what's happening via instant messaging, document sharing, and discussion boards for a few years now. Web based solutions enable connecting anywhere, anytime. What's new is the act of opening these up to customers and/or others in the supply chain for instant feedback and meaningful dialogue promoting better customer retention, understanding consumer needs, and analyzing processes. Output from these communities to mobile devices is possible so people don't have to be online to be connected to the buzz. A similar technology but often used quite differently is Blogging – which enables employees to publish information to a website from their phones, PDAs or laptops (known as moblogging). Content is easy to publish and could include photos – e.g. of competitive products, voice e.g. elated reaction to a successful sales call that promotes enthusiasm and morale and text comments in real time to a website which can also be accessed remotely. All of this can be summarized and pushed via email or browsed. Of course, security and guidelines are important to address but the point is that low cost enabling of employees to interact, be informed and publish relevant information on the go can enable organizations to make faster, better decisions.

A related approach is "Podcasting", a term coined in September, 2004 combining the words iPod, (a portable audio player) and broadcasting which simply means publishing and/or subscribing to audio content created professionally or otherwise on the device of choice, much like many subscribe to aggregated news feeds now. There is already free content out there that would benefit your managers but creating you own is also quick and easy and could be deployed by your Corporate Communications and Learning teams. Content could include audio from business leaders, leadership programs, cultural change related content, etc. and would be available whether at home, in the car listening to a CD or on the move with mp3 players or using a cell phone that are increasingly mp3 enabled. The use of portable distributed audio to inform and educate is likely to grow as evidenced by the growing consumer demand for downloadable audio books. At least one organization in the UK is considering handing out mini-iPods at the end of key workshops that would cost less than 1% of the cost of the course with key lectures and discussions pre-loaded on them. What a way to address the current practices of giving out so much print material in a course that they are offered to ship them back home? Instead, employees can try out their new toy on the flight home with only high gain reinforcing content on them to start.

### **The Classroom, Revisited for Mobile Workers**

Re-invigorating classroom training is a focus for many CLO to get better results and return on investment. The time is here to re-equip classrooms to take advantage of technology that enables more people to participate in the learning process while getting more out of the content created.

Inexpensive webcams or higher end cameras can be used to film lectures in unobtrusive ways that can then be viewed live or asynchronously around the world by mobile workers. With wireless laptops and PDA's connecting at high speeds in coffee shops, airports and homes, viewing key presentations in moments of down time becomes a reality and you get more out of the original lecture or discussion.

With a webcam on their device also enables users to contribute to learning sessions and participate in collaborative learning with experts no matter their location and if experts no longer have to travel to the workshop, they are more likely to agree to share their expertise because it doesn't take them off the job for a day or more to contribute for an hour or less. There are a few software tools out there that are easy to implement that help you produce and manage this type of learning that can be captured, shared and reused in a continuous learning loop that raises the level of knowledge. This same technology can enable instant video conferencing with shared whiteboards which supports the trend towards peer to peer informal learning. The use of mobile phones in the learning process is also an opportunity. Participants can take photos and share and discuss either together or remotely.

Using automated SMS distribution systems that tie into your corporate directories, text messages can be sent out to reinforce key concepts or provide last minute joining instructions. Combining instant messaging groups, text message and email subscription lists at the end of learning events whether virtual or physical is a method to keep the dialogue and learning happening. Some organizations and universities have started using text messages to poll and test learners in the classroom or after. Blackberry type devices can also be used in this way as a method of reaching participants and keeping them engaged.

### **Mobile Phones for *Delivering Learning*?**

Blended learning approaches that utilize mobile phones are an opportunity to reach employees on a computing device that is always with them. Questions often come up when discussing the viability of using mobile phones for learning. Marc Prensky, author of *Digital Game-Based Learning* summarizes types of learning possible on mobile phones in his article "What Can You Learn from a Cell Phone – Almost Anything!" "There are many different kinds of learning and many processes that we use to learn, but among the most frequent, time-tested and effective of these are listening, observing, imitating, questioning, reflecting, trying, estimating, predicting, hypothesizing and practicing. All of these learning processes can be done through our cell phones." He adds that this can only be done if designed right. This is of course true for delivery on any device.

Another untapped opportunity for learning with phones is the creation and use of engaging mobile phone based games that can introduce key cultural, ethical and strategic concepts or to reinforce/build key concepts. Marc and many others are major proponents and the exploration of using games for learning continues to be a hot topic especially in the US and the UK, exemplified by the Serious Games Summit selling out last fall and another one being scheduled just five months later.

### **Location Based Learning**

This is an emerging field with dozens of universities and corporations partnering to find ways to enhance learning by using the physical location and context of the learner as part of the learning process. This is known as Augmented Reality in the US and more commonly referred to as Ambient Learning in Europe. A great example of this is the Symbol location based learning project produced in partnership with Symbol, MIT and a top learning and technology firm. The system automatically delivers just in time content to a handset, based on the worker's location in the manufacturing facility and checks to see they have the right equipment and clearance/qualification. The greatest growth in Ambient Learning has been in

Europe where corporations, higher education and museums are already using it to deliver information, learning and peer interactions and for team building events with users interacting with each other either in person or virtually with handheld devices that detect location. While it sounds a bit far out, realize that by the end of 2005, all cell phones in the US that are sold will have to have location based detection capability to support Enhanced 911, and Microsoft revealed that their new operating system under development called Longhorn will have location-aware software components.

### **Intrigued? Take Action!**

The business drivers for mobile learning and the technology to enable it are growing stronger. Taking appropriate action now will enable you and your organization to take advantage of the capabilities in a way that benefits your employees, organization and shareholders.

Here are three suggestions to get started rethinking how mobile technology can produce results for your organization and taking the next steps.

1. The best place to start is by experiencing first hand what its like to get the information you need in the format and location you want. Here are some ideas:
  - **Blackberry users:** subscribe to an email news feed to keep yourself informed of a topic of interest. There are several that focus on mobile technologies that reinforce the points made above. Consider what else you would like to have in your palm, and how polling and delivering content to learners might add value.
  - **PDA users:** Try AvantGo – a free service that downloads news and content of choice. Take a look at lessons produced by Learn 2 Hand teaching language and other skills. Try connecting to a Wifi network to view video and audio news clips. Think of the message or content most valuable to your employees you could have produced for next to nothing.
  - **Cell Phone Users:** Go to your carrier's website and see what services and content are available and explore the capabilities of your phone. While your company may not support your downloading games or accessing location based content, try with your own phone. Consider how sharing of photos might be used in a leadership development course.
  - **mp3 Audio Player users:** Try an audio book. You can find them for free and of course for fee. Does your device record audio? Many do. How might these be used for learning?
  - **Tablet PC and WiFi enabled laptop users:** Subscribe to an interesting blog and listen to some Podcasting content. Use a webcam to stay in touch with your family or team. Experiment with using virtual classroom type software that best supports video with shared whiteboards and try some of the audio/visual ideas from above.
2. With the experiences you've had exploring mobile learning yourself, discuss mobile technology strategy with your CIO on an ongoing basis. Understand what's available and what's planned and point out the business drivers that require enabling some of the approaches above. Strive to find internal champions to further enable and leverage the technology investments already made.
3. Build collaborative partnerships with leading experts that can make sense of these nascent technologies and help you explore how these approaches could support your learning strategies and business priorities. With your internal champions in place and support of your IT leadership, tap into this network once you've picked the high gain business needs to address and get started!

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# Blending mobile and ambient technologies to support mobility in practice based education: the case of teacher education

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## **ABSTRACT**

Practice based education is gaining a growing popularity in fields as diverse as, e.g. software engineering, pedagogy, and medical studies. Practice based education involves mobility of students since the learning takes place in different arenas. In this paper we focus on a practice-based pedagogy course we are cooperating with. In this case, students are moving around the university, where theoretical lectures take place, and the schools where they do their practice. In this context we introduced a mobile blog to support informal cooperation among students and teachers. Mobile devices were expected to support the students in collecting and publishing fragments of their experiences to be used for reflection and shared with other students. However, our experience with the initial introduction of the mobile blog shows that students' mobility dramatically limits the visibility of the system. In this paper we propose the usage of shared ambient displays to enrich the spaces that are inhabited by the students to assure a better visibility of the system. Access to the system when students are mobile could be achieved by mobile technologies, e.g. via mobile phones. However, shared displays can promote a higher degree of visibility because they support "chance encounters" with the system. In addition, the system is in this way contextualized in the community life and the information is made visible in a context where it can be used to foster informal cooperation among students.

The work reported is part of the MOTUS2 project (<http://www.idi.ntnu.no/~divitini/motus2>).

## **KEYWORDS**

Practice based education, shared ambient displays, blog

## 1. Introduction

Practice based education is gaining a growing popularity in fields as diverse as, e.g. software engineering, pedagogy, and medical studies. Practice based education involves mobility of students since the learning takes place in different arenas. Support for mobile students has mainly focused on providing access to remote resources while on the move. The space of possibilities opened by advanced mobile technologies, allowing to be connected all the time, independently by time and space, is considerable and can overcome many of the difficulties that students are facing in getting access, for example, to lecture notes, syllabus, and the like. At the same time, different attempts of introducing mobile technologies have resulted in failures and problems, see e.g. (Smørdal et al. 2002). We can expect that some of the reported problems will be overcome with the evolution of the available devices and a better connectivity. Other problems, however, require a more thorough understanding of the needs of students out in the field and to overcome the oversimplifying assumption that mobility of students requires mobility of the supporting technology.

Research in the field of ubiquitous computing and ambient intelligence has put the focus on the spaces that are inhabited by users and the support that can be provided by enriching these spaces (Streitz et al. 2005; Tscheligi 2005). This line of research can be useful also in learning environment and, we claim, in particular, to support practice based education.

In the paper we focus in particular on ambient displays, i.e. displays hanging in community spaces and visible to everybody in the area. Ambient displays have been recently advocated as a novel technology for supporting collaboration (O'Hara et al. 2003). The growing interest in these devices comes from the popularity of conventional bulletin boards and similar paper-based artifacts. Bulletin boards play a variety of roles in any space inhabited by a group, a family, or a community. Electronic counterparts of these artifacts are developed with the hope to overcome their limitations, such as limited interactivity and no support for remote access. As pointed out in (Luff et al. 1998), a combination of shared displays and mobile devices can be used to support different degrees of mobility and a smooth switch from individual to collaborative activities, from public to shared information. Shared displays can also facilitate socialization, as suggested in (Agostini et al. 2002). In this paper we propose an ambient display to promote practice-based teacher education. Our proposal is based on our collaboration with the teacher education programme at our university. The programme encompasses

traditional classroom activities as well as practice periods. During practice periods students get the opportunity to work in a school and get first hand experience of teaching.

The paper is organized as follows. In section 2 we briefly describe our case and some results from our observations and questionnaires. For a more complete description of the case, the reader can look at (Divitini et al. 2005; Morken et al. 2005). Based on our experience, in Section 3 we identify some requirements for an ambient display system to be used in practice based education. In Section 4 a demonstrator of the proposed system is introduced. Section 5 concludes the paper.

## 2. Practice based pedagogical education

In this section we briefly describe the course Practical Pedagogical Education (PPE) and reflect on students' usage of common spaces and bulletin boards of different types. We also briefly reflect on the usage of different technologies during the course.

### 2.1 Description of the course

PPE is organized as a one-year course, with normal classes as well as teaching practice. In this course our university cooperates with 30 schools that are grouped to create partnerships. A partnership includes 5 schools that offer teaching practice to circa 30 students. Normally the students of a partnership are spread on the five schools of their partnership, but sometimes they all go to the same school. This happens, for example, during a takeover, i.e. when students have the responsibility for all the teaching in the school while regular teachers are away. A number of mechanisms and strategies are adopted to ensure that students are constantly helped in their learning process and to promote reflection. Examples include regular meetings with supervisors, support groups, plenary meetings during practice periods.

The PPE staff is aware of the need to develop an adequate technological infrastructure to keep students informed about important issues, but also to promote cooperation between students and teachers as well as among students. Different ICT solutions are adopted. Mailing lists are used to distribute information. The university Learning Management System (LMS) is used to support course activities, e.g. delivering of exercises, and to keep an overview of students' progress. In addition, during the week of takeover, when we have observed students out in practice, we have introduced a blog to promote informal interaction and the sharing of experiences

among students. Blogs allow easy publishing on the Web, generally supporting the chronologically presentation of entries (Nardi et al. 2004). Blogs have become very popular in the last years, and they have been used in educational settings, see e.g. (Dron 2003; Higgins et al. 2004). In the blog we adopted, a third party solution was used for entering SMS to the blog and we informed students about the possibility to upload pictures.

The reflections reported in this paper are based on an extensive analysis of material describing the course, observations of the students, the results from a questionnaire distributed after the observation period, the logs and the contents of the blog.

## 2.2 Reflections on the usage of message boards and spaces

The school where the takeover took place has separated areas for teachers and for pupils where activities outside teaching take place. The teachers' area, used during the week of takeover by the PPE students, is divided into dedicated workspaces and common areas. Dedicated workspaces are cubicles with desks and some computers that groups of 3-4 teachers can use to prepare lectures. Common areas include a copying room, a small kitchen, and an area with tables and chairs where teachers can relax, read, and meet with others. The teachers' area is relatively open, allowing getting an overview of who is present and what is going on. Sharing the same area gives students continuous occasions for short unplanned meetings. The conversations during these encounters are sometimes about topics not related to the teaching practice. Often, however, these encounters are not only promoting socialization, but become an important occasion for sharing experiences. The openness of the space also makes it easy to "look over people's shoulders", often triggering informal collaboration.

The space around the entrance to the teachers' area is the central space for providing information. There are several boards placed in this area and mailboxes for the teachers. In particular, a central role is played by a board at the entrance of the teachers' area. This board contains different types of information, such as time plans, announcements, and pictures (Figure 1). Another important source of information at the entrance of the area is a whiteboard used to write messages of a more volatile nature. When there is no space enough for hanging important information in a highly visible place, the information might be put elsewhere but with a note on highly visible boards to increase the chances that students see it. For example, on the whiteboard we have observed the

message: "Students: inspection plan is hanging on the board in the library."



**Figure 1:** Message board at the entrance of the teachers' area.

Information is also hanged around depending on the needs. For example, during the takeover teachers left a poster in the kitchen specifying students what they could use and what not. This message was at the same time granting students the right to use the space, and limiting what they could do. A glass wall inside the teachers' area was also extensively used during the takeover to communicate information to the PPE students (Figure 2). Printouts with information relevant to the students were hanging on both sides of the wall.



**Figure 2:** Information hanging on the glass wall in the teachers' area.

It is interesting to note that the PPE students used the space in a slightly different way that the regular

teachers: some boards used by the teachers were taken in use also by the students, others were not, some spaces not regularly used by the teachers were appropriated by the PPE students.

The observations that we have briefly summarized in this section point out the critical role of community spaces in practice based learning. In line with what reported in previous literature related to different working settings, the existence of a common space is critical to promote chance encounters and awareness of other people's activities. This can result in improved cooperation (Olson et al. 2002) and knowledge sharing (Davenport et al. 1998).

Common spaces are also critical to give visibility to information, thanks to the usage of different displaying areas. Displaying areas might be different in nature, from permanent to very volatile, as in the case of printouts hanged on a wall or post-its on a folder. Each area has associated implicit rules that govern the type of information that it visualizes and its usage. Displaying areas do not live in a vacuum, as discussed also in (Crabtree et al. 2003) in relation to the home environment. They rather form an ecology of interconnected displays that together satisfy the information needs of the community inhabiting the space. This is evident, for example, in the case of the message displayed on one board to link to the inspection plan available in another area. This way of using one board to refer to another relates to a problem often encountered with boards - they can only take on a given amount of content. The solution to this is often to place different content on different boards. But having only limited central spaces, this may cause problems with people not seeing or being aware of information provided.

Displaying areas are generally rather flexible, with the possibility to change the type of information and its organization depending on varying needs, as in the case of the glass wall used during the week of takeover. Displaying areas serve different purposes: (1) they give visibility to the information, (2) they can indirectly support coordination through the information provided, e.g. inspection plan or through messages with specific instruction to be followed by the reader, and (3) they support socialization by making visible, for example, pictures and announcements interesting for the community. In addition, the information displayed, being made available where people meet, can trigger conversations and promote socialization.

Displays support people mobility because they allow people to keep informed about different aspects of community life without requiring that all the members of the community are physically collocated all the time.

### 2.3 Reflections on the usage of IT

During the course, students had access to a number of technologies that they can use. Here we can distinguish between personal or public resources. In our case, students have access to a number of computers at the university and, when they are out in practice, they can, with some restrictions, access the computers of the school. In the staff area they have access to some computers, while in the classrooms the access is more limited. In addition, during teaching the students need to be highly focused on their work and on supporting the pupils. There is little spare time during a lesson, and thus little time to use technology for purposes other than teaching.

Students are expected to use the university Learning Management System. The system is used for collaboration among teachers and students. The system provides some basic support for sharing documents and the possibility to create discussion forums. Despite the strong commitment of the course organizers, the system is poorly used. Most of the students access it only if it is strictly necessary.

In addition to public technologies, either hardware or software, students have access to private equipment. Most of the students in our case have Internet access at home. Mobile phones are also widely used and most of the students use SMS to contact other students. In general, the technology available to the students seem inadequate to support their mobility. The public technology mainly focuses on providing access to official information resources, with little support for interaction of students and teachers. The technology also does not support in any way a contextualized and flexible sharing of information.

With the introduction of the blog, students' mobility was partly supported by of the possibility to upload pictures and sending in SMS messages. This allows, while mobile, to collect fragments of information that can later on be used for reflection. There is however no support for students to view the content of the system, or know about changes, while mobile. In this way students are not aware of what is happening, e.g. if new information has been added. They need to connect to the system from a stationary PC, with no possibilities for "chance encounters" with the system. This limited visibility of the system might negatively impact on its usage when, like in the case of learning in the field, students are often on the move and without access to workstations.

In the case we have focused on submitting information via mobile devices, though in a very primitive way. However, contributing to the system while mobile does not seem to be the major problem.

Mobility, and a tight schedule, reduces the willingness and the chances to use the provided ICT support. This was observed for the blog as well as the university LMS. For a system to be used we have to increase its visibility. Given the observed usage of community space, the adoption of shared ambient displays seems a possibility.

### 3. Implication for design

The complexity of practice based education requires the combined adoption of different solutions. In addition, the needs of students might vary quickly and be different depending on the particular context where they are acting. In general, in our case we have observed students having problems in getting an overview of the information they need and a limited visibility of what is going on. Collaboration is important but it is often jeopardized by students' mobility, limited time to dedicate to activities that are not strictly connected to teaching, and the lack of adequate support for cooperation in the existing ICT support.

Given our observations on the usage of common spaces and the artifacts enriching these spaces, we suggest the adoption of an ambient display resembling the displays available in the school. Ambient displays can provide various benefits. The objective is to create a system that provides the same benefits than traditional bulletin and message boards, at the same time overcoming their limitations (Divitini et al. 2003). To meet the needs of students out in practice, ambient displays should be designed so to provide a *single access point to different information sources* that are relevant for the students. The usage of an ambient display hanging in a common area can assure that the content of the system is highly visible to the students. In addition, the visualization is contextualized in the spaces of the community. This means that students can discuss with other people the content of the system, for example to get immediate clarifications. The same way a common space triggers chance encounters with other people, the usage of ambient displays assures chance encounters with the system, increasing the possibility of students' participation.

In order to be useful for the community the display must provide students with the possibility to access a set of services that are needed by the students in different conditions. The needs of the students might vary during practice and the type of services that might be relevant, for example, during a takeover are not the same then when regular teachers and PPE students are collocated. It is therefore important that the ambient display is not seen as a monolithic entity

but rather as a complex system that is build as a flexible constellation of services. The importance of changing the content of the system depending on the varying practices that take place in the common space was also evident is a previous experience we had with the adoption of ambient displays in an office environment (Divitini et al. 2004).

In the following we provide a list of students' needs, as emerging from our observations, and examples of services that might be provided in the display in order to meet those needs.

***Support for awareness of other students and activities:*** presence services and activities indicators

***Support for remote communication:*** access to chat and e-mail tools

***Support for sharing of experiences:*** access to individual and shared blogs

***Support for socialization:*** visualization of information related to the social life of the community, for example pictures of events people have participated to and birthday lists

***Support for access to external information sources:*** access to a web browser for access to Internet, visualization of relevant databases

***Support for coordination:*** visualization of and access to shared calendar, scheduler, project plans

***Support for chance encounters with members of the community that are geographically distributed:*** buddy list with presence information, audio/video connection among different practice schools

***Support for switching from chance encounters to focused cooperation:*** access to a set of tools that may be used for supporting focused collocated cooperation, e.g. drawing and writing in a common document.

Given the mobility of the students and the problem they have to access desktop computers, it is important that the ambient display system supports different forms of interaction.

Interactive touch-screen displays can be useful when there is a need to navigate the information in the system or to insert some quick information. This can happen, for example, when a student want to activate a browser to check some information on the Internet or when he wants to leave a short message for students coming later. The usage of PDA or mobile phones can provide a richer interaction with the system for students that are in the physical space



where the display is available. This can be necessary for example when a student want to activate and control an application or when he wants to personalize the services that are visualized on the display.

The display system should not only support collocated interaction, but also remote students. This might include both receiving information from the system while mobile as well as posting information while mobile. For example, when travelling, a student might be interested in receiving on her mobile phone a notification of certain types of changes in the content of the display, e.g. when the running text changes. This will increase her awareness of what is happening even if she is not present in the community spaces. At the same time, it can be useful for a student to have the possibility to send in via SMS a message to be visualized on the display to inform the students in the school that she is late for a meeting.

#### 4. Demonstrator

To illustrate the system that we envision we have developed a demonstrator with Flash called PPE-board (Figure 3). On the bottom of the display is a line with running text visualizing messages from the PPE teachers to the students, for example regarding important meetings or last minute changes in the daily plan. On the right it is visualized the blog of the students. In this way students can see new entries, getting aware of changes, and possibly be motivated to contribute. We also expect that this can trigger discussions around the content of the blog with other people that are in the room. On the left, from the top, it is possible to see:

- A list of the contact information for the students doing their practice in the school
- A calendar with the possibility to insert new events and appointments
- A message board, with the possibility to insert new messages that will be added to the list following a chronological order
- A button to access the student intranet (Innsida)
- A button labeled “tools” that allows selecting commonly used tools, such as a drawing tool, a text editor, or a web browser
- Images from a remote location. In the display there is space for showing the video captured in two different locations, though only one video streaming is activated in the figure. The objective is to create an audio-video connection between the school where the display is located and other schools where other members of the community are located. This is expected to improve awareness by creating a media space (Mackay 1999).



Figure 3: The PPE-board

As discussed in Section 3, different forms of interaction should be supported to meet the needs of different users. In Figure 4 we see the PPE-board projected on an interactive board. In this case input can be inserted directly by using the touch-screen. Other forms of interaction should be made available, for example by using mobile devices, e.g. mobile phones or PDAs.

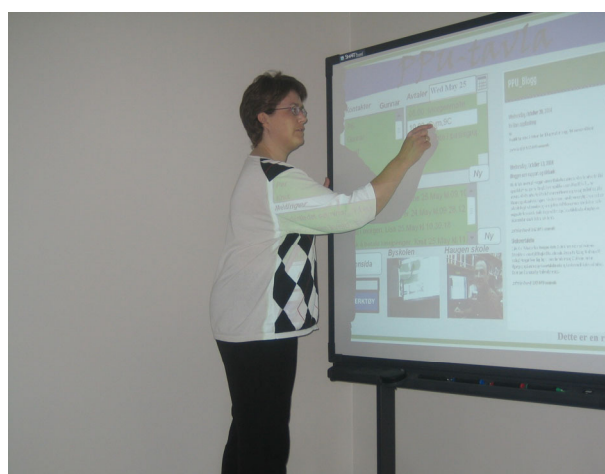


Figure 4: The PPE-board on an interactive board

#### 5. Conclusions and future work

In this paper we have discussed the importance of common spaces in practice based education and the important of bulletin boards of different types to support students. Based on our experience we have identified some main requirements for the design of an ambient display system to support practice based education. To illustrate the system, we have briefly described a demonstrator that we have developed. The demonstrator is intended to provide an overall

idea of the possibilities offered by the usage of shared displays. In a previous work we have developed a fully functional prototype of a display for a working setting (Divitini et al. 2003). As part of our future work we intend to extend this system to develop a fully functional demonstrator of the PPE-board.

The focus of our future research will be on the integration of ambient displays and mobile technologies to provide a better support to mobile students. Though our case is related to teacher education, we believe that our proposal can be generalized to other situations of practice based education where students share a common space. To verify this hypothesis will be part of our future work.

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# The “ME”-Learning Experience: PDA Technology and E-Learning in Ecotourism at the Tshwane University of Technology (TUT)

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**Abstract** Ecotourism means nature-based tourism with an educational, economical and spiritual dimension. Educated ecotourism practitioners have many advantages for the industry and to conservation. To provide well-trained practitioners, learners in Ecotourism at the Tshwane University of Technology receive extensive training in Biology. They undertake field trips into nature to become actively involved in the nature-based experiences to prepare for their careers. This article reports on the application of mobile devices (PDAs) during field trips as an alternative to conventional paper-based workbooks. Two groups of learners participated in this study. The objective was to determine how mobile devices could be used to enhance and support learners during field trips. Various information files were prepared prior to the



field trip by the lecturer and transferred to the PDAs. During field work learners took notes and became cognitively involved in activities provided on the PDA. Although there are some limitations, the results of this study indicate increased motivation and more outcome-based appropriate assessment opportunities when using PDAs. Learners benefit from the features and tools of the PDA. They also have the opportunity to reflect by integrating the electronic Learning Management System and mobile technologies to receive and submit assignments. Follow-up investigations will reveal more opportunities and the sustainability of using handheld devices during field trips.

**Keywords:** Mobile technologies, field work, educational, PDA, mobile learning.

## **Introduction and background**

Mobile technology is the emerging technology and becomes a very powerful tool in combination with e-learning opportunities in teaching and learning. In this project mobile and e-learning technologies have been applied in Ecotourism to support and enhance the learning experiences of the lecturers and learners at Tshwane University of Technology.

### ***Ecotourism***

Before explaining the need for training in ecotourism, it is important to realise what is meant by “ecotourism”.

It is generally agreed that ecotourism is nature-based tourism. In their descriptions of ecotourism, writers generally refer to nature as the basis, but have placed different emphases on responsibility, local culture, sustainability, education, and local economic benefits. For example, the Ecotourism Society defines ecotourism as responsible travel to natural areas, which conserves the environment and improves the welfare of local people (ResourceAfrica, 2004). Although there are many definitions for ecotourism, all appear to have four elements in common:

- The natural environment
- Ecological and cultural sustainability
- Education and interpretation
- Economic benefits at the local level

It is nevertheless distressing to realise that no definition mentions the spiritual or even psychological benefits of ecotourism. De Crom (2005) proposed arguments that find it reasonable to claim that ecotourism originated from and exists due to the desire of individuals to reconnect to nature. They fulfil this desire by experiencing unspoilt natural environments both physically and spiritually. Therefore, a personal experience in nature is an essential element of any definition of ecotourism.

### ***Ecotourism and education***

In all countries of the world, both rich and poor, ecotourism has the potential to play an outstanding role in educating people about the importance of an environmental ethic. This ethic must include recognition of the complexity and sensitivity of nature and a rejection of the belief that we can understand nature scientifically and manipulate it with technology. Participation in sound ecotourism can contribute to the development of a deep environmental ethic among people who travel internationally to visit wildlife settings, especially those in developing countries. Minorities of rural people are educated to behave responsibly toward the natural environment. The least environmentally concerned are residents of rural areas living in close proximity to wildlife settings (Fredrickson, 2002). They are almost totally dependent on the local flora and fauna for their sustenance. For them, the land is not for leisure, but a means of livelihood and survival.

People visit natural environments to reconnect (De Crom, 2005). Education and interpretation are important elements of the ecotourism experience. It will not only enhance the reconnecting experience of the ecotourist, but should also help to ensure better management for conservation purposes and development objectives. If ecotourism seeks to promote responsible travel, then its foundation must be education.

Ecotourism learners at the Tshwane University of Technology undergo extensive training in Biology, a major subject in the Ecotourism Management degree. To answer the question of why ecotourism learners have to be trained in subjects such as Biology, the following arguments are applicable:

- Because ecotourism means nature-based tourism and therefore every aspect of ecotourism is in some way related to nature, it is essential for ecotourism practitioners to have a thorough knowledge of nature and the interactions taking place within nature.
- Ecotourists are often well informed about the area they intend visiting. They also want to learn more about the environments they visit and they want to understand their connections with nature (Black, 1999:1). Therefore, they need well-informed guides or interpreters to be able to achieve this.
- Ecotourists often mention untrained or poorly informed guides and interpreters as a main concern as they contribute to rather negative experiences in nature. Well-informed and knowledgeable guides will not only enhance the nature experience of the ecotourist, but should also help to ensure better management for conservation purposes and development objectives.

Therefore, advantages of well-informed, trained and educated ecotourism practitioners (the product of TUT's Ecotourism Management course), are summarised as follows:

- Environmental awareness, concern and commitment through an increased understanding and appreciation of the natural and cultural environment are created.

- Providing education as part of an ecotourism experience has the potential to make people aware of, and become actively involved with the natural environment, following their experience (De Crom, 2005).
- Education and interpretation have an essential function in the natural resource management of every park, recreation area and reserve, as it has the capacity to reduce inappropriate behaviour (Alcock, 1991; Beckmann, 1988; Hall & McArthur, 1996; Herbst, 1979). This does not only apply to the visitor, but essentially to the owner, manager and all other role-players involved in the park or reserve.
- Tour guides are one of the key front-line players in the tourism industry. Through their knowledge and interpretation they have the ability to transform the tourists' visit from a tour into an experience (Ap & Wong, 2001:551). Therefore, there is a need for trained guides and interpreters who can set examples by their behaviour and insights.
- Knowledgeable, trained managers, guides and other role-players have an understanding for nature. In addition they may also reduce the negative impacts of tourism on an area as a whole. In the process the environmental awareness of the local community is increased, the tourist is provided with environmental education and conservation principles, and finally employment to the local people is provided because they are the 'informed' people of the area.

## ***Mobile Technologies***

### *What is a mobile device?*

The wireless transmission of data gives rise to many different devices, features and services between device-users. As a result, people attain different meanings to the word 'mobile'. Therefore, just as important as to understand 'ecotourism' it is important to realise the meaning of 'mobile device' as used in this study. However, the purpose of this study is not to conceptualise the construct but to report on the application of mobile/handheld devices in teaching and learning.

Clarke (2003) provides possible interpretations of the term 'mobile' which may be summarised in the sense in which it is used in this research, and possibly for educational purposes, as follows:

- devices that are easily and conveniently portable and can transmit data wirelessly
- devices that can be used in different locations and situations and at different times
- devices that can be in any location from which transmission to another device is possible
- devices that can move with a person (e.g. in vehicles, trains, aircraft, busses, etc.) and still be able to transmit data

This study focuses on the use of PDAs (Personal Digital Assistants) in conjunction with laptop computers.

Powerful new hardware and software, capable of supporting mobile computing, offer new options in education. The PDA, which was primarily used in this study, is a hand-held computer approximately one-eighth the size of a laptop. Some models receive user input from a scaled-down keyboard, while others rely on an electronic stylus and incorporate handwriting recognition. Some are equipped with a camera and most have sound facilities for recording and play-back.

### **The “E” in the ME-Learning experience**

The Partners@Work 2004 programme, an initiative of the Telematic Education department of the Tshwane University of Technology, provided an opportunity for lecturers to develop online (electronic) learning material for learners. As a result of the abovementioned identified needs and requirements for well-trained ecotourism practitioners, it was decided to develop the first level of Biology for the course BTech: Ecotourism Management. Biology IA provides the necessary background to ecological principles and covers the invertebrates of the animal kingdom.

The main objective for the online development of Biology IA was to determine how technology can support and enhance the learning and teaching experience in ecotourism training.

The following traditionally encountered problems in Biology IA were addressed:

- Limited exposure of learners to real-life situations in Biology
- Unknown terminology such as scientific names of organisms
- Similar facts for different organisms and phenomena
- Learners who did not have Biology as a school subject
- Limited time in which to complete the required syllabus
- English as a second language for 95% of the learners and of the lecturer

Biology IA was developed on WebCT (Learning Management System) as a tool for learning and teaching in addition to the prescribed textbook and formal lecturing. No content was duplicated from the textbook to the electronic material. The purpose was to integrate different tools to enhance the teaching and learning process.

With the implementation of WebCT-based Biology IA in January 2005, the value of WebCT tools, e-testing, animations, graphics and interactive exercises was noticeable even after the first exposure of learners to WebCT. Learners were inspired and enthusiastic during lectures to gather information and participate in group discussions. They were eager to stay in the class after completion of the lecture to search for the required information, complete quizzes and review the



PowerPoint slides and interactive sites provided on WebCT. Pre- and post-knowledge tests, as well as mastery learning quizzes, encouraged the learners to prepare and revise the relevant sections of the syllabus.

During the implementation phase, a further need was identified for electronic aid in the teaching and learning process, namely the use of technology during compulsory field trips. Ecotourism learners need to attend these field trips for 5 to 12 days every semester in order to gain practical experience and apply the theory of the indoor class. Conditions in the field are often not suitable for note-taking or the use of books as they visit places such as caves, rocky shores, mountains and hiking routes where a certain amount of physical and mental activities and awareness is required. Learners often complain that they “missed what was said”. The use of mobile technology, which includes laptop computers and PDAs, was tested to address these problems.

### **The “M” in M-E-Learning in Ecotourism**

As the use of PCs, Learning Management Systems such as WebCT, video-conferencing, multimedia and video-recording has reshaped the traditional classroom, both the learners and lecturers have become more comfortable with accessing and utilising electronic technologies. In addition to the mentioned technologies, textbooks, the library, and conventional lectures are still used as principal educational sources. Compulsory outdoor training excursions form part of the curriculum of many of the courses offered at TUT, e.g. Ecotourism Management. Learners need to participate and understand these hands-on aspects

in order to understand and apply the theoretical subject matter. Learners of any nature related course are usually attracted to the discipline because of the opportunities it offers to leave the lecture room to explore, experience and learn in the natural environment.

No technological replica can replace field learning. However, technology can be taken into the field to support and enhance the learning experience. This paper reports on a pilot study in which the synergy of technology and field studies of ecotourism learners is facilitated.

The application of PDAs in field learning was an exploratory study initiated by investigating the rationale for training excursions (field trips) as part of the curriculum for learners in the Department of Nature Conservation, with special reference to those in the Ecotourism Management course. During these field trips learners are transported to various destinations in South Africa. The objective is for the learner to get hands-on experience and learning opportunities “in the field”. The usual programme involves the following:

Prior to departure each learner receives a workbook (project book) with a list of questions and assignments to be completed during the field trip. This completed workbook should be submitted before the end of the last day of the trip. This implies that learners have to obtain information from textbooks, brochures and other resources and write this summarised information in the workbooks. They also need to do this while being transported to the destination, walking or listening to lecturers and guides in the field - a difficult and inconvenient way of taking

notes. Learners also have to carry textbooks, field guides, paper and stationary for note taking, a clipboard, binoculars, etc. with them while studying the outdoors. These and other external barriers inhibit the concentration, enjoyment and ultimately the learning experience of the learners. The quality of submitted work is, understandably, also not good and is subject to the conditions under which the learners have to complete the workbook. These workbooks are evaluated and a mark is allocated which contributes to the predicate (a semester mark allowing the student to write a final exam).

The research problem for this study is located in questions raised in terms of the experiences and learning that take place during these field trips, e.g. What do the learners do?, What do they learn?, How do they learn? and Are the conventional tests, projects or workbook sufficient to evaluate the learners?

### **Research Question**

Based on the research problem and existing literature the following question was formulated: How can the use of mobile technology support and enhance field learning for ecotourism learners?

Sub-questions resulting from the research question are:

- How can specific field experiences be enhanced by the use of mobile technology?
- How does mobile technology motivate learners to improve learning?

- In which ways are cognitive and psychomotor skills of learners stimulated in this environment?
- In what ways will learners benefit from the tools available?
- What features should the mobile computing systems provide?
- How do learners at various levels of experience use the provided technology?
- Are traditional evaluation methods appropriate for mobile learning?

### **Research Methodology**

Both qualitative and quantitative methods were used in this study. Qualitative measuring instruments include interviews, observations, video-recordings, photographs and open-ended questionnaires and surveys, while instruments for quantitative measuring involve questionnaires and tests.

#### *The participants*

Two groups of learners used PDAs during field trips in the first and second week of April 2005:

- The first group consisted of 40 first year Biology learners in Ecotourism Management. This group was comfortable with the use of technology as they have been using WebCT and online learning in Biology since the beginning of the academic year. These learners were subjected to a training session in the use of PDAs prior to the field trip. They had some time to practice using the stylus and keyboard, had to answer questions and take notes on the PDA and had to use

various programmes (MSWord, Excel, My Pictures) in creating sample documents. On the day of departure learners were supplied with PDAs. All the learners participated in using the PDA. No paper copies of documents were handed out to this group.

- The second group consisted of 32 second year Ecotourism Management learners. They had not formally used WebCT and none of their subjects had been fully developed for WebCT. They received no prior training in the use of PDAs and did not have the opportunity to practice with the PDAs prior to their field trip. They were supplied with PDAs on the day of departure on a voluntary basis. The conventional paper copy of the workbook was also handed out to this group. A brief training session of the basic functions and use of the PDA and the accompanying programmes was provided. These learners had the opportunity to “play” with and discover the PDA *en route* to the first destination. Although reluctant at first, all the learners volunteered for a PDA, with the exception of 3 individuals. All participants in this group had the option of working on the PDA, but in addition also had to complete the workbook for evaluation by a co-lecturer.

#### *Information provided on the PDA*

Prior to the field trip the following information was created on a laptop computer and transferred to each PDA:

- A route map
- Information on features, sites, destinations, workbook questions, etc.

- Illustrations and photographs of aspects to be covered during the excursion (Figure 1)
- Discussion questions
- Surveys
- The Workbook questions

In addition, the multimedia programme, Robert's Birds of Southern Africa, was provided for use on the PDA.



Figure 1: Example of a photograph of natural features on the PDA that learners had to interpret during a field trip.

## Data Capturing

Learners used the PDAs in the following ways:

Pocket Word:

- Note-taking during lectures, discussions and informal conversations
- Reference for information finding
- Answering questions/evaluation
- Surveys

Pocket Excel:

- Data capturing during field observations
- Species lists

Multi-media:

- Bird identification and personal bird lists with Roberts Multimedia
- Games

PowerPoint Presentations:

- Graphics and text for information display

Learners also took photographs of interesting observations with their camera equipped cell phones or digital cameras during field work. These photographs were transferred to a laptop and viewed by the whole group as PowerPoint slide shows during discussion sessions. The photographs could also be transferred to all PDAs if required.

Some learners used both PDA and paper to take notes. Textbooks were always part of data collection.

### *Daily procedure*

After a day's activities each learner's data was transferred from the PDA to a laptop via infrared. Each learner had a folder with his/her learner number with separate files for each day. This data transfer process was necessary to ensure that the data collected for each day by each learner was saved and the PDA could be recharged for the next day.

### *PDA and WebCT*

Back on campus each learner's data was e-mailed to him/her in WebCT. The learners had the option to add information to the data collected during the field trip, to organise or to improve the overall presentation and to resubmit the completed assignment on WebCT in the assignment tool. Almost 40% learners used this opportunity and resubmitted the data in a PowerPoint slideshow format with additional data. The extra effort was credited. Examples of these presentations were presented to the class during a lecture. The impact of these efforts of fellow learners was extensive enough to encourage other learners to ask for permission to resubmit their improved field data as well. Permission was granted as this was regarded as an additional opportunity for the learners to learn according to outcomes-based education principles and to experience the new approach.



### *Submissions for evaluation*

- Learners of the first year group who did all their note-taking, tasks and questions on the PDA did not have to submit any written material at the end of the field trip. Those who used both PDA and paper, submitted the written material in addition to that what they had done on the PDA.
- Learners of the second year group submitted the conventional workbook and the data they captured on the PDA.

### **Results and Discussion**

Much has been written about the value of teaching and learning in natural and biological sciences in ways that are authentic and engaging to learners as they inquire and collaborate with others. According to Soloway (1996) today's learners are not mastering concepts or applying their classroom knowledge. He is of the opinion that a disconnection exists between what goes on in the lecture room and what goes on outside. Soloway (1996:270) proposes helping learners to make sense of their studies by providing tools that "can extend and amplify learners' cognitive processes". The implementation of mobile technology such as PDAs as done in this study, may be one of these tools implicated by Soloway.

In the first instance some valuable capabilities and features was identified to be available for educational purposes on the PDA. These include:

- Windows operating system which makes it compatible with other devices

- Internet
- Pocket Word
- Pocket Excel
- PDF Viewer
- Presentations (PowerPoint Viewer)
- Real-time player (Video recordings)
- Audio recordings and player
- Graphics display (if camera is available)
- Multimedia

The challenge was to explore these features of a PDA to enhance and support teaching and learning of learners on field trips.

Some limitations of the PDA experienced during the study include the following:

- Limited battery life: Although the battery lasted for at least a complete day's work in the field, it had to be charged every night to prevent data loss. The availability of separate SD cards on which data can be saved, will prevent this. (No separate SD cards were available during this study.)
- Stylus vs keyboard created some initial psychomotor difficulties: Some learners mentioned that they could not 'type' as fast as they need to with the stylus.
- Screen may be too small for reading, especially some PowerPoint slides with much detail.

- Limited memory on main device: Separate documents had to be created in cases of high volumes of data.

The interest and captivated attention of learners in both groups were clearly noticeable from the first exposure to the PDA. During previous field trips learners used to sleep, eat, have loud irrelevant conversations, etc. while being transported to the destinations. They always find it “impossible” to write and take notes while on the move in a bus or mini-bus. Therefore, much of what is being said by the lecturer is lost during these trips. Learners usually also tend to lose interest in the environment and quickly fall asleep in the bus.

This pilot study indicated that learners used the PDAs almost constantly on the way to the destinations. They took notes of what was said and interpreted by the lecturer, asked for statements to be repeated if they had missed something, used the existing information on the PDA to get answers to workbook or discussion questions and participated in meaningful discussions with each other on topics provided on the PDA. They concentrated on what was going on in the environment as illustrations and questions on the PDA drew the attention to noticeable features along the route.

When engaged in practical fieldwork, learners did not have to carry along all the textbooks, field guides, notepaper, clipboards, etc. Expensive books could be left at the camp. Everything needed was on the PDA. Attention was with what was going on around them and not with the heavy pack on their backs. Back at the camp textbooks, field guides and collected samples were used to add to or verify

information gathered throughout the day. Data was consolidated and compared and learners consulted each other for additional information or verification. Solomon (1991, in Rieger & Gay, 1997) suggests helping learners solve ambiguous and complex problems by giving access to data, and by offering opportunities “to collaborate, investigate and create”. Suggestions from these and other researchers (Brown et al., 1989; Newman et al., 1989; Resnick, 1987) are that biological science teaching should engage learners in real life problems and promote collaboration. During this study it was clear that learners collaborated in gathering more data on or by means of the PDA than paper-based, solving problems by comparing data and maintaining attention to various aspects of field learning by comparing information on the PDA with that found in nature (real life).

Educational researchers (Resnick, 1987; Soloway, 1996) argue that learners learn best when given the opportunity to learn skills and theories in the context in which they are used, then construct their interpretations of a subject and communicate those understandings to others. Mobile computer-mediated learning environments may support this process. This is of great significance in ecotourism training, as it is essential for learners to be able to find, organise, understand and interpret information, and communicate those understandings in an interesting and understandable manner to ecotourists or other role-players in the industry.

Mobile technology also supports “just-in-time” learning. This is an adoption by educators of a successful industry technique that involves delivery of parts and finished products at precisely the time in which they are needed (Schorr, 1995). Transferred to education, learners may receive context-related information or

complete a skill-building task, at the most appropriate teachable moment. In this study learners had the opportunity to consult applicable information when it was needed. For example, when walking in the bush and hearing the call of a bird, access to information to identify the bird by the sound it makes was immediately available. During these teachable moments (listening to the bird call in the natural environment), “just-in-time” learning is an essential part of the field experience of learners in biology. In few, if any, other circumstances can they learn and understand the interactions in nature at these specific times. The PDA is an excellent instrument in this learning environment.

While there is a wealth of literature describing technology’s potential for supporting education, little has been written from an education or communication perspective specifically about the value of mobile computing. Many projects concentrate on technical rather than learning concerns (Concord Consortium, 1997; Foster, 1995; Schnase et al., 1995).

The data gathered from this pilot study indicates a variety of possibilities in the use of mobile technology to support and enhance the field learning experience of the learner, as well as the teaching experience of the lecturer.

To answer the main research question, ‘How can the use of mobile technology enhance field learning for ecotourism learners?’, answers need to be found for the sub-questions:

1. How can specific field experiences be enhanced by the use of mobile technology?

- Information should be organised in ‘consumable’ quantities and time units ensuring that learners do not perceive an information overload on day one.
- Brief lecture notes or keywords should be available on the PDA during field work, ensuring that learners do not “miss out on what is said”.
- By using a PDA in field work, a calculator, dictionary, note-book, keyword reference and graphical representations are always available on one single hand-held unit and reference books need not to be carried along during all field projects.
- Sound and picture identification of a variety of natural features are available “just-in-time” in one unit.
- The PDA has the ability to store a significant amount of information.
- Stored information can be revised prior to submission for evaluation, adding to the field learning by doing additional research and organising information.
- Some PDAs and mobile phones are equipped with a digital camera which had been used to take photographs of features or sightings to be clarified, discussed or identified at a later stage.
- Reference material was always available (“just in time”).
- By synchronising PDAs and desktop systems, data was revisited, revised and improved where needed.

These aspects may contribute to the pedagogical experiences of the learner in the field and enhance the learning experience with technology at hand.

Apart from the abovementioned utilities, PDAs could be useful with enabling technology in aid of learners with disabilities such as those with an experiential backlog, or physical and cognitive disabilities. In addition to the functions listed above, specific uses that can aid those with disabilities include:

- As a dictation machine (on machines with sound facilities)
- As a text reader (on machines with sound facilities).

## 2. How does mobile technology motivate learners to improve learning?

Learning addresses the cognitive, affective and psychomotor skills of the learner. According to Malone & Lepper (1987) motivation, as an affective skill, is the central point of departure of all learning. Intrinsic motivation makes learning fun and results in a challenge, has a fantasy factor and leads to curiosity of the learner. This puts the learner in control of his or her own learning, creates satisfaction, improves the self-image and contributes to cognitive involvement. Some of the learners' experiences with reference to the motivational skills are summarised as follows:

Fun: "It was *fun* to work with these things", "It was more *fun* typing than writing", "I figured it would be *fun* and *interesting* to learn something new..."

Curiosity: "I was very *curious* about how the Roberts Birds program worked...", "I was *curious* to see if this method works better for me than pen and paper notes..."

Challenge: “...something new and *challenging* in life”

Interesting: “I was *interested* in improving my knowledge is a more modern and convenient way...”, “...increasing my *interest* and making me work more”

Satisfaction: “...technology is so advanced and things are now becoming so easy for us...”, “you can do a lot on a small computer in the palm of your hand”, “I enjoyed everything and I am willing to learn more”

Results from the open-ended questionnaires, interviews, video-recording and observations indicate that the majority of learners have a positive experience when using the PDA as a motivational factor. The learners accepted the challenge of the alternative technology and adapted to the new learning strategy. A follow-up field trip will indicate the sustainability of this experience.

3. In which ways are cognitive and psychomotor skills of learners stimulated in this environment?

#### *Cognitive skills*

Traditionally the learners received a workbook with questions that they had to complete and hand in on completion of the field trip. The opportunity for learners in this environment is to receive their tasks in an electronic format. They take notes and gather information and compile their own constructed knowledge. In the end this information is send to the learner via WebCT (LMS) in an electronic format with the opportunity to add and expand before submission. The learners get more



cognitively involved and have the opportunity to add photographs, additional information and even go beyond the usual and present their final assignments in PowerPoint.

Comments such as the following are evidence of learners' psychomotor experiences:

#### *Psychomotor skills*

- “It is so small one can use it like a computer”
- “I find it equally easy, it will take me a while to get used to the PDA but I am sure I'll get the hang of it pretty soon”
- “You can use the stylus on the screen like an ordinary pencil, much easier than typing”
- “I find using the keyboard much easier than the PDA. ...I first have to practice before I can type now...”
- “The keyboard is much faster than the pen”

#### 4. In what ways will learners benefit from the tools available?

The PDA includes the use of the tools such as the Internet, Pocket Word, Pocket Excel, Clear View Presentation, Clear View PDF, My Pictures, Media Player, sound recordings and other available software such as multimedia or programme specific software. An important factor is the portability of the device. Guidelines in the application of these in teaching and learning in field trips were non-existing. This pilot study was conducted to determine how the tools of the PDA could be utilised.

The following application could be identified during this first introductory field trip.

Information display (MS Word, MS Excel, ClearView Presentation): Pocket Word, PowerPoint Presentations and My Pictures were used most often while Excel was used to a lesser extent for information display. Comments from learners include:

- “It makes it much easier to use in the bush, because one does not need to carry hundreds of books and paper along.”
- “You can move around with your information in your pocket”
- “The PDA can be used as a visual tool in the identification of all fauna and flora.
- “The learner can carry all the relevant identification literature in his/her pocket and the facilitator would be able to fast track through the part that would normally take the longest.”

Information gathering / Note-taking (Pocket Word and Pocket Excel): Students typed in short notes during outdoor lectures, guest lectures and informal discussions for use at a later, more convenient time. Students’ use of the device for this purpose was mentioned as follows:

- “I mainly used it out in the field to take notes”
- “...to enter new information that we learned during the excursion and to do a road strip count [game survey]”
- “To make notes when being lectured ...”
- “To make a tree list, species list, bird list ...”

Multimedia: The Roberts Birds<sup>1</sup> multimedia programme was emphasised in almost all the feedbacks as a huge advantage and assisting in (1) creating an interest in bird watching - a growing industry in ecotourism, and (2) identifying birds. The bird calls were highlighted as extremely helpful in identifying birds. Learners expressed the need for similar programmes, e.g. mammals, trees and wildlife features in general. The following excerpt from a student's feedback summarises a general feeling: "I used the PDA mostly to identify the birds, as I was lagging behind as far as birds are concerned. Now I can easily identify and know my birds".

Games: Learners played games mainly during quiet times or when travelling to and from a destination. Reasons given for their motivation to play games include "...to get used to the typing, etc."

Portability: The light-weight and easy-to-handle size of the PDA were regarded as positive features to replace books during walks and visits to 'remote' areas.

Comments from students in this regard include:

- "I like the fact that it is small and compact, no writing is involved ..."
- "It will help a lot especially in places where there are no computers at all!"

Although the lecturer, technologist and the learners were unaware of the full potential of the PDA, it quickly became clear that information display and information gathering (note-taking) as well as multi-media applications are some of the major advantages for teaching and learning. Learners even played games to improve cognitive and psychomotor skills.

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<sup>1</sup> Roberts Birds Multimedia is available on SD Card

5. What features should the mobile computing systems provide?

Introducing an unknown technological device in teaching and learning is not always easy. From the experiences and comments the following could be included as essential software features for mobile computing systems: Windows Operating system, MS Word, MS Excel, Clear View Presentation, Clear View PDF and Pictures. Although it has not been tested during this particular field trip, a follow-up may include Internet connectivity, e-mail, Media Player and Sound recordings.

Comments from students on features that they found to be less positive include:

- Multi-tasking: “I don’t like the fact that you can’t close a window / return to the previous worksheet”
- Battery: “The fact that it switches off due to a low battery all your work will disappear”
- Fixed stylus or keyboard: “Typing is a hassle, it would be better with a small keyboard.”

However, if all the features are considered, the PDA is a valuable tool to use in teaching and learning and can replace expensive computer centres in the future.

6. How did learners at various levels of experience use the provided technology?

Both participant groups coped equally well with all the features of the PDA. Although the second group (with no prior training) appeared to be less comfortable with the device initially, they soon managed the stylus and produced the same results as group one. Some individuals in group two showed even higher cognitive skills with the PDA by creating interesting files on animal tracking and counts on own initiative.

The following comments, transferred from a survey on the PDAs, are representative of 95% of both learner groups:

- When we were given the PDAs on our 1st day, I was really sceptical and I thought... do we really need this in the bush? (After a while) it struck me that technology and wildlife could mix. I held it and it was “love at first handle”... This PDA... makes life easier. I enjoy the Roberts program most, it has so much to offer.
- I find the PDA extremely powerful and useful. When it comes to birding, it is in a class of its own. I use my bird book in conjunction with the PDA. The PDA will be extremely useful in helping to identify LBJ's, because one can listen to the calls.
- I think the PDA is a stunning idea, especially for us studying ecotourism. Now I'm able to take notes where I usually am not able to. The fact that you can load things like Roberts bird program, as well as all the other information one can load on is stunning! I don't need to carry 10 different books as well!

When asked whether the PDA caused learners to lose interest in the environment (a vital aspect for ecotourism learners), the answer was “No, the PDA was a tool and not the experience.”

#### 7. Are traditional evaluation methods appropriate for mobile learning?

Evaluation methods need to be adapted as learners' approach to addressing problems, answering questions and debating issues online differs from the traditional pen-and-paper based methods. Answers tend to be more concise and to the point in comparison with the long irrelevant written answers. Instead of only evaluating the reading matter submitted by the learner at the end of the field trip, the day-to-day input and understanding can be monitored and addressed when problems arise. Most of the critical crossfield outcomes of outcomes based education are also incorporated in the use of mobile technology. Evaluation methods should be adapted to incorporate these outcomes, e.g. groupwork, collaboration, problem solving

#### **Further research**

All the abovementioned results should be followed up during the next field trip. Although most of the objectives of this research have been achieved in this pilot study, further research questions already originated, such as:

- What is the influence of mobile technology on the nature experience of people?
- How can mobile technology be applied in a career in ecotourism?

These and other possible questions will be investigated in a second field trip with the same groups within five months.

## **Conclusion**

Mobile technology, in conjunction with other e-learning tools, can efficiently be used to enhance and support the field training of ecotourism guides, interpreters, managers and developers. By providing real-life problems and situations by means of mobile devices, training can be improved to ensure ecotourism role-players who can set examples by their own behaviour because they have the needed knowledge of nature.

Education and interpretation are important elements of the ecotourism experience. Using mobile technology in the teaching and learning process will not only enhance the reconnecting experience of the learner, but should also help to ensure better management for conservation purposes and development objectives due to exposure to real-life situations during field training.

The market is moving towards the convergence of enterprise applications and wireless devices that will open the doors to mobile learning. Cell phones, hand-held computers and PDAs now have the capabilities, connectivity and features to support learning activities. Technology enablement is critical for keeping workers engaged.

Mobile learning gives the front-line workforce - such as a retail sales associate,

soldier or cable repairman - the access to the critical information sources, learning materials and expertise to learn what they want, where they want, when they want.

The following concluding response typed on a PDA was received from a learner who sat quiet for almost half an hour, experiencing a sunset in the bushveld:

Its times like these that the beauty of a sunset leaves you with such amazement, it makes you forget to breathe... and truly leaves you breathless. One now realizes that there is so much more to life than that what humanity experience in general. No time will ever be wasted spent in nature. It opens up your mind and gives you a mental message, because it leaves you so relaxed... so connected...

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# Interactive Logbook: a Mobile Portfolio and Personal Development Planning Tool

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## 1 Abstract

Interactive Logbook is an integrated Personal Learning Environment (PLE) for use in both formal and informal settings. The metaphor of a multimedia logbook describes its functionality and simplicity.

The PLE brings together all the tools and networked resources required by the learner. Running on the learner's PC it helps the user to plan, manage, track and review their learning activity. The Logbook is essentially a shell application with plug in support for any local or networked tool. Example plug-ins include: word processor; email client; virtual learning environment (VLE); internet messaging; weblog aggregator.

The system keeps a record of the user's activities, which the student can then review as a personal learning diary, or revise and present as a portfolio of achievement, where evidence of learning can be mapped to a Personal Development Plan (PDP).

For the mobile learner, three features are key: offline access to online resources when out of network range; Tablet PC enhancements for note-taking; a mobile phone client for when access to a PC is impossible or inappropriate.

The phone client is a 'helper' application, allowing the user to continue making log entries wherever they are, whilst accessing a subset of the networked resources such as email, calendar and news feeds.

This paper describes the technical, human and institutional challenges encountered in trying to develop an open source consolidated learning environment in the emerging ePortfolio and ePDP field. It also discusses findings from user trials and future challenges including how to mine and present the data contained in the log.

## 2 Keywords:

Mobile; Personal Learning Environment; PDP; Portfolio

## 3 Introduction

As the range of digital resources and communications methods for learning increase, students are finding it harder to manage this information. What is required is a form of personal learning organiser or Personal Learning Environment. (Corlett et al. 2005) A PLE offers pedagogical as well as administrative benefits to the learner, as described below.

We propose the architecture for a PLE system with particular emphasis on its benefits for creating portfolios of learning and planning one's personal development. To fulfil the

requirements for such a system, we believe a combination of personal and mobile technologies are required as set out in this paper.

Last year we presented the Interactive Logbook as a student design project in which a team of undergraduate Engineering students developed a personal learning environment (PLE) for students, to support rich collaborative interactions through a Tablet PC interface. (Kiddie et al, 2004).

Since then, the Interactive Logbook has been redeveloped as an open source project and has taken on a new focus. The Joint Information Systems Committee in the UK has funded development work on the Interactive Logbook under the Distributed eLearning Tools programme (JISC, 2005) with the aim of making it available free of charge to all Higher Education (HE) institutions in the UK. The priorities for this round of development have included creating a robust and scaleable architecture, supporting learners across multiple institutions and over time, and providing for ePortfolio and ePDP activities.

The software developed to date has been evaluated for usability and technical quality. The outcomes of the testing are described and discussed in this paper, together with future plans for in-depth pedagogical evaluation.

## **4 Personal Learning Environments, ePortfolios and ePDPs**

### **4.1 Personal learning environments**

For all the benefits of a well-run institutional Virtual or Managed Learning Environments (VLE and MLE), there are a number of significant shortcomings with respect to their value to the individual. First, they are not intrinsically *learner-centred*. Courses are largely created and structured around the curriculum and administrative organisation of the institution, which leaves little freedom for involvement in the design by the learner. A PLE is structured by the learner, for the learner.

Second, *individualisation* is weak. Although the learner will see their own selection of courses and may be able to make some graphical modifications (mostly in the interest of accessibility), there is little scope to choose a personal suite of tools or resources according to individual learning styles and work habits. A PLE contains the tools of the learner's choice and resources as chosen and managed by the learner.

Third, VLEs and MLEs offer *collaboration* tools (discussion, chat, whiteboard) but these are only available to members of the course and often only for the purpose of the course. Our previous research (Corlett and Sharples, 2004) has shown that students are much more flexible and informal in their approach to collaboration, with many work-based discussions taking place in social spaces and vice versa. They also want to determine who they communicate with and how, and may not want all their exchanges to be visible to a course tutor. A PLE should ensure that a variety of communication tools are available to the learner, and that he or she can choose with whom they communicate, and who is privy to this. A wider variety of collaboration means should also be available, including electronic support for face to face sessions as well as entirely online ones.

Fourth, technology needs to be *situated* (Jonassen and Land eds, 2000). In order to practice real-world situations, learners need to be in real-world situations. This means that the learning environment also needs to be present and appropriate to the situation. In many cases, a live connection to the internet is not possible (in various laboratories, work places, social environments etc.), and without an offline client to the VLE, there can be no electronic interaction. Even though most mobile phones can provide data services, these are still prohibitively expensive. Wireless networks (WLAN) are still not widely available or economic. Again, a PLE should overcome this problem.

Fifth, learning happens everywhere and at all times. A VLE or MLE cannot be *ubiquitous*. A single thought or conversation can be a learning experience and it is important that ad-hoc, informal experiences as well as planned or formal ones are supported and recorded. Even where a connection to the Internet is possible, the design of most institutional systems prohibits quick, simple interactions. First, generally a full-size browser client (PC or similar) is required, with internet connection. Then the user must log in and select a specific course, then take part in some structured activity. This also presumes that there is a relevant part of the VLE for the experience that is taking place. A PLE must provide appropriate services, information and connectivity at all times and in all places.

Finally, a PLE must support *Lifelong Learning*. This requires support over time, amongst institutions, and through a variety of technologies (Gemmell *et al.* 2004). Learning habits are changing. It is not unusual for learners to be studying at more than one institution at a time, often whilst also engaged in work. A PLE should provide access to all relevant electronic resources, at all times and without logging on to multiple web sites, email accounts etc. These resources should also be available when the learning episode is formally finished, for reflection and revision purposes.

VLEs and MLEs are still a very important part of the learning experience within institutions, but should be seen as only appropriate to certain times, places, interactions and learning experiences. From the learner's perspective they are not the complete solution and require a form of portal, a 'glue' to coordinate and manage the rich mix of electronic resources relevant to learning. See (Divitini *et al.* 2005) on systems to support multiple social structures and multiple interactions for learning.

## 4.2 ePortfolios and ePDPs

In the UK there is a strategic drive to introduce Progress Files in the HE sector. The purpose of these is manifold, including "to contribute to an individual's lifelong record of learning and achievement" and "to support the process of personal development planning" (QAA, 2000). It was recognised going into the current round of development that these are areas in which the Interactive Logbook can make a significant contribution.

To address this agenda, Universities are increasingly turning to electronic solutions that will help the students to keep portfolios which can be monitored by the institution. The JISC is funding a number of such developments and more are being developed commercially. Valuable though these are, their approach generally introduces barriers to the learner gaining from their full potential.

Not least of these barriers is ownership. To be of value as a reflective and planning tool the learner needs to be able to record his or her complete learning journey. Something owned by an institution, that is only available for a period of time and which requires a web-based log-on will fail to capture learning taking place elsewhere, at other times and of an informal nature. Even that which is related to the course will be filtered by the learner to present a favourable view.

The Interactive Logbook seeks to provide a place in which personal information can be stored completely, privately and for all time. By being integrated with the environment in which much of the learner's activity takes place, physical time and effort barriers can also be reduced, made even lower by automated logging of basic documents and events (emails, documents, diary entries,...).

Institutional portfolio systems are valuable in helping the learner to reflect in partnership with their tutor or learning mentor and as an official record of learning at the institution. To this end, it is important that a personal portfolio tool is capable of import/export of a selection from the full portfolio.

## 5 Scope and Design of Interactive Logbook

## **5.1 The metaphor**

The metaphor of the Interactive Logbook was conceived from the very traditional personal learning environment – a logbook, kept by students to record lectures, laboratories, project notes and more besides. Although in many subjects, especially in the science disciplines, logbooks are still an integral part of courses, they are not well used by students. Since many learning activities are taking place digitally: writing essays, analysing data, browsing the web, online discussions - it doesn't make sense to print or copy out the output for a paper-based logbook. Although the IL extends to network capability and digital search, the name 'logbook' gives an impression of the flexibility and purpose of the tool, and was behind the initial choice of delivery platform: the Tablet PC.

## **5.2 Chosen hardware and platforms**

Two platforms were chosen for the Interactive Logbook's implementation. First is the PC. Written in .NET, the application runs on recent versions of Microsoft Windows ®. In particular, enhancements are included for the Tablet PC edition. Although market share of this platform is still relatively low, it is increasing and offers interaction closest to that of a 'real' logbook. Desktop and laptop devices are also supported and account for the largest part of ownership amongst learners.

To offer nearer ubiquity of access, it was decided to also create a mobile phone implementation. As of 2003, 90% of young adults owned a mobile phone and 75% in the general adult population (National Statistics, 2003). Although the scope of applications for a mobile phone client is much smaller, it is well suited to short data, such as instant messaging, text messaging, calendar, email, news and other sources already frequently used in the learning process. A mobile phone also makes an excellent device with which to make short log entries, it being present on more occasions when the learner is engaged in learning. To ensure widest possible uptake, including PDAs, a mobile Java (J2ME) platform was chosen.

## **5.3 Avoiding duplication**

Although many of the emerging specifications for the logbook include applications already widely in use (word processor, spreadsheet, email client,...) , it is not the intention of the Interactive Logbook to replicate functionality where it can be provided by an existing best-of-breed tool, or at least one that the user has already chosen to invest in. Instead, the IL uses a plug-in architecture that allows applications already available to the user to 'plug-in' to the interface, bringing their full functionality into the integrated environment.

## **5.4 Networked services**

One aim of the Interactive Logbook is to present the user with their networked resources (email, VLE, discussion forums, web pages, web logs, news,...) in one place, and to offer offline synchronisation. For email, the standard protocols of POP and SMTP are utilised. Web-based content at its most simple can be represented by a cache of web pages on the users device. However, standards and transport mechanisms such as RSS and SOAP allow for a richer set of interactions, including aggregation and filtering of information. Although systems that support SOAP are still few, an increasing number of commercial VLEs and other institutional systems are embracing this new technology.

## **5.5 Logging and goal-setting**

The learning log and goal planner are at the heart of the IL and is the most novel element of the application. A goal-setting tool exists to help the learner structure and plan their learning aims. A hierarchical layout allows the learner to break down their learning goals to a level of granularity that best serves their purpose. For those who are unfamiliar with detailed progress planning, institutions may offer a provisional plan of assessments, milestones,

competencies or other targets relating to a course. The user can integrate this into their personal targets and modify as appropriate.

Log entries can be made by the user at any time. Each of the plug-in tools provides a 'Log This' button. A log entry can be filled with as much detail as desired by the user. Data fields include 'title', 'date / time', 'keywords', 'comments' 'links' (to URLs or local files) and 'comments'. Some of these fields are pre-filled based on the current file or activity. The user can also choose for other triggers to create log entries, for example the arrival of an email, each new web page visited, or on saving a new document. Log entries may also be made to record ideas independent of a particular activity or document.

Additionally, each log entry can be linked to one or more targets. This helps the learner to organise their portfolio whilst also keeping track of progress against their pre-determined goals.

Since no existing tools are available to meet these requirements, a special plug-in has been developed to search, filter, view and manage log and target entries. Should a better application become available in the future, the architecture would allow the existing tool to be 'plugged-out' and a new one plugged-in in its place.

Because of the potential size and complexity of a portfolio, it was decided to only implement the full management tool on the PC. The mobile phone client allows for the creation of log entries only.

## 6 System Architecture and Specification

### 6.1 PC application

The PC application plays host to the following plug-ins at present, at the selection of the user:

- Generic web browser
- Generic diary/organiser
- Generic (ink) notepad
- Generic POP 3 email client
- GMail RSS email client
- Generic file manager
- Bespoke log/target manager
- SharePoint Portal client
- MSN Messenger\*
- Microsoft Word\*
- Microsoft Excel\*
- Microsoft Outlook\*
- Microsoft PowerPoint\*
- Star Office\*

\* subject to existing licensed installation on user's computer

Selected elements of the log and target may be exported in a variety of human and machine-readable formats. A HTML export can be used to view plans and achievements, or as the starting point for a CV when opened in a word processor. A basic XML export allows the user to take their complete log with them to another IL-enabled machine. An IMS LIP (IMS, 2001) formatted XML document should ensure that data can be imported into a variety of VLEs and ePortfolio/ePDP systems.





Figure 1 : Interactive Logbook with application selection tabs, web browser and file browser visible

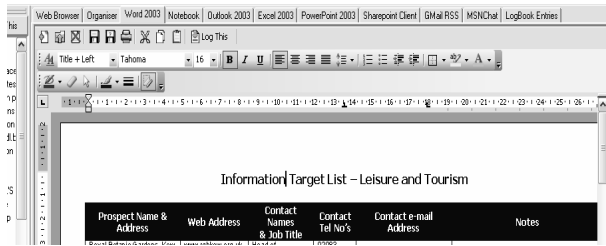


Figure 2 : Interactive Logbook with Microsoft Word® plug-in

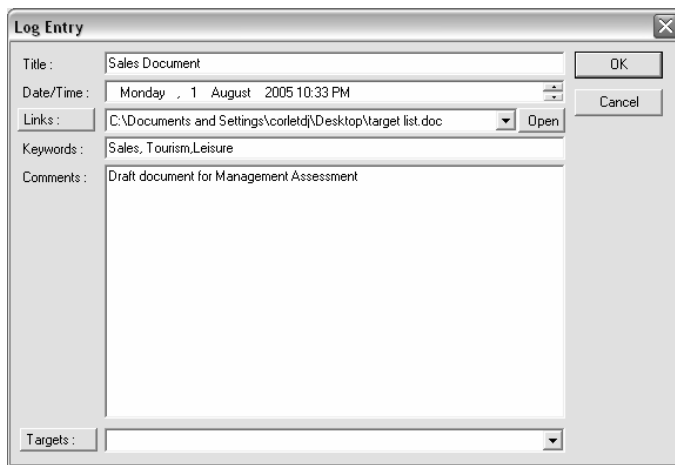


Figure 3 : Interactive Logbook log entry dialogue

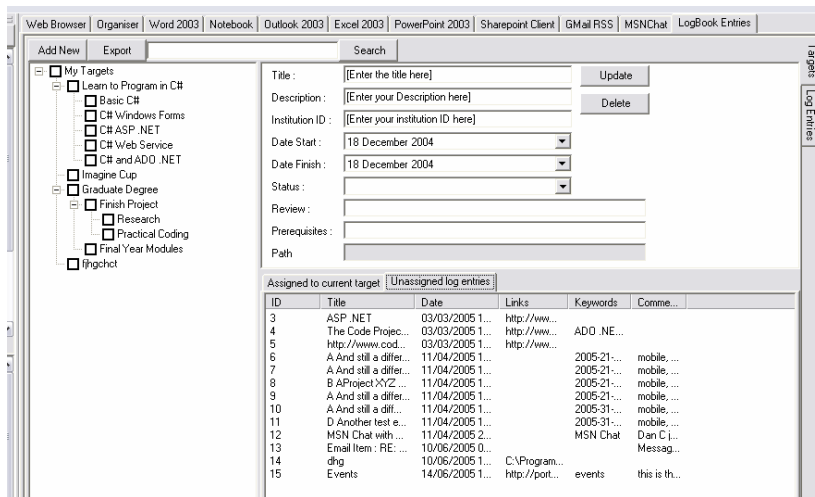


Figure 4 : Interactive Logbook Log and Target management tool

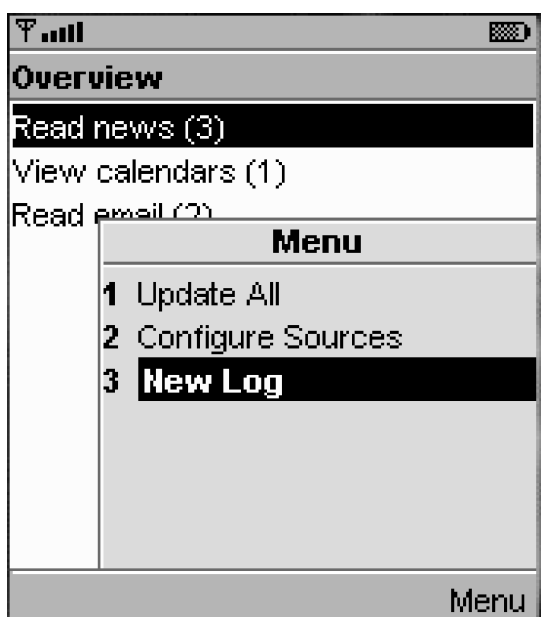
## 6.2 Mobile phone application

The mobile phone application allows the user to configure a range of tools as shipped with the IL or as provided by an institution. The standard installation includes POP/SMTP email client, RSS news reader, generic calendar application. Log entries can be created from

within each of these applications or as a simple memo to self. The Logbook can be synchronised as determined by the user so as to give full control of the data exchange (and hence cost) to the user. On synchronisation, new log entries are sent as an email attachment to any predetermined email account. If the PC IL is configured to collect from this email account, it will recognise the attachment on receipt and open them in the log/target manager on next use.



Figure 5 : Interactive Logbook mobile phone client



*Figure 6 : Interactive Logbook mobile phone client screen shot*

## **7 Evaluation**

### **7.1 Usability**

As the IL has been developed using the Socio-cognitive Engineering methodology (Sharples et al., 2002), an iterative process of user-informed design and usability testing was conducted. Five versions of the software were publicly released during the seven month development phase. Users were involved in structured focus groups and heuristic evaluation before and after each release. Twenty students from a mixture of science and humanities disciplines, who were either notebook or Tablet PC users, trialled the software over a ten weeks and reported bugs and observations on an ad-hoc basis. Usability specialists from within the team also conducted expert reviews. An external reviewer was appointed by JISC, who thoroughly tested the penultimate release.

### **7.2 Technical**

Technical conformance to requirements was evaluated through expert review within the team. Unit testing (JUnit and JUnit) was employed to ensure quality of individual components of the software. A group of Engineering students were given the task of 'destruction testing' both public releases and interim versions. Once again, an external reviewer appointed by JISC tested the penultimate release for code quality, stability and functionality.

### **7.3 Outcomes**

The outcomes of the technical and usability evaluations were a series of change requests. These initiated from the users and experts, were reviewed by the design team and then prioritised according to urgency and amount of work involved to effect. Some large changes to overall functionality are yet to be made and have been scheduled for subsequent phases of development. Some bug reports were raised in relation to the applications that are harnessed by IL, however these were mostly beyond the team's control.

At the time of writing, all critical fixes have been completed and a release candidate version has been made public and is available from [www.il.bham.ac.uk](http://www.il.bham.ac.uk) .

To date, there is a paucity of other learning systems with which we can share learner data using the IMS LIP standard. Therefore, other than to inspect the exported data for XML validation, we are as yet unable to determine the user experience of sharing portfolio information with peers, tutors or other groups.

Although the system has been used by real students in their study, and was created according to real learners' needs, the pedagogical value of the IL has yet to be evaluated. It is envisaged that the greatest implications for learning will relate to the use of the log as a reflective learning tool. As such, it will require long term studies to genuinely measure any effect or perceived value. Such studies would require that learners regularly use the software for a minimum duration of one module, preferably over a whole year or longer.

Despite passing the technical and usability evaluations on a standalone basis, the mobile phone client has too many drawbacks to recommend it for wide deployment. These drawbacks are generally related to the platform and are therefore out of the scope of this project to change. Three main issues were prevalent. First, users found downloading and installing a Java application particularly difficult (irrespective of the application), and few had previous experience of installing anything more complicated than a ring tone or

wallpaper. Second, different mobile platforms (even differing versions from the same manufacturer) rendered controls and menus differently. The lack of predictability made it difficult to design for the end user or to produce adequate user guidance. Third, the tool depended on a working data connection to the phone or PDA. Most users reported severe difficulties or complete failure to configure a data connection for their device. For those who had successfully connected to their service provider, differences in the way applications handle connections and ambiguity over connection state made it difficult to send/receive data from the Logbook, or to troubleshoot problems.

## **8 Further Work**

### **8.1 Pilots**

A new phase of Interactive Logbook has begun, again funded by the JISC. In addition to making changes to the software, we will be running pilots in order to conduct thorough usability and pedagogical evaluations. Four cohorts of up to forty learners in each will use the software between September 2005 and March 2006 and will feed back via questionnaires, focus groups, diary studies and interviews. The log for each learner (once anonymised) will also be used as data.

One of the main aspects of research will focus on whether the IL really lowers (or even presents) barriers to recording learning, and how these barriers may be further lowered.

### **8.2 PC client**

Although running all of the user's software inside the Interactive Logbook makes for an integrated experience, users have commented that this is not always the most appropriate mode of interaction. For extended periods of work in, for example, a word processor, it would be better to use this in its native full-screen mode. Also, there will inevitably be applications that cannot or have not yet had plug-ins created for them. For both of these reasons, the current redesign will allow for the Interactive Logbook to be used in two modes: the first, as originally designed and as demonstrated in (figure 1) above; the second will be a 'factored out' approach, where applications (themselves designed for plug-in functionality) will gain an IL menu item or 'Log This' button, while a task tray icon will provide access to the log itself. In this second mode, the task tray icon will offer further utilities including a screen-grabber to be used where content in applications cannot be accessed directly.

The second imminent change will be to increase the user's choice regarding automated log collection. As users will inevitably wish to use their log in many different ways, it is certain that they will have differing requirements for the amount and type of data collected by the log. Some may wish to record automatically everything that happens and every piece of information processed. Others may only want to add records manually. Some may wish to be prompted to make log entries. More likely, users will wish to adjust between each of these methods, depending on the document or application they are using, or the people with whom they are collaborating on any number of other rules. A form of control panel will be added to allow for this.

Third, there are clearly shortcomings in the tools available for managing and making sense and use of the portfolio. Determining good practice in this regard is itself a significant research project. The pilot implementations are expected to throw further light on this topic, together with an increasing body of literature and other software systems.

### **8.3 Mobile phone client**

Development on the mobile phone client has been halted for the time being owing to the difficulties described above. However, we believe the application to be important to the success of IL. Future development is likely to take one of three directions. Standardisation and enhancement to the mobile Java platform may make the existing development path

more viable. An alternative approach would be to make platform-specific implementations for each of the three or four major phone operating systems on the market. This should increase the success ratio, but will also be considerably costlier to develop. The second alternative would be to wait for Macromedia's Flash Lite (Macromedia, 2005) to be deployed on devices in Europe and investigate whether it has advantages over the Java platform as a multi-OS delivery medium.

## 9 Conclusions and Discussion

The Interactive Logbook has been developed at the University of Birmingham, following in the wake of many other mobile learning research projects. Lessons learned from those earlier investigations have been used to guide the design of this system. Such lessons include: the learner's need for single point source of digital information; the need to lower barriers to recording progress; the need to incorporate familiar, best of breed tools rather than substituting home-grown applications.

By creating a 'one-stop-shop' for digital learning on a personal device, it becomes possible to create a more complete record of learning than would otherwise be achievable. A lightweight mobile client is believed to be important to the success of the Logbook because of its ubiquity. However, technical limitations in the platform at this stage are preventing widespread uptake. It is envisaged that significant advances either in the mobile Java platform or in some other standard, will make this possible within the next year or two.

Although still in a phase of research and development, the team have delivered a piece of open source software, available to others in the HE community for trial and further development. The system to date has been favourably evaluated from technical and usability points of view. Full review of the benefits of such a system will have to take long term pedagogical evaluations into account as well as observation of the patterns of use. Such a strategy has now been formulated and will commence in the next academic session.

Networked institutional systems such as VLEs are no longer adequate, having almost fallen victim to their own success, with so much learning activity now taking place online. Future scenarios of use are likely to see students consuming from and engaging with such systems in increasing measure. However, the demand for more personalised, portalised (or aggregated) experiences will see such interactions taking place through intermediate systems, which are likely to be under the learner's ownership, and some of which will necessarily be mobile. We believe that Interactive Logbook could be the first of this new generation of integrated, aggregated, personal, mobile learning environments and is likely to be joined by others in the near future.

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# Adult Multimedia Learning with PDAs – The User Experience

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## Abstract

Can rich interactive multimedia learning experiences be created for adults to use on a Personal Digital Assistant (PDA)? This was the research question that prompted this exploratory work into creating mobile learning applications. The result is the development of two prototypes of multimedia learning applications for the PDA. The first is a mobile local history tour designed to support informal learning. The second is a learning object on Java programming for higher education students, which has been adapted for the PDA. The applications will be briefly described, with the underlying design and pedagogic principles. Both have been evaluated with representative target users, and the remainder of the paper will focus on the user experience of using the applications and the PDA in these two distinct learning scenarios. Despite their differences, a number of themes emerge. Some of these were expected such as the advantages afforded by mobility and portability and the new learning spaces that become available. Others not anticipated relate to the learning experience the PDA provides. Both user groups particularly liked the use of audio: for example “audio provided real depth to the tour”, “I learn more by hearing”. The students found the PDA object “much more interactive”, “more understandable” and particularly liked it because it “is smaller than a book”. The paper presents more of the in-depth and rich feedback from users, illustrating the success of this research.

## Keywords

*PDA, adult learning experiences, multimedia learning materials, learning objects*

## 1. Introduction

This paper reports on the results of our initial work in developing mobile multimedia learning materials for the personal digital assistant (PDA). In particular, it focuses on the users’ experiences of using the applications and the PDA. The impetus for this work came from a number of research questions that we wanted to explore and find answers for. Can rich interactive multimedia learning experiences be created for the PDA that will foster more mobile and flexible learning resources? We were also interested to know how adult users would respond to the PDA as a learning tool, and what (if any) benefits emerged. We had been working in developing innovative multimedia eLearning materials, using the benefits of multimedia to engage, stimulate and support the learning process (Boyle, 1997). Could the pedagogic and design principles employed in developing rich multimedia materials be applied to mLearning, utilising widely available mobile devices?

A number of benefits are associated with the PDA, encouraging its use as a learning tool. It is small, lightweight, portable and can be held in the hand. Users perceive PDAs to be novel, personal, and even cool, and consider them to be more like mobile phones than computers, with comparable ease of use. Whilst still largely viewed as a professional tool, they are becoming more prevalent. During our interviews with students, one mentioned that about 60% of his fellow students studying Business Computing had a PDA, suggesting that they are becoming more common amongst H.E. students. Several research projects have been implementing PDA learning trials with adults, and are now publishing the resulting conclusions and benefits. The European ‘MOBilearn’ project has explored new ways to use mobile environments to enhance learning in various contexts (MOBilearn Project Website). The ‘m-learning’ project used mobile technologies with young adults (16-24) to try to engage them in learning activities and promote lifelong learning. A trial of using PDAs with homeless learners reported an enthusiasm to continue with mobile learning, which could be considered to point towards its sustainability as a learning tool (Savill-Smith, 2005). The Tate Modern art gallery in London has trialed PDA-based multimedia

tours. They also found that users were enthusiastic about the service and the tour, and that visitors generally see this technology as an exciting and inevitable part of the future landscape in museums (Proctor and Burton, 2004).

Our research aimed to capitalise on the optimism and viability of using the PDA as a learning tool, and to start providing answers to our research questions. Two prototype applications for the PDA were developed. The first is a mobile history tour designed to support informal learning. The tour is taken on the streets of an area of London, and combines a series of walks with audio guides, and multimedia historical information (maps, photographs, illustrations, audio accounts). The second is a learning object on Java programming for higher education students, designed to support their campus-based learning. This object has been specially adapted for the PDA. The paper describes the two prototypes more fully, and then discusses detailed evaluation data gathered from users about their experiences of using them on the PDA.

## 2. The Mobile Local History Tour

The ‘Lost Worlds of Somers Town’ is a mobile local history tour of an area in London using a PDA. On the tour the user learns about, explores, and discovers the history of the area over the last 200 years. There are eight short walks. Each is highlighted on a map on the PDA, and has an audio guide that gives instructions on which way to walk, what to look out for, and provides historical information about the area. Each walk finishes at a ‘dig’, a location with specific historical significance. At each dig, users can explore the history of the location, by looking at photographs, illustrations and maps, and listening to historic accounts of the area from contemporary witnesses. These elements combine to give the user a glimpse into the ‘lost worlds’ of the area that no longer exist. The tour is interactive and users have full control over how they use it. A supporting website (Mobile History Website, 2004) provides materials and links for further learning. The tour can be downloaded and installed on a PDA, and it can also be tried out online from the web site.

A number of design and pedagogic principles have been incorporated into the tour. Multimedia is used to bring history alive, provide sensory richness and engage and stimulate the user, through images, text, and audio. The audio guides are an important part of the tour, and were designed to achieve a sense of intimacy and “act like a friend” guiding you around the area, inspired by one of the findings from the Tate Modern pilot (Proctor and Burton, 2003). Devising interesting ways to present local history, to allow users to carry out historical discovery and exploration was also a key aim. A tangible model of the past is offered, that users can imagine and compare with the present, and make their own interpretations. The tour provides opportunities for users to uncover many possible narratives rather than presenting “a God’s eye-view of a subject” (MacKenzie, 2001).



Figure 1. A screen from the mobile history tour

The tour integrates a number of learning paradigms as advocated by Naismith et al (2004). It has been designed to support informal learning. It is context-aware: user’s draw on the environment around them as they walk along the tour route, guided and informed by the PDA and its supporting material. Learning about the area’s history is situational, rather than museum based or desk-bound. The tour also supports constructivist learning as learners are actively constructing their own view of this environment and its history as they progress through the tour. Learning should take place where visitors are allowed to discover things for themselves (Raiselis, 2002), a process that will involve the user in constructing a mental representation of the historical world (Russell, 1994).

## 3. Learning Object for Java Programming



A prototype of a learning object on Java programming for the PDA was developed by adapting an existing object designed to help first-year students to learn programming. These learning objects are part of a blended solution for students, and are delivered through a VLE. They are authored in Macromedia Flash, and are short, self-contained resources that focus on one small learning objective or topic and explain the often abstract key programming concepts that students find difficult to understand. This was achieved by employing a number of constructivist learning techniques that encourage active learning, but also support the student's progressive understanding. They are interactive, engaging and easy to understand. Java programming code is broken down into step by step sequences that is visually highlighted, and explained using simple text descriptions. Visualisation of abstract concepts is supported by the use of everyday familiar examples, animated where possible. Interactive models that illustrate Java code examples enable the students to change variables and see what happens. Scaffolding is used to provide learners with transitional support in learning a task, for example through interactive quizzes that allow programs to be constructed from fragments of code. The pedagogical design of the objects is discussed in more depth in Boyle and Cook (2003), and an online paper has further descriptions and links to some of the learning objects (Bradley and Boyle, 2004).

Our concept of learning objects as small, self-contained units or chunks of learning material offered within a broader structured pedagogic framework should naturally adapt to the PDA, where small, short pieces of learning can be fitted into available time slots whilst students are traveling, have periods of free time, etc. As such, our learning objects lend themselves naturally to the mobile learning paradigm - learning when and where it is appropriate for the learner. We have found from the evaluation of our learning objects that students at London Metropolitan University like the added flexibility afforded by having online learning materials. Students now are likely to have other roles in life, for example parent, carer, and many are working to support their studies. Mobile learning objects could extend this flexibility of use.

The research agenda was to see if one of the objects could be adapted to the PDA, whilst retaining the multimedia richness and pedagogy of the original, but offering a more flexible, mobile alternative. It was also important that the PDA provided comparable functionality and performance. A learning object on 'while' loops was selected for adaptation to a Pocket PC or Palm. The PDA screen dimensions of 320 x 240 pixels (full screen) meant re-thinking some aspects of content presentation and screen layout. Most of the explanatory text was replaced with audio commentaries, alleviating potential problems of screen overcrowding, text legibility and readability. In developing the audio for the PDA, careful scripting and tone of voice for the commentaries was crucial to ensure it was effective for students. Buttons for the audio explanations replaced the text on each screen. Animations were reduced in scale, and details were simplified to retain clarity. Some of the interactive elements had to be changed, to suit the 'point and click' method of user control on the PDA, for example in the self-test quiz, but the fundamental goals of the task were not changed. The underlying pedagogy was not compromised in the PDA version.

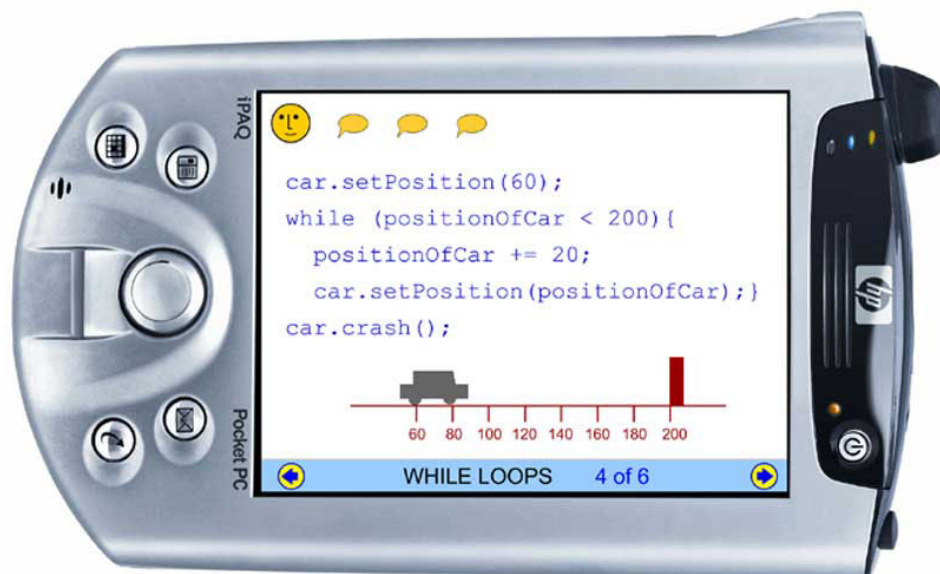


Figure 2. A screen from the 'while' loops learning object for the PDA

The completed PDA learning object can also be used online on a desktop PC (see Learning objects for introductory programming website). Another paper describes both of the prototypes in more depth, and the development and design process (Bradley and Haynes, 2005).

#### **4. Users' experiences of learning with a PDA**

Both of the prototypes have been evaluated in depth with representative users to provide feedback on the prototypes, the use of the PDA as a learning tool, and the resulting learning experience. The history tour was evaluated by 10 users, 5 males and 5 females, all over the age of 25 with some interest in local history. Half the users had some prior experience of using a PDA and half had none. In pairs, they used the tour around the streets of Somers Town for at least an hour, equipped with a PDA and headphones. On completion of the tour, each user completed a 4-page paper-based questionnaire designed to capture both quantitative and qualitative data.

The While loop learning object was evaluated in depth by 4 students studying computer science at the university. All were males, aged between 20 and 37, and had used the PC-based learning objects during the Java module. Only one had some experience of using a PDA before. The students attended individually, and each was given a PDA with the object installed and a set of headphones and instructed to take as much time as they needed to work through the object. They each used it for between 10 and 15 minutes. Afterwards, each student was interviewed using a standardized set of questions. They then completed a paper-based questionnaire, comprising 22 questions designed to capture both quantitative and qualitative data, and provide triangulation with the interview data.

Data from both studies has been analysed using grounded theory (Strauss and Corbin, 1990). The data has revealed a number of recurrent themes that are common to both user groups and their respective learning scenarios on their views of using the PDA as a learning tool. This is the data that we will focus on in this paper.

##### **4.1 Benefits of the PDA for learning**

Much of the anticipated feedback related to the nature of the PDA and the advantages afforded by mobility, portability and the new learning spaces that become available as a result.

Our student users were comparing the use of PDA and PC applications, and made many comments about the mobility and portability of the PDA. Being able to use it anywhere and everywhere was an advantage cited by all of them. Examples given ranged from at university, on the way to and from university, on a bus, tube, train, in a car, at work, at home, on holiday, anywhere in the world, wherever I am. Convenience is confirmed by comments such as "It provides an opportunity for the learner to learn at their own time and at their own pace". Another said that one of the advantages of using a PDA for learning and support for a course was that it was "flexible". Size was an important issue for all the students. Two students described the PDA as "handy", and another "compact". Two students spoke of the PDA being "comfortable", something that you can easily hold and use. One of them said that he didn't like to study sitting down at a desk in front of a computer, preferring to study when relaxing, such as lying on his bed. The other said "This is really comfortable because even if I'm just walking down the road I can just have a quick look at it if have an exam etc. It is smaller than a book or A4 paper with your lecture notes." The use of the PDA device also attracted positive comments. All of them agreed that they found the PDA easy to use and control the learning aid (3 strongly). The performance of the PDA was also not a problem for them, all agreeing that the responsiveness of the PDA was satisfactory (3 strongly) and that reliability was satisfactory (2 strongly).

The students identified few disadvantages of using the PDA for learning. Any disadvantages mentioned centred on the device itself: the cost, security and limited storage space. High costs for students were a barrier to them using a PDA for learning. One student was concerned about the risk of being mugged when using it. Another was concerned about possible radiation from devices using radio frequencies. Adjusting to the smaller screen was not mentioned as a problem.

The history tour users gave more varied responses. The tour relies on a mobile device, but carrying it and using it on the streets of a city caused problems for some users. 7 agreed with the statement 'I liked the portability of the handheld, and you could hold it in your hand, and easily slip it into your pocket' and 3 disagreed (1 strongly). One said of portability, it "doesn't go in female pocket". Of the 3 things not enjoyed about the tour, 5 reported problems with carrying and using the equipment, ranging from "stylus too fiddly", "no strap on handheld", "I found the handheld plus headphones cumbersome", whilst one said that they kept accidentally

unplugging the headphones. 3 users reported problems in being able to see the screen in bright sunlight. 2 were concerned about their personal security in using the PDA, "I felt vulnerable in busy places". Other comments were that it's "not easy to use when walking (moving)", and "felt very conspicuous". Two users however did not seem to have any difficulties "never used a handheld before, but found it straightforward", "impressed as first time with handheld it was easy to use".

## 4.2 The learning experience

When we started this work, we did not know how users would react to the learning experience from using the PDA and application. We hoped they would not only find it a stimulating experience, but that it would also provide another dimension to alternative methods for learning. Of the themes that emerged here, many were not anticipated, and we were pleasantly surprised by the feedback we received.

Both user groups felt that their respective applications offered added value to their experience. 9 users agreed that the Mobile History Tour brought the history of the area alive (4 strongly), and all agreed that the technology of the handheld enhances a local history guide book or oral history tour (3 strongly). Comments included: "Fascinating, and different from anything I've ever done before. Very impressive."; "For those interested in local history I'd say it's an attractive way to gain local knowledge whilst enjoying yourself."; "Pointed out areas of interest I'd not normally notice." For the Java learning object, all users agreed that it made the concept of the 'While' loop clear (2 strongly) and that the technology of the PDA enhances the learning aid (2 strongly). They all strongly agreed that they could imagine using PDA-based learning aids in their own time. One user found it "more effective" because of its ease of use and interactivity and "because it's easy and understandable". Another particularly liked the combination of interactivity, sound and the fact that it was nicely presented – "for all these reasons, I think it gave me a better learning experience". In the interviews, one said that they had never seen such a sophisticated learning aid, another said that "it is really good to do this for the PDA" and another "I really didn't imagine this on a PDA".

We underestimated the impact that the use of audio content would have on the user experience. The majority of users have reacted very positively to this in both applications. Audio is an integral part of the history tour. 9 of the users agreed that the audio guide for each walk was very useful (3 strongly). When asked for their first impressions of the tour and for 3 things they enjoyed about it, audio was mentioned 7 times. Reasons include "Voices describing social history brought it to life."; "I liked the different voices, the variety"; "I didn't have to look to read anything". Not only did the users like the audio guides and accounts, but they found them to be an effective medium of communication in a mobile situation. A comment relating to using the tour was that "Audio provided real depth to the tour, and highlighted areas of surprising interest." The main negative comments about the audio were that you should be able to pause it, and that some walk instructions could be clearer.

For the Java learning object, all users strongly agreed that the quality of the audio is high and it is easy to understand. One said that the sound "made the PDA version more fun and less stressful to use". When asked which 3 things they particularly liked about the application, all of the users cited sound. One said "it enforced a form of realism", and another "the sound is really effective for understanding it better". We asked about their opinion of the use of audio rather than text in the application. The first student said that "I learn more by hearing", "reading is a longer process I think, it is part of the learning process as well, but I prefer listening and interaction". The second said that "I like things that help me learn without me reading too much". "I find it easier to learn by listening, but obviously you have to concentrate and understand what you hear". He thought that the audio has more realism, and is more like someone speaking to you. The third student did not mention the lack of text, but liked the combination of audio and graphics. The fourth student said "the sound is really effective", "it's really helpful" and that "the audio is more interactive". He thought that audio played a big role in helping people to learn, especially if you are learning by yourself. Two users specifically mentioned that they thought that the audio contributed to an enhanced learning experience in the PDA version.

Some users liked the combination of multimedia content: being able to listen to the audio, whilst also looking at visual information or their surroundings. The "combination of map and audio worked well". Two students said that the PDA version of the learning object was more complete, with its combined multimedia elements and simple easy to understand audio explanations.

On user interactivity and control of the application, the mobile history tour users provided little feedback. One did say that one of the three things they most enjoyed was being "in control of information". Another said of the PDA "its use as a tour guide was rewarding in that there is an element of control in being able to look at visual reference and audio information at your leisure". For another user this was a barrier "an audio tour would have

suited me better, less stopping and clicking and having to get the handheld out on the street". However, three of the students volunteered many comments about interactivity, with the words interaction and interactivity used positively 33 times in the interviews and questionnaires (one did not mention them at all). These three students all cited interactivity as being one of the three things they particularly liked about the PDA application. They said it was "better than a book because of its interactivity", the learner can learn "at their own pace", "the interactivity in the learning aid plays a big role". All three students also thought that the PDA version was more interactive than the desktop one. The use of audio was thought to be instrumental in this, as it explains every stage of the while loop, and because "you listen and you take part in it". Two students also cited the self-test quiz at the end in which they test their understanding. Two students also said in the interviews that interactivity helps them to learn. One said "I can assimilate much faster and better with interactive learning support like the PDA". Another said he preferred to learn from things that were interactive.

User engagement and making the applications more interesting and fun to use was an important factor in making them more effective for learning, and we thought that the novelty of the PDA would enhance this. Both user groups were asked if their PDA applications were enjoyable and stimulating. For the history tour 9 agreed it was enjoyable (2 strongly) and 9 agreed it was stimulating (3 strongly). They all thought that the tour was memorable, and agreed that the design of the tour was attractive (5 strongly). Comments included that there were "interesting facts", "the idea of the digs, they give detail and interest to the tour", and that the tour was an "interesting and innovative idea". The feedback on the Java learning object was also very positive. All agreed it was enjoyable (2 strongly), stimulating (3 strongly) and that the design was attractive (1 strongly). Of the 3 things they particularly liked, one said it was nicely presented, another liked the overall graphic style because it was not dull, and another mentioned its attractiveness. Each student gave more expressive comments in the interview, "I think this kind of aid is amazing, it's wonderful", "overall I feel that it's really nice", "this is brilliant, this is really good", "it's really great though, it's a nice thing".

## 5. Conclusions

Whilst the scope of this work is limited to the development of prototypes and in-depth evaluation with a small number of users, it has shown that rich multimedia learning materials can effectively be produced for the PDA. Both our user groups consider that the resulting applications provide an enhanced learning experience over alternative learning methods.

The students were excited about the opportunities afforded by the mobility and portability of the PDA, in being able to learn anywhere and everywhere, at their own convenience. The only disadvantages mentioned for using it as a learning tool were cost, security and limited storage space. The history users also liked the portability of the PDA, but some users encountered problems in carrying and using it on the move on the streets of London. Some were also concerned about their personal safety. In spite of any difficulties, all users in both groups felt that the PDA applications enhanced their experience over alternative learning methods. The use of audio in the applications was highly rated by the majority of users. For the history tour it provided depth, variety and brought social history to life. Several of our student users expressed a preference for learning from audio, and the PDA version of the object is seen by them to be much more effective and interactive because of this. The feedback shows that using audio rather than text suits some user's preferred learning style. On the PDA, audio can be an easier medium to assimilate; it enables the user to be able to look at graphics or animations on the screen (without having to concentrate on reading text), and is easier to concentrate on when the device is used in a mobile situation. But it was the combination of multimedia content that some users liked. User interactivity and control was also mentioned by most users to be important for them. The students felt that the PDA version of the learning object was more interactive, saying that interactivity not only engages them more in the learning process, but it also helps them to learn more effectively. Some of the history tour users mentioned that they liked being in control of the tour and information. All the users bar one considered that their PDA applications were enjoyable and stimulating, and many positive comments were made about them being memorable, innovative, interesting and attractive. Such comments suggest that the PDA may encourage user engagement and make learning applications more interesting and fun to use.

A number of benefits of using PDAs for learning with adult groups are becoming apparent, and the results of our studies can contribute to this work. We can certainly report user enthusiasm for learning with PDAs, as found by other projects. An important benefit is that mobility adds another dimension to the flexibility and experience of learning, allowing a truly learner-centred approach to learning, in which the learner has more choice over when, where and how they learn. McLean says the ultimate assumption behind the mLearning paradigm is the transformation of learning (McLean, 2003), and there are many opportunities to explore the extent to which this can be taken, for both formal and informal learning

So far we have focused on delivering multimedia content, and there are opportunities to combine this with the communication and networking capabilities of mobile devices to provide more holistic learning environments and collaborative and sociable learning experiences. It is clear that mobile technology used within appropriate pedagogical frameworks offers many educational benefits.

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# A Proposed Theoretical Model for M-Learning Adoption in Developing Countries

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## ABSTRACT

This paper investigates the use of wireless technologies in education with particular reference to the potential for m-learning in developing countries. The reports of a number of current m-learning projects are explored, from which the perceived benefits of using wireless technologies in education, and potential barriers to their use are derived.

The use of wireless technologies in education impacts learner motivation, collaboration and mobility, which results in benefits for learners, parents and teachers. Benefits are perceived to outweigh the difficulties encountered when integrating wireless technologies in education. Considerations to be examined include limitations of the devices, pedagogical issues, safety and security concerns, training and support issues, as well as cost considerations. By examining the recommendations from developed countries, wireless technologies can be adopted by the educational sector in developing countries. These recommendations include the establishment of guidelines and principles to ensure the appropriate use of wireless technologies, designing the devices with the end user in mind, and involving all stakeholders concerned.

The proposed theoretical model for m-learning adoption in a developing country emphasises the importance of taking a systems view of all the elements that need to be in place in an m-learning environment, including the necessary stakeholders and key elements (communication infrastructure, mobile devices, learners and teachers), in order to ensure the effective adoption of wireless technologies in education. This model embraces the key issues with regard to m-learning as well as the critical success factors that are essential in ensuring successful adoption.

Keywords: *theoretical model, adoption, developing country, m-learning.*

## **1. INTRODUCTION**

There is an increasing and unprecedented adoption of wireless technologies in developed and developing countries alike (Keegan 2003). Wireless technologies are revolutionising education, transforming the traditional ways of learning and teaching into 'anytime' and particularly, 'anyplace' education. Empirical studies have reported the advantages of using wireless technologies in learning environments, including supporting group work on projects, engaging learners in learning-related activities in diverse physical locations, and enhancing communication and collaborative learning in the classroom (Liu, Wang, Liang, Chan, Ko, and Yang 2003). The focus of this research is to study wireless technologies in education. The paper investigates wireless technologies in the context of current uses, benefits and potential problems encountered with their use, and the subsequent relevance of m-learning in developing countries. Considerations to bear in mind when making use of wireless technologies in education will be explored, and recommendations for adoption will be made. The potential for mobile learning in developing countries is examined and the proposed theoretical model is presented.

While the more technical aspects of wireless access and a detailed technical analysis of the latest mobile technologies are not included here, it is acknowledged that the technical capabilities of mobile devices are a crucial factor in developing and sustaining feasible m-learning projects. A number of handheld computers offer telephone functionality as well as e-mail and Internet access, alongside conventional personal digital assistant (PDA) features. At the same time, a number of mobile telephones offer some computing or data functionality, making the distinction between phone- and data-centric handheld devices ever more difficult to draw (Becta 2004). Therefore, it is assumed that both handheld computing devices (for example, a PDA) and mobile phones are in fact handheld devices, and will be referred to as such in this paper.

Limited research has been conducted on the potential of wireless technology for educational use in developing countries. Wood (2003) states that using wireless technologies in education may contribute to combating the digital divide in developing countries, as this technology is generally cheaper than desktop computers, particularly mobile phones and PDAs. In order to develop a model that could be used for m-learning adoption, it is essential to gain a greater understanding of the considerations associated with the use of wireless technologies.

Results from current m-learning projects indicate that wireless technologies are emerging as a portable solution that enables learners to engage in collaborative and interactive learning activities. Considerations that need to be taken into account when exploring the adoption of wireless technologies in education range from limitations of the wireless technologies themselves, to broader issues such as safety and security, and training and support considerations. This paper concludes that using wireless technologies at educational institutions can be beneficial to all involved, provided that the necessary guidelines and policies are in place. The author identifies areas that are critical to the successful adoption of m-learning, and consequently need to be taken into consideration. These areas comprise the stakeholders (including parents, teachers and learners), critical success factors, communication infrastructure, and the mobile devices.

## **2. CURRENT USES OF WIRELESS TECHNOLOGIES IN EDUCATION**

Educational efforts to experiment with m-learning appear to be boundless, particularly within the academic community. Handheld devices are becoming more common, and their quality and capability is increasing due to technological breakthroughs in miniaturization and advancements in wireless bandwidth and data networks (Keegan 2003). According to the British Educational Communications and Technology Agency (Becta) (2004), handhelds are useful where learners need to record information during a lesson, but where moving to a desktop computer would be disruptive or impractical. For example, inputting data, extended writing (where the handheld has a good-sized keyboard and screen), shared writing (where text files can be moved easily between handhelds), and working on individual pieces of work around a table (where face-to-face interaction would be interrupted by sitting at a desktop computer). Juniu (2003) states that wireless technologies are easy to integrate into existing classrooms and school network environments. An important pedagogical aspect concerning handheld devices is that they extend the learning environment beyond the classroom, as they are portable, support the paperless classroom, and provide additional methods of communication (Juniu 2003). Roschelle (2003) postulates that handheld computers may become an increasingly compelling choice of technology for classrooms because they enable a transition from the occasional, supplemental use associated with computer labs, to frequent and integral use of computational technology.

Three European projects investigated wireless technologies in education, namely M-learning, DfES/Becta PDA Project, and MOBlearn. The M-learning project addressed the social and educational problems in young adults using handheld devices, and its aim was not to replace traditional education, but rather to re-engage those who have left educational institutions (M-learning 2004). The DfSE/Becta PDA project evaluated the use of small, handheld computing devices for both teachers and learners in schools (Becta, 2004). MOBlearn (2004) explored new ways to use mobile environments to meet the needs of learners working by themselves, and with others, using the latest wireless technologies. A further project conducted in Japan, investigated the extent to which mobile phones were utilised for educational purposes among university learners, and measured learners' reactions to educational materials developed specifically for mobile phones (Thornton and Houser 2004).

An m-learning initiative, primarily providing administrative support, at the University of Pretoria in South Africa is having significant success (Brown 2004). An m-learning initiative in Chile is introducing handheld personal computers into Chilean high schools in an attempt to improve the quality of education, by incorporating mobile technology in the classroom. Zurita and Nussbaum (2004) conducted an m-learning study in one low-income elementary school in Chile and state that this aspect of the larger Chilean m-learning project looked at the problems that occur in collaborative learning (widely used in elementary classrooms) when working without technology support. It also examined how a mobile computer supported learning environment, using handheld devices, can address these weaknesses.

### **3. IMPACT OF WIRELESS TECHNOLOGIES ON EDUCATION**

Mobile technology extends learning beyond the walls of classrooms, and this section explores the benefits for learners, parents and teachers with regard to the impact of wireless technologies on portability, collaboration and motivation.

#### **3.1 PORTABILITY**

Juniu (2003) states that many benefits accrue when using handheld computers, the most important of which to the learners and teachers is the opportunity to take the learning experience outside of the confines of the classroom. Due to their portability, these devices can be carried from class to class or wherever one goes and information can be acquired while interacting with one's peers. According to Perry (2003), too often Information Communication Technology (ICT) is taught in a specialist room and as the learning environment changes, teachers often find themselves in a foreign room with technology that they use infrequently. Teachers need ICT to support the subject being taught and available to "grab" those learning opportunities as and when they arise (Perry 2003). Portability can make a difference in a wide variety of settings, namely the classroom, a field trip, or outside of the school environment.

#### **3.2 COLLABORATION**

Handheld devices allow learner groups to distribute, aggregate, and share information with ease, resulting in more successful collaboration. According to Becta (2004), the use of wireless technologies results in parents' increased involvement in education and their increased knowledge of their children's learning and capabilities, owing to the increase in learning activity being situated in the home. Perry (2003) states that wireless technologies, notably PDAs, are proving to benefit 'family learning' as learners are able to use them for various literacy tasks, note-taking, reading e-books, and then take them home to continue working on them with their parents.

#### **3.3 MOTIVATION**

According to Vahey and Crawford (2003), teachers report that learners using handheld wireless technologies demonstrate an increased autonomy in learning, as learners show increased self-directedness in learning and take the initiative in finding ways to use the handheld devices for learning. According to Perry (2003), Becta project schools are unanimous that their learners were excited and highly motivated when they began using the handheld devices. Belt (2001) states that after implementing wireless technologies in the classroom, learner participation increases and they appear "more engaged in the process". According to Perry (2003), giving learners wireless technologies "lights up" their enthusiasm, although whether this will always be the case remains to be seen. Belt (2001) agrees with Perry (2003), suggesting that the increase in learner participation and enthusiasm can be partially explained by the novelty of using a handheld in the classroom. However, after the novelty of the new devices has worn off, learners come to view the devices as working tools (Belt 2001).



## **4. RESULTS OF CURRENT M-LEARNING PROJECTS**

This section focuses on the research findings of educational projects concentrating on mobile learning in developed countries and encompasses the successes and difficulties that the projects have experienced. To a lesser extent, this section explores considerations for the adoption of wireless technologies in education, examining potential barriers to use.

The M-learning project (M-learning 2004) findings show that mobile phones play an increasingly important role in the lives of young adults as a communication tool, and those new services, such as games designed to improve basic skills, are of interest to young adults. Stead (2004) states that it is easy to incorrectly assume that the learning process will be similar to that using a personal computer (only at a smaller size), but the M-learning project findings show that in fact both the limits of the technology and the lack of control over how and when the learning happens implies that a different learning model is needed. The M-learning project finds that with mobile learning learners are often surrounded by distractions; therefore learning has to be engaging. Developing materials that can be used in different forms across different technologies is imperative as it prevents the learning materials from being “out of date” when new mobile devices are released (Stead 2004).

### **4.1 AN OWNERSHIP PERSPECTIVE**

Becta's (2004) findings show that some of the most pronounced benefits are gained in schemes that give learners wireless technologies for their own use. According to Becta (2004), there is also evidence that ‘ownership’ of wireless technologies increases the learners’ motivation and responsibility to extents that do not necessarily derive from the use of PCs and shared school-based hardware. Perry (2003) finds that allowing children personal ownership of equipment can bring benefits to disadvantaged learners who would otherwise have no access to ICT at home. However, personal ownership and home use of wireless equipment brings about concerns for the security and safety of children carrying such devices (Perry 2003). K12 Handhelds (2004) agrees, stating that many schools are reluctant to let learners take home handheld devices, fearing theft, loss, and damage of the wireless technologies. This seems reasonable when mobile phone crime – especially among children of secondary school age – is widespread (Perry 2003). Vahey *et al* (2003) emphasise the need to establish clear acceptable-use policies and parental agreements when assigning the wireless technologies as personal devices, in order to be effective in minimising the loss, theft, and inappropriate use of the devices.

### **4.2 A COLLABORATION PERSPECTIVE**

According to Becta (2004), there is evidence that the use of wireless technologies can help to increase collaborative learning and communication, as well as independent learning among learners, because of the mobility and capacity of the devices. Stead (2004) states that in every M-learning project trial, the learners engaged the most with the learning that they could do together, either by sharing the wireless technologies or by passing data between the devices, consequently learning should be built around this. The results of the Zurita *et al* (2004) research show that wireless technologies solve the weaknesses of coordination, communication, organisation, negotiation, interactivity and mobility encountered in collaborative learning (without technology) in education.

### **4.3 A TEACHER PERSPECTIVE**

Handheld technology has a beneficial impact on the learning environment in the classroom - teachers report greater learner engagement, more effective collaboration and increased learner independence when handheld devices are thoughtfully integrated into the classroom (Vahey *et al*. 2003). According to Becta (2004), information regarding the educational and technological capacities of the wireless technologies must be available, and both teachers and learners require sufficient time for familiarisation with the wireless technologies. Wood (2003) reiterates Becta's (2004) sentiments, stating that teachers and learners may require additional training in order to be able to use the wireless technologies effectively.

### **4.4 POTENTIAL BARRIERS TO USE**

Thornton *et al* (2004) report that some learners had difficulty hearing the audio on both PDAs and cellular phones, and learners suggest headphones would be required when studying in trains and other public places. Overall, Thornton *et al* (2004) find few serious technical limitations to widespread use of wireless

technologies in education. According to the Becta research, possible weaknesses include small screens, possibly not 'rugged' enough for school use, data input (especially free text) takes time, costs of software and accessories, and the necessity to charge the batteries regularly (Perry 2003). Thornton *et al* (2004) show that reading text on small screens does not concern Japanese university learners. Secondly, rich multimedia can capture their interest, and pushing study opportunities at learners via email (to their handheld devices) is effective in assisting them in learning. Perry (2003) notes that other concerns expressed include the need for more comprehensive training and access to technical support (in addition to the teachers), and the complexity of synchronisation with laptop or desktop machines (at home or networked at the school). Additionally, schools have to consider the size of the m-learning project, an estimated timeline for the plan, whether or not the school is eligible for any type of grants or funding, and the maintenance and ongoing support costs (Perry, 2003). Vahey *et al* (2003) note that simply having a set of handheld devices does not imply that they will be integrated into a teacher's curriculum with ease, and difficulties may be encountered. Keegan (2003) states that the main pedagogical issue to consider is the suitability of a course to the m-learning environment, as not all courses are suited to the m-learning environment. For example, short courses and mainly theory and information type courses are better suited to the m-learning environment.

## 5. THE POTENTIAL FOR M-LEARNING IN AFRICA

This section briefly describes the lack of telecommunications infrastructure in Africa, and investigates the prevalence of mobile phones on the continent and their growing adoption rate.

The African continent has many developing nations that are technologically far behind the developed world, and this lack of technological development has a detrimental effect on the education sector. As a result, young people in developing countries face immense challenges, which make it difficult for the next generation to catch up with the developed world (Beute 2004). According to Brown (2004), due to the lack of infrastructure for ICT (cabling for telecommunications and the Internet) in certain areas in Africa, the growth of wireless infrastructure is more rapid than in many first world countries. Jensen (2002) holds similar views to that of Brown (2004), and states that most of the existing telecommunications infrastructure in Africa cannot reach the bulk of the population, with 50 percent of the available lines concentrated in the capital cities, where only about 10 percent of the population lives. In more than 15 countries in Africa, over 70 percent of the lines are still located in the largest city. However, according to Jensen (2002), the situation is not quite as bad as it would appear because of the penetration of mobile networks, where these subscribers have now surpassed fixed line users in most countries, underlining the demand for basic voice services. Due to the low cost and long range of the cellular base stations, many rural areas have also been covered.

According to Jensen (2002), the use of the Internet has grown relatively rapidly in most urban areas in Africa, in much the same pattern as the adoption of the mobile phone that followed shortly after. As an indication, five years ago only a small number of countries had local Internet access, now it is available in every capital city. Jensen (2002) states that although these are encouraging trends, the differences between the development levels of Africa and the rest of the world are much wider in this area than they are when using more traditional measures of development. Generally the level of technology penetration in Africa is low compared to developed countries, primarily because the general population cannot afford it (Beute 2004). According to Jensen (2002), of the approximately 816 million people in Africa in 2001, it is estimated that only:

- 1 in 13 have a TV
- 1 in 35 have a mobile phone
- 1 in 40 have a fixed line
- 1 in 130 have a PC
- 1 in 160 use the Internet
- 1 in 400 have pay television

The fact that more people in Africa have mobile phones, in comparison to fixed lines, indicates the potential for m-learning in Africa.

<b>SOUTH AFRICA</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>
Mobile phones (per 1,000 people)	191	242	304
Telephone mainlines (per 1,000 people)	114	111	107

*Table 1: Growth of Phone Technology (World Development Indicators database, 2004)*

As indicated by the statistics and Table 1 above, mobile cellular telephony has experienced rapid growth in Africa, and more specifically, South Africa. The International Telecommunications Union (ITU) states that Africa has seen an increase of more than 1000% in cellular phone subscribers between 1998 and 2003 (Berger 2004). According to Jensen (2002), cellular providers have expanded from a presence in only six countries ten years ago to over one hundred networks in 48 countries serving over 14 million customers (excluding the ten million in South Africa), and provide access mainly in the capital cities but also in some secondary towns. Jensen (2002) states that although few studies have been made in Africa of the number of rural users in comparison to urban, it is safe to say that users in cities and towns vastly outnumber rural users. According to Berger (2004), what makes this growth seem to be particularly significant is its comparison with fixed-line subscribers on the continent whose numbers appear to be shrinking.

Brown (2004) suggests differentiating between two ideal target markets for m-learning, one consisting of first world learners who are the workforce on the move (with state-of-the-art mobile devices), and the other being third world rural or remote area learners who have mobile phones. Brown (2004) claims that the most appropriate mobile devices for learners in Africa are mobile phones. The research conducted by Thornton *et al* (2004) finds that when actually using educational materials designed for mobile phones, learners evaluate them positively and the test results show that the learners were able to learn via this medium.

With reference to the European based M-learning project, Keegan (2003) states that poor literacy, reluctance to participate in conventional education, and ICT “haves” and “have nots” resulting from a lack of access to computers, are the issues that need to be addressed using handheld devices. The poor literacy and creation of ICT “haves” and “have nots” can be likened to the situation in Africa, particularly in rural areas. The same problems exist in both developed and developing nations, and therefore m-learning with handheld devices can also be used in developing countries to address the aforementioned issues. The study of Japanese university learners conducted by Thornton *et al* (2004) show that wireless technologies such as mobile phones and PDAs can be effective tools for delivering foreign language (English) learning materials to learners. This could be particularly beneficial in developing countries like South Africa, where many learners are not educated in their home language. According to Brown (2004), mobile learning in Africa is a reality that will continue to grow in form, stature and importance, and it will become the learning environment of choice.

## **6. PROPOSED MODEL**

This section explores recommendations and proposes a model for the adoption of m-learning in developing countries. The proposed new model is not solely based on any particular existing model, but does draw on certain aspects mentioned within the current literature in order to provide a new model designed to provide a strategy for the effective adoption of wireless technologies in education. This proposed model takes an all encompassing view of the factors influencing the successful adoption of m-learning, and is applicable in developed and developing countries alike. Although the model requires necessary policies and standards to be in place, these will not be looked at in detail as that is beyond the scope of this paper.

### **6.1 RECOMMENDATIONS FOR THE ADOPTION OF M-LEARNING**

Becta (2004) recommend that when considering the adoption of wireless technologies in education, schools need to ensure that learners, teachers and parents are involved as much as possible in the planning of mobile learning initiatives. Becta (2004) suggest that schools need to contemplate whether they will be able to provide the training and technical support that may be necessary for the effective teacher and learner use of wireless technologies. Wood (2003) agrees with the Becta (2004) recommendations, stating that one has to make certain that the learners, their parents and the teachers, contribute to the wireless technologies adoption planning, and that the school concerned is able to provide support and training, in order to make a success of m-learning. Other recommendations include establishing guidelines and principles to follow ensuring appropriate use of wireless technologies (to exploit the potential of wireless technologies in education) and designing the devices with the end user in mind. The aforementioned recommendations for the adoption of m-learning are primarily based on reported experiences gained from using wireless technologies in education in developed countries. These suggestions can be as appropriate and effective to use in developing countries, provided that the countries have the necessary infrastructure in place.



## 6.2 PROPOSED MODEL AND DISCUSSION

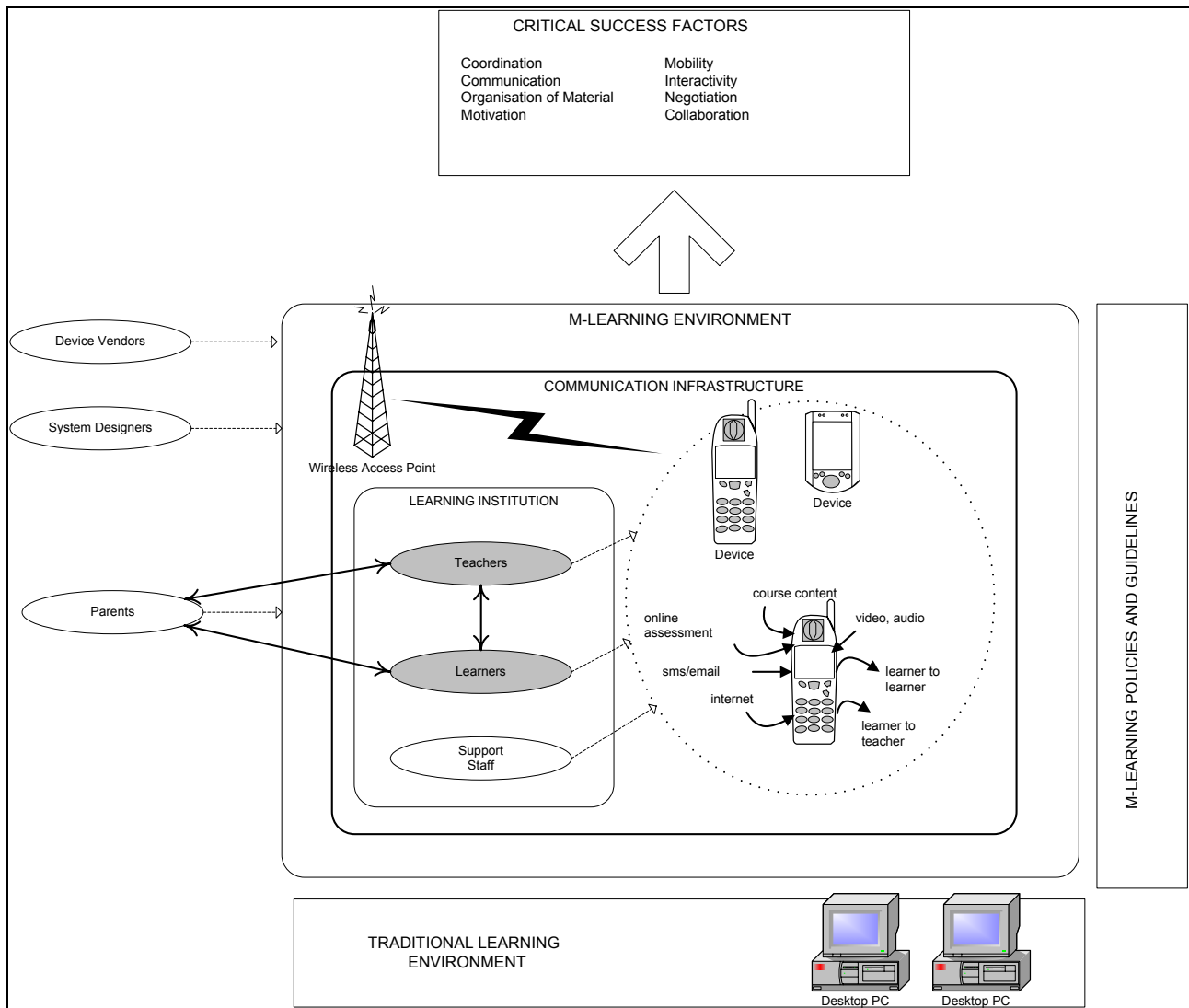


Figure 1: Model for M-learning Adoption

This proposed model for m-learning adoption contains an m-learning environment, which is underpinned by the traditional learning environment and also supported by effective m-learning policies and guidelines. Within the traditional learning environment, as indicated in the model, learning can still take place through desktop PCs. Within the m-learning environment, there is a communication infrastructure (represented on the diagram as a dashed line) containing wireless access points which enables communication between the mobile devices. The mobile devices depicted in the model can be mobile phones, PDAs or any other wireless handheld device. The proposed model demonstrates that the mobile devices can be used as academic support for learners via online assessment, providing course content and access to the Internet. The mobile devices in the proposed model for m-learning adoption enable learner-to-learner communication, as well as learner-to-teacher communication. The model portrays some of the essential elements of a mobile learning environment, as proposed by Chang, Sheu and Chan (2003), including at least one teacher, learners, learning and instructional mobile devices, and a communication infrastructure.

### 6.2.1 STAKEHOLDERS

The stakeholders identified in the proposed model (represented as ellipses) include learners, their parents, teachers, system designers, device vendors, and support staff. The designers of the systems that execute on the devices, the vendors that sell the devices, and the parents of the learners involved all occur outside the m-learning environment. However, they still have an impact on the m-learning environment. The system designers depicted in the proposed model include both software developers and hardware manufacturers. Teachers, learners and support staff are found in a learning institution within the m-learning environment.

The learning institution can be any type of educational institution (for example, a school) or it could simply be a community centre that functions as a place of learning. The proposed model indicates that the support staff are a part of the learning institution as opposed to outsourcing this function. The support staff would be involved in the day-to-day support and maintenance of the mobile learning infrastructure within their particular learning institution. As depicted in the proposed model, a unique relationship exists between three of the stakeholders. Although relationships do exist between the other stakeholders, the one depicted on the diagram is the most important as it is between the three primary stakeholders in m-learning adoption. Teachers and learners are the immediate beneficiaries of m-learning as they are actual users of the devices (represented as shaded ellipses in the diagram), and parents benefit from m-learning to a lesser extent. Teachers communicate with learners via traditional learning activities and using the mobile devices and vice versa. Learners and parents communicate after hours, and teachers communicate with the parents about the learner's progress. The mobile devices also enable communication with other learners, as well as enabling communication with peers and teachers about homework. Learners, teachers and parents should be included in the planning of an m-learning initiative in the learning institution (Becta 2004).

### **6.2.2 CRITICAL SUCCESS FACTORS**

Critical success factors in the proposed model are simply the collaborative learning components that determine the successful adoption of mobile learning. These include those factors emphasised by Zurita *et al* (2003) such as interactivity, coordination, negotiation and communication, organisation of material and mobility. Interactivity refers to the amount of interaction between learners using the mobile devices, and the extent to which using handhelds force learners to share information in a learning activity. Coordination refers to the use of mobile devices encouraging active participation by all learners and a need to coordinate activities. Using handhelds allows for negotiation between learners within group activities, as a consensus needs to be reached before moving on to another activity. Communication implies that a mobile learning environment needs to open the channels of communication between learners, and with their teacher. Mobility refers to the portability of the devices and the extent to which they enable the mobility of the learners. Additionally, the proposed model includes motivation and collaboration. Motivation implies the extent to which the m-learning environment motivates learners to engage with their learning and encourages teachers to develop innovative ways of using the devices to complement traditional teaching methods. Collaboration refers to the m-learning environment promoting collaboration between learners and teachers.

The proposed model emphasises the key issues with regard to m-learning, as well as the critical success factors that are essential in ensuring successful adoption. This model gives a broad, slightly user-centric, overview of all the elements that need to be in place in an m-learning environment, including the necessary stakeholders and key elements (communication infrastructure, mobile devices, learners and teachers), to ensure a seamless adoption of m-learning by the educational institution.

## **7. CONCLUDING REMARKS AND FUTURE WORK**

The prevalence of wireless technologies in education is growing, leading to an increase of literature on the subject of m-learning. This paper explores current available literature and expands on the existing m-learning models, in order to propose a new model for m-learning adoption that includes key stakeholders and critical success factors.

The current uses and the impact of wireless technologies in education were discussed. The proposed model was formulated based on the findings of the literature. Future research may lie in investigating the guidelines and policies that need to be in place to ensure the successful adoption of m-learning. Once determined, these policies (whether global m-learning guidelines or unique to each educational institution) must allow for an m-learning environment to be established. Other future research may lie in analysing the technical capabilities of different wireless technologies, and determining their suitability to an m-learning environment. This could then result in an "ideal" device being developed, adaptable to any m-learning environment, including educational institutions and the business environment.

Using wireless technologies in education impacts motivation, collaboration and portability, as well as resulting in benefits for students, parents and teachers. A few problems may be encountered when integrating wireless technologies in education. However these can be overcome and are therefore not critical in ensuring the success of wireless technologies, with the benefits clearly outnumbering the perceived difficulties. The proposed model highlights the importance of taking into account all the stakeholders of m-learning. The use of the proposed model will depend on the policies and guidelines with regard to use of m-learning. These need to be carefully considered in m-learning adoption.

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# From Research and Development to Mobile Learning: Tools for Education and Training Providers and their Learners

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## **Abstract**

The m-learning project involved four years of planning, research and development plus reflection and large-scale trials of mobile learning systems and learning materials with hard-to-reach learners in diverse situations in three European countries. The findings from these trials and the lessons learnt during the research and development work are currently informing a project to develop a practical, easy to use mobile learning toolkit for teachers. The experience of the project and the lessons learnt can also inform the work of other research and development projects and those working to implement mobile learning systems or to embed mobile learning elements into education or training.

**Keywords:** *mobile learning, staff development, personalised learning*

## **1. INTRODUCTION**

The independent evaluator's report described the m-learning project as:

"large and complex, developing, exploiting and integrating a range of innovative technologies and devices, and delivering mobile learning to hard-to-reach youngsters who were economically and educationally marginal. The project culminated in large-scale trials, probably the largest to date, across a diverse set of situations, organisations and of learners."

The findings from these trials and the lessons learnt during three years of research and development can inform not only the work of other research and development projects but also those working to implement mobile learning systems or to embed mobile learning elements into education or training.

To-date they have inspired the development of several new mobile learning projects in the UK and in the wider world. Two of the m-learning project partners have also applied these findings and lessons to the development of a set of practical and easy to use tools for teachers which will be described in this paper.

## **2. THE LESSONS OF THE M-LEARNING PROJECT**

### **2.1. The m-learning project and the findings**

The m-learning project was funded by the European Commission's Information Society Directorate General, the project partners and, in the UK, the Learning and Skills Council (LSC). The project developed learning materials and systems accessed on, or via, handheld mobile devices. These were intended to stimulate an interest in learning and to assist with improvement of literacy, numeracy and life skills. The project explored whether the enthusiasm of young adults for mobile phones can be harnessed to encourage participation

in education or training. One aim was to ascertain whether mobile learning can result in improved literacy, numeracy or changed attitudes or behaviour, including greater enthusiasm for learning and progression to further learning.

The m-learning project was a significant learning experience for all parties involved in the three partner countries (UK, Italy and Sweden) including not only the young people and their teachers and mentors but also the researchers and developers.

The findings from the work with young people, mentors and teachers in the learner research, systems and learning materials trials in the second year of the project are discussed in detail elsewhere (e.g. Attewell, 2005 and Attewell and Webster, 2005). Key findings indicated that mobile learning:

- allows truly anywhere, anytime, personalised learning
- can be used to enliven, or add variety to, conventional lessons or courses
- can be used to remove some of the formality which non-traditional learners may find unattractive or frightening and can make learning fun
- can help deliver and support literacy, numeracy and language learning
- can help learners and teachers to recognise and build on existing basic literacy skills which allow young people to communicate in notational form via text messages
- facilitates both individual and collaborative learning experiences
- enables discrete learning in the sensitive area of literacy
- can help to combat resistance to the use of ICT by providing a bridge between mobile phone literacy and PC literacy
- has been observed to help young disconnected learners to remain more focused for longer periods
- can help to raise self-confidence and self-esteem by recognising uncelebrated skills, enabling non-threatening, personalised learning experiences and enabling peer-to-peer learning and support

## **2.2. Lessons for future projects and implementation**

Other lessons resulting from four years of planning, carrying out and reflecting on the m-learning project relate to the mobile technologies and their use for learning as well as to the process of developing learning materials and systems for new and fast evolving technologies.

### **Planning for development with fast evolving technologies**

In 2001 m-learning was one of a very small number of mobile learning projects worldwide and most other projects were focused on the use of palmtop computers for learning rather than mobile phones. Widespread use of mobile phones was still a relatively new phenomenon although the project partners' countries were early adopters and high percentages of young people across all socio-economic groups in the UK, Italy and Sweden owned mobile phones.

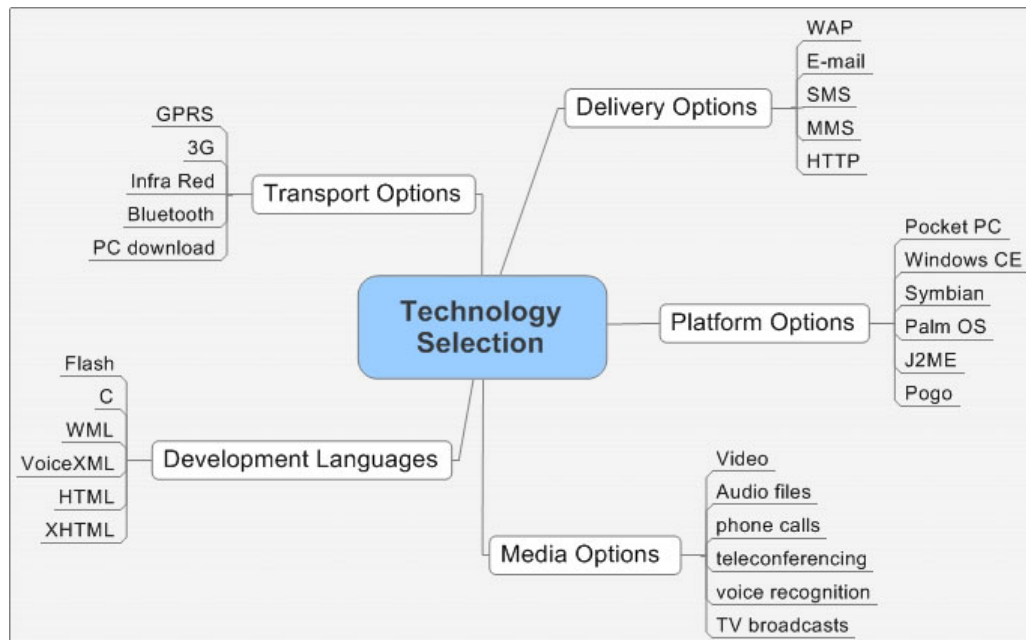
A major dilemma faced by the project team was whether to adopt a very inclusive approach by developing materials and systems for the lowest specification mobile phones to be found in the pockets of young people in 2001 or to future proof the findings of the project by attempting to predict the type of device which might be in their pockets, or readily available to them three of four years in the future. It was recognised that such prediction would be very difficult and that selecting specific delivery platforms, tools and technologies to develop with would not be easy. As the project began it had recently become clear that WAP was not going to provide the exciting mobile Internet service which had been widely predicted and

that phone buyers were mostly unimpressed. There was much excitement concerning future third generation (3G) networks but a lack of clarity around availability and cost of this. At the same time, in the fast growing and evolving handset market, there was a constant stream of new models, each manufacturer used their own proprietary software and they were more interested in fighting for market share than agreeing standards.

In order to assist the process of selecting development tools and planning delivery technologies the project team developed a Technology Selection Roadmap and a process for carrying out roadmapping i.e. identifying, evaluating and selecting technologies and revisiting selection decisions frequently in the light of experience and the emergence of new technologies.

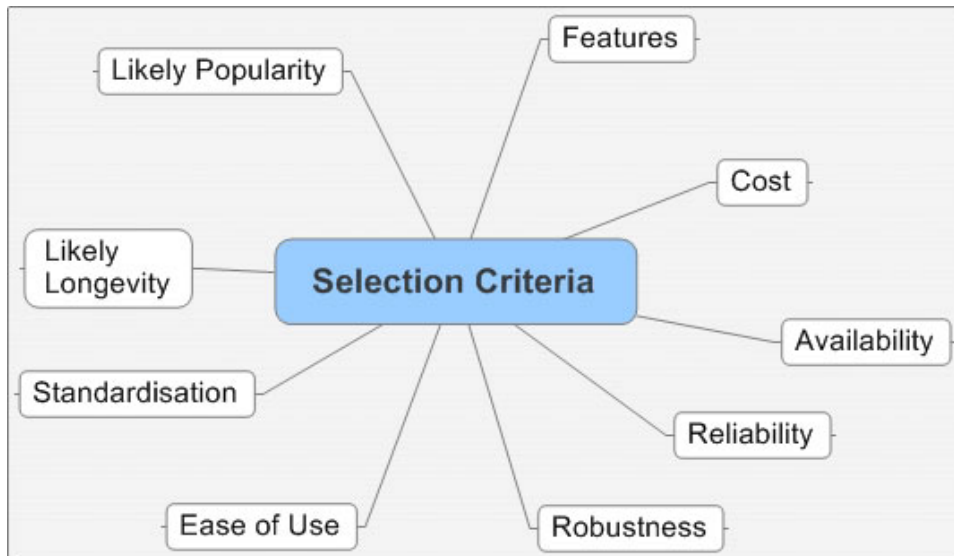
The roadmapping process was informed by initial desk research and experimentation to ascertain what technologies were available and how they might serve the projects aims and objectives.

Five broad categories of technology were identified, within which specific technologies would need to be selected, these were: transport, platform, delivery and media technologies plus development languages and are described in figure 1.



**Figure 1**

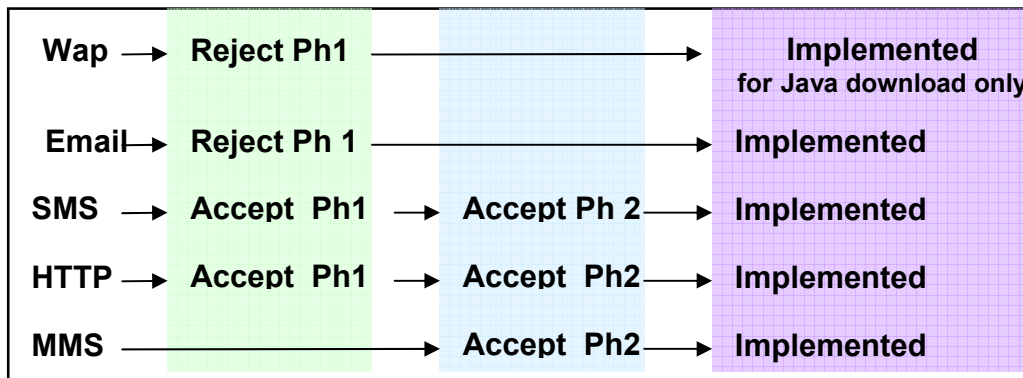
Discussions between project partners established seven criteria necessary to consider in selecting technologies to be used (see figure 2). These were: the usefulness of the features offered by the technology; cost issues, availability in the partner countries and patterns of availability within those countries (e.g. a service might only be widely available in urban areas); reliability; robustness; ease of use (for both users and developers); standardisation (and thus how portable materials developed might be); likely longevity in the market place and likely popularity (particularly with members of our target audience i.e. 16-24s).



**Figure 2**

Each technology identified as potentially useful to the project was considered and allocated a score against each of the seven criteria. As not all criteria were considered equally important, and relative importance varied between different types of technologies, weightings were agreed for each of the criterion within each of the technology categories and applied to the scores. Members of a technology selection sub-committee each allocated scores to all technologies and then during discussion a common set of scores was agreed upon. This process was repeated several times during the project to take account of experience gained and to consider, or reconsider, new or improved technologies. Figure 3 illustrates how decisions concerning some technologies changed over the life of the project.

**DELIVERY OPTIONS**



**Figure 3**

The Technology Selection Roadmap process encouraged detailed discussion of the merits and problems of each technology and facilitated logical and thoughtful collaborative decision making with the aim of making the selection process as objective as possible.

### **Lessons for mobile learning developers and implementers**

Some key lessons learned during the m-learning project were:

- A mixture of online learning and learning using materials previously downloaded onto handheld devices helps to reduce costs and the inconvenience of signal disruption whilst traveling or poor signal in some remote rural areas.
- The use of software layers to insulate learning materials from device-specific features and delivering learning materials in a browser helps overcome some lack-of-standards issues but does not offer full platform independence.
- Attempting to deliver a monolithic mobile learning system leads to inflexibility, limits ability to take full advantage of the heterogeneous mixture of hardware and services available and detracts from facilitating blended approaches to learning delivery.
- An iterative approach to development informed by learner feedback results in better learning materials and systems.
- Whilst it is possible to re-purpose learning materials developed for PC delivery to run on mobile devices, this approach may not make best use of the strengths of the mobile technologies.
- A flexible, collaborative and pragmatic approach to development works well in an environment where the technologies are new and standards are evolving. This is aided by working within a small consortium.
- It is important to be aware that, when delivering learning or offering support services to learners' mobile phones, one is encroaching on their personal space.
- For our target audience teacher/mentor enthusiasm and involvement seem to be very important for successful mobile learning.
- Sufficient training preceded by training needs analysis is important for teachers/mentors as mobile literacy and confidence varies.
- Fast response to mentor and learner problems is crucial to avoid disillusionment and stalling momentum and proactive support for those just starting to support mobile learning plus ongoing access to advice is helpful.

### **3. THE TEACHERS TOOLKIT**

Two of the m-learning project partners (LSDA and Tribal-CTAD) are currently working on the development, piloting and evaluation of a mobile learning toolkit for teachers. The toolkit includes authoring tools which teachers use on a PC to create learning materials which are then accessed via learners' mobile phones or transferred onto learners' palmtop computers.

The tools include:

- An SMS (text message) quiz authoring tool  
this tool allows teachers to set up an automated response system for a multiple choice quiz. The quiz can be presented to the learners in any way e.g. a paper handout, a poster, a website or on a whiteboard or in a PowerPoint presentation. When the learners send the answers to the questions by SMS they receive almost instant feedback.
- A mediaBoard authoring tool  
this tool allows teachers to create interactive learning tasks and projects for groups of learners. Each mediaBoard a teacher creates is rather like an Internet message board but consists of a visual image. Learners can attach audio, text and images to areas of the image, sending these by e-mail, or by multi-media message (MMS) from a palmtop computer or a mobile phone.

- A Pocket PC authoring tool  
this tool allows teachers to author multiple choice quizzes, including pictures and text, for delivery via any device supporting the PocketPC operating system. They can also author simple Pairs or Snap card games and small pages of text.

Piloting and evaluation of these tools will include consideration of ease of use and usefulness to teachers as well as exploring the different uses teachers find for the tools, the contexts in which they use them and the learning materials they develop.

The development of this toolkit draws upon the experience of the m-learning project and is the next step in a process starting with research and development and resulting in practical easy to use tools which will allow teachers to develop mobile learning materials and experiences tailored to the needs of their particular learners in their specific context.

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## XML saves the day: Porting a Rich-Media Collection to a Mobile Platform in Three Weeks Flat

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### Abstract

Since 2001, we develop specifications and tools for creating and deploying rich-media content. Our GLIFOS Markup Language (GML) is an XML-based specification that separates the content (videos, transcriptions, slides) from the rendering of the rich-media player. Using our tools, the University Francisco Marroquín (UFM, Guatemala) has created and hosts an online library of over 300 hours of enriched streaming video ([www.newmedia.ufm.edu](http://www.newmedia.ufm.edu)) to support web-based and classroom teaching.

GML is technology, platform, and format independent. We claim that these qualities guarantee content portability to diverse platforms in use today, as well as to those that will arise in the future. We had backed this claim by proving how simple it is to port GML to the leading platforms (e.g., Real Player and Windows Media Player), however, we had yet to port it to a truly new platform—that is, one that arose after the design of our XML specification and our content creation tools.

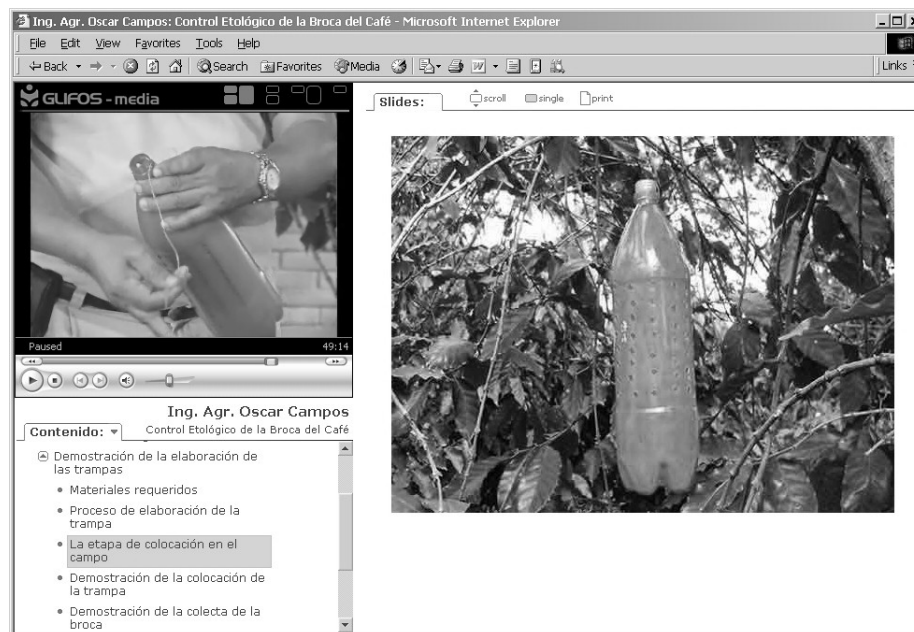
This paper describes our XML specification and content creation tools, and gives a week by week description of our experience porting the UFM's collection to the new PDA models. Such mobile devices are able to stream video through their Wi-Fi connection, without clogging their CPUs or draining their batteries. Finally, we discuss how this experience has validated the importance of XML for digital preservation and our tools' ability (so far) for porting content to new platforms.

### Keywords

Rich-media, digital preservation, XML/XSLT, mobile learning

## 1 Introduction

When working with rich-media, we always keep two basic principles in mind. First, rich-media content should integrate video, audio, text, and images in such a way that the richness of each individual format is fully realized. For instance, the more convenient way to present a list of tools and materials may be plain text, while video is a richer medium for reproducing the process of making a particular knot, and a high-res image can show in great detail the *broca* worm trap you need for protecting your coffee trees (Fig 1). This mix of media also helps support various learning styles and reinforces the topic being taught in complementary ways.



**Figure 1. Building a *broca* worm trap: rich-media presentation of a manual process**

The second principle we refer to is inspired in the time-tested paratextual devices employed in bookmaking—that is, we strive to give video and audio the functionality that a *text* enjoys once it is built into a *book* (Genette 1997; Pasch 2004, p.33-40.) Thus, among other actions, users should be able to easily navigate the media content, to find specific sections or terms, to make annotations, to bookmark specific parts, and to extract references. Such features allow users to interact with the media, which has been shown to support learning (Shephard, p. 296)

One perceived limitation of rich-media is its lack of interaction, both between student and instructor and among students. This "limitation" is shared by books, where the interaction between reader and author is non-existent or, at best, asynchronous. Still, for centuries the written word has successfully been (and will continue to be) an important part of most learning environments, just like "on-line learning resources that embed streamed video can increase opportunities for independent learning" (Green et al., 2003). Although neither books nor rich-media by themselves may satisfy the learning needs of those students who prefer face to face learning, recent studies show that students enrolled in distance learning programs prefer by far the convenience and control of asynchronous media content over more interactive and expensive synchronous set-ups and even face to face classes (Baessa & Fernández, 2002; Beyth-Marom et al, 2005; LeBlanc, 2004.)

The value of rich-media resides in the aggregation of content into a *collection* large enough to support academic reference and research—that is, a rich-media library. We have been building a rich-media library since 2001, and by mid-2005 it contains over 500 hours of content. Obviously, the value of such a library depends on its usage, both in the short and in the long term. In the short term, our software tools should facilitate access to its content, enabling users to locate individual segments within rich-media contents via the full-text search capabilities of the library catalog. And to ensure its long term usage, our digital preservation strategy should guarantee content portability to future platforms.



Within this context, we decided to port our rich-media collection to the new wireless PDA platform. We did so for several reasons:

1. **Proof of concept.** We have argued elsewhere that our XML-based digital preservation strategy guarantees portability to future platforms (Pasch & Arias, 2003; 2004), but until now, we had yet to port content to a truly new platform-- that is, one that arose after the design of our XML specification and the deployment of our content creation tools.
2. **Lower access cost.** Currently, a PDA with WiFi and color display costs half as much as a PC, and only one third of a laptop. Thanks to its high mobility, PDAs are even more suitable than laptops for some learning environments.
3. **A research tool.** Some trends indicate PDA functionality is being subsumed within mobile telephone devices, while such devices continue improving its processing capacity, display resolution and data bandwidth. Thus, a wireless PDA within university campus boundaries gives us today a test bed for what will be available out in the "real world" in the coming years.

## 2 Rich-media Content Creation

Rich-media production at the Universidad Francisco Marroquín (UFM) in Guatemala began in mid-2001 at the newly formed New Media department ([www.newmedia.ufm.edu](http://www.newmedia.ufm.edu).) The purpose of this initiative was preserving unique, locally produced content and distributing it widely via the Internet (Pasch & Stewart, 2002; Pasch, 2004a.) By mid-2005, over 500 hours of streaming video have been produced in-house and deployed as rich-media content. About 90% of these videos present one-hour lectures enriched with tables of contents and/or PowerPoint slides. There are two main uses for such content: as primary material for web-based courses and as reference sources in both distance and face to face classes. Courses include topics like business ethics, forensic science, and everyday logic. Speakers include important and once in a lifetime visitors to the UFM campus, such as Vernon Smith (Nobel in economics), Jeff Taylor (CEO, monster.com) and Carol Brey (President, ALA). Often, such visitors may show up unexpectedly, but the New Media team is able to move from preproduction to completed, web-posted product within the same day. Successful and fast development depends on a well thought-out workflow, which briefly consists of three steps.

1. Preproduction: discuss desired uses for presentation and plan the production schedule
2. Media production:
  - a. Tape the presentation, or convert existing video or audio to digital format
  - b. Gather and prepare additional materials, such as accompanying images (projected PowerPoint slides, overhead slides, photo slides, blackboard scribbles and drawings), audio/video (VHS, CD, DVD, mp3, etc.), printed materials (handouts, photocopies, books) and other digital objects (websites, simulations, demo programs and data files).
  - c. Digital editing of the video or audio. When required, some additional materials may be edited into the final video or audio file
  - d. Media rendering into desired format/s (streaming Windows media, QT, etc)
3. Rich-media production:
  - a. Index and synchronize the media file with the additional materials
  - b. Render all elements for viewing on desired platforms
  - c. Deploy via Internet or CD
  - d. Archive physical and digital products

A project manager experienced in rich-media production is in charge of preproduction and also checks all intermediate and final results. Media production is under the direct supervision of video production professionals who are aware of the needs for streaming media and rich media products. The rich-media production stage requires the application of specific rich-media tools, such as the GLIFOS-media suite developed by us (Figure 2) and applied by subject specialists for the analysis and publishing of content.

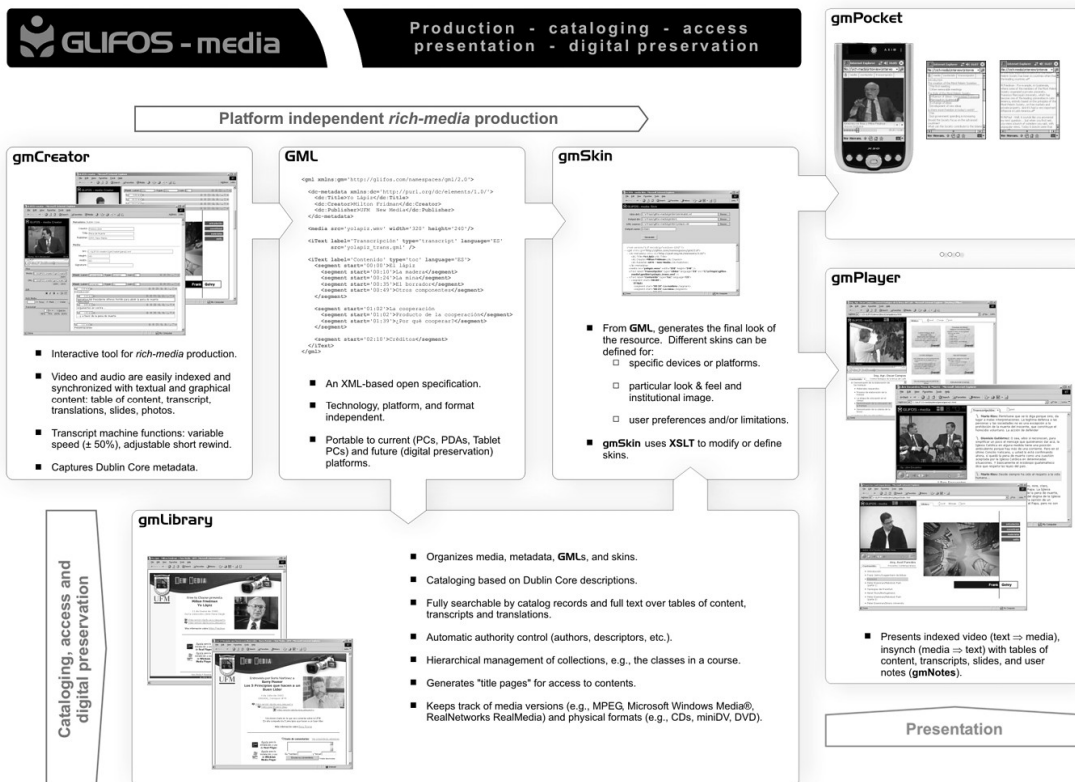


Figure 2. The GLIFOS-media toolset

First, gmCreator provides an easy to use, graphical interface for media indexing, transcription, synchronization, and metadata markup (Figure 3). For applications that require licensing, content can be signed with one mouse click. This module outputs a GML (GLIFOS Markup Language) file that follows the specification described in section 3.

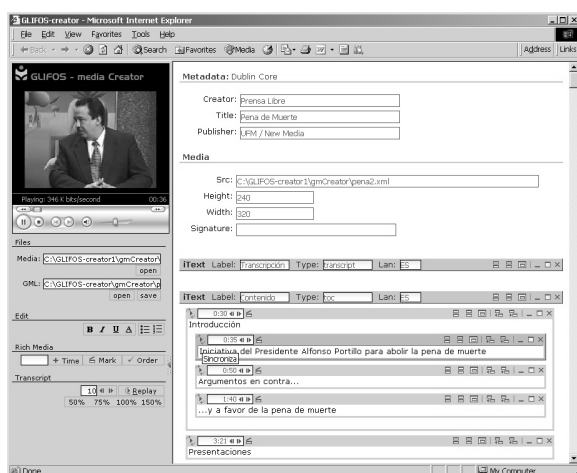
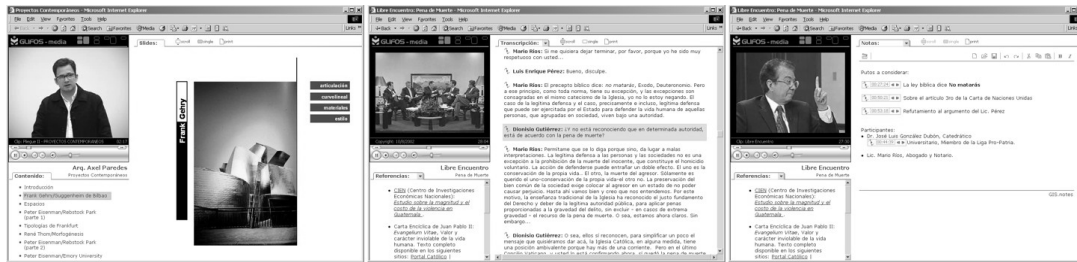


Figure 3. The gmCreator interface

Next, gmCreator is used to publish the final rich-media presentation by applying the desired skin or skins for rendering on various platforms. The skins are expressed as XSLT files that are tailored to each client's requirements. Figure 4 shows three views of the same presentation. The presentation can be published to a website or can be distributed on CDs or DVD-RAMs.

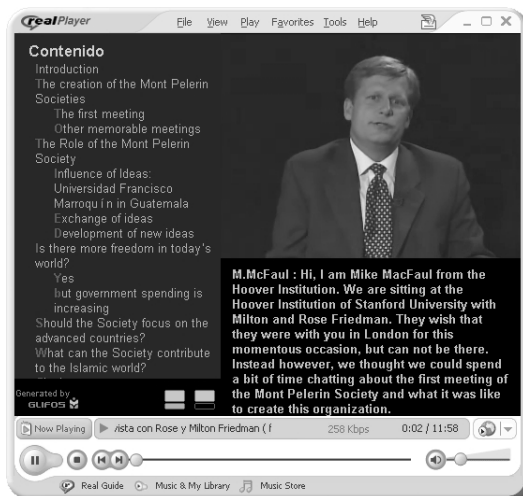


**Figure 4.** Final rich-media presentations created with the GLIFOS-media toolset. Left: a "normal" view with streaming video, clickable table of contents, and PowerPoint slides. Middle: video, links to related web resources, and full-text transcript. Right: video, references, and annotation pane that allows users to synchronize the video to their own notes.

Finally, gmLibrary supports the creation of a rich-media library by keeping track of the various elements in the production of rich-media, that is: the media files themselves, the skins used, the corresponding GML files, final renderings, and auxiliary files.

### 3. A case for content oriented XML

An open and widely adopted XML-based standard does not suffice to ensure the digital preservation of content. By the late 1990s, SMIL 1.0 (Synchronized Multimedia Integration Language) was a widely accepted XML standard, and RealNetworks' RealPlayer was the platform of choice for both streaming and locally stored media. It is easy to understand the basic component and features of SMIL by studying a simplified example. Figure 5 shows a video enriched with a table of content and synchronized transcript.



**Figure 5.** SMIL-based rich-media content shown with the RealPlayer

The SMIL files needed to generate this video are shown in figure 6. First, **f.smil** shows how `<layout>` distributes the three content regions. Note the functional dependencies in the `<region>` attributes `top`, `width` and `height` (Glushko & McGrath, 2002). Next, **f\_toc.rt** shows the tricks that are needed to properly indent the table of contents (e.g., `<ul><ul>`). However, none of these layout and formatting codes has any meaning on other platforms. On the small display screens of mobile devices it would make more sense to show just one "region" at a time (video, table of contents or transcript) and let the user switch between them. For such an interface the `<layout>` section has no meaning. Similarly, the `<ul><ul>` antics work only for RealPlayer.

### SMIL File: **f.smil**

```
<smil xmlns="http://www.w3.org/2001/SMIL20/Language">
<head>
  <meta name="author" content="Hoover Institution" />
  <meta name="title" content="Entrevista con Rose y Milton Friedman" />
  <meta name="copyright" content="(c)2004 InfoLib, S.A." />
  <layout>
    <root-layout backgroundColor="#000000" width="540" height="410" />
    <region id="wmedia" top="0" right="0" width="320" height="240" />
    <region id="transcript" top="250" right="10" width="300" height="100%" />
    <region id="toc" top="0" left="0" width="220" height="410" />
  </layout>
</head>
<body>
  <par endsync="wmedia">
    <video region="wmedia" src="f.rm" />
    <textstream region="toc" src="f_toc.rt" />
    <textstream region="transcript"
      src="f_transcript.rt" />
  </par>
</body>
</smil>
```

### RealText File: **f\_toc.rt**

```
<window version="1.5" type="generic" width="220" height="420"
  bgcolor="#282828" link="#B0B0C0" underline_hyperlinks="false" >
<pos x="15" y="20"/>
<font face="Arial" color="#D0D0D0" size="4">
<b>Contenido</b></font>
<font face="Arial" color="#404040" size="3">
  <ul>
    <a target="_player" href="command:seek(0:00)">
      <font color="#5555CC"><b>I</b></font>ntroduction
    </a>
  </ul>
  <ul>
    <a target="_player" href="command:seek(0:15)">
      <font color="#5555CC"><b>T</b></font>he creation
      of the Mont Pelerin Societies
    </a>
  </ul>
  <ul><ul>
    <a target="_player" href="command:seek(0:25)">
      <font color="#5555CC"><b>T</b></font>he first meeting
    </a>
  </ul></ul>
  <ul><ul>
    <a target="_player" href="command:seek(3:02)">
      <font color="#5555CC"><b>O</b></font>ther memorable meetings
    </a>
  </ul></ul>
  ...
</font>
</window>
```

**Figure 6. Simplified SMIL and RealText files**

Moreover, if the SMIL code is not generated but hand-coded, different content will surely end up with different tagging techniques that produce similar or different results. Even worse, as RealPlayer evolved through its versions G2, 7, 8, One, etc., the SMIL code also evolved to take advantage of the new features and to adapt to the new specifications (SMIL 2.0). As a result, porting a hand-coded rich-media collection based on SMIL and RealPlayer that started back in 1998 to newer platforms might pose a hard problem. Rule based systems may work if just a manageable number of different patterns are needed, but developing and fine-tuning those systems takes time, and their results are rarely 100% accurate.

Since digital content collections routinely outlive their comparatively short-lived platforms and standards, and migration costs rise proportionally as collections grow, the long term perspective of digital preservation becomes more apparent and urgent. This perspective guides our implementation priorities in several ways: 1) content becomes much more important than the current system, 2) each system should facilitate content migration to the next standard, and 3) content should be stored in a format that is as independent from current technologies as possible.

```
<gml xmlns:gm='http://glifos.com/namespaces/gml/3.0'>
  <dc-metadata xmlns:dc='http://purl.org/dc/elements/1.0/'>
    <dc:Creator>Hoover Institution</dc:Creator>
    <dc:Title>Entrevista con Rose y Milton Friedman</dc:Title>
    <dc:Publisher>UFM New Media - Guatemala</dc:Publisher>
  </dc-metadata>

  <media src="f.rm" width="320" height="240"/>

  <iText label="Contenido" language="en" type="toc">
    <segment start="0:00">Introduction</segment>
    <segment start="0:15">The creation of the Mont Pelerin Societies
      <segment start="0:25">The first meeting</segment>
      <segment start="3:02">Other memorable meetings</segment>
      ...
    </segment>
  </iText>
</gml>
```

**Figure 7. GML 3.0 example**

The GML version of the previous example is given in Figure 7. This presents exactly the same content as the SMIL example, while avoiding all previous inconveniences:

- It avoids any ephemeral layout and format information.
- It avoids functional dependencies (Glushko & McGrath, 2002).
- It eliminates ambiguity, e.g., table of contents hierarchy is formally specified.
- Changes in platform versions and format do not affect the content.

We have verified the advantage of GML in practice. Every time we have ported GML content to a different platform, or to upgraded versions, we have effortlessly and consistently generated the code for those platforms. For instance, it is simpler to generate SMIL from GML than vice versa (in fact, the example shown in Figure 6 was generated from GML). More than a curiosity, this is evidence of the importance of semantic information -- for translating SMIL to GML we need to add knowledge, but for mapping GML to SMIL we just need to derive code.

After showing how simple it is to port GML content to the leading platforms (e.g., RealPlayer + SMIL and Windows Media Player + DHTML) and noticing that nothing in GML specifically considers those platforms, we argued that GML's technology, format and platform independency ensures our content portability to future platforms. However, we had yet to port it to a truly new platform—that is, one that had appeared after the design of our XML specification and the implementation of our content creation tools. When the current PDA models were able to stream video through their Wi-Fi connections without clogging their CPUs or draining their batteries, we were eager and ready to validate our hypothesis with a real life case.

## 4. Portability in real life: UFM case study

### 4.1. Week 1: mobile platform evaluation and development of a functional prototype

As soon as the Dell Axim X50 520MHz Pocket PC arrived, we ran some basic tests to measure its prowess. In contrast to older Pocket PC models, the new Axim was very capable to down stream via its WiFi a full hour of near VHS quality video full-screen (512kbps, 320x240) without draining its batteries. After such promising results, we proceeded to review the available software platforms for presenting rich-media on Pocket PCs. We decided not to use Macromedia Flash Player for Pocket PC as this point, mainly because it isn't (yet) a strong player in the streaming media segment. A second possibility was the Microsoft .NET

Compact Framework, however, this platform is specific for Microsoft's Windows Mobile operating system, which would hinder our porting our implementation to other mobile operating systems. Finally, we decided to double check Microsoft's Pocket Internet Explorer. Although the name may imply that this is sort of a Mini Me (Wikipedia, 2005) version of Internet Explorer 6.0 for PCs, it is actually a very different, limited version of IE 6.0 that does not support most of the DHTML functionality.

We made a list of the essential functionality that Pocket IE must provide to be a feasible platform, and we organized the list into two categories:

- Access and control of the Microsoft Windows Media Player mobile (WMPm) object model: Pocket IE should be able to stop, pause and play the WMPm at specific times, WMPm should provide connection status and progress time information, and there should be a way to generate a time based event.
- Layout redesign: since the pocket PC resolution (320x240pixels) is less than 1/10<sup>th</sup> of the XGA resolution (1024x768pixels), a complete layout redesign was needed. The new layout should be able to present just one rich-media format at a time (video, table of contents, transcript, etc) and switch between them easily.

After a brief testing and validation period, we weighed the inherent platform limitations. For instance, since the media progress slider built into WMPm wasted too much display real estate, we decided to implement our own slider. Also, for the time being we decided to present just the first two levels of the table of contents (more levels looked confusing in such a narrow space), and we did not include slide presentations (although we added them later).

At this point, we had a working prototype (Figure 8) but we weren't concerned with look and feel, because one of the main advantages of XML/XSLT is the ability of separate content and format not just at the conceptual level, but also at the developer's role level.



**Figure 8: First-run results (Week 1)**

#### 4.2. Week 2: XSLT based skin development for rendering content on mobile platform

After producing a functional proof of concept, the rest of the work became quite mechanical. Our graphic designer proposed a look for our new player, and our skin developer started the generalization of the working prototype to create its corresponding skin. This particular skin is mostly XSLT code that

automatically generates the HMTL and Javascript code needed to present the rich-media on the new Pocket PCs. Both at the design and skin creation level, special care was given to several factors:

- User interface should be intuitive and natural
- A clean and clear look and feel was desired
- Any wasted space should be eliminated

Figure 9 shows the final result of the new skin design.



**Figure 9: Final results (Week 3)**

#### 4.3. Week 3: streaming media capabilities, testing and refinement

The remaining tasks, before the beta release for end user testing and feedback, were:

- Skin generalization and validation using a wider sample of GML contents
- Real life testing (e.g., campus-area testing, checking Internet bottlenecks)
- System testing, bug fixing and fine-tuning

Even though we have performed a robust unit testing during weeks 1 and 2, the system as a whole exhibited some problems during its real life tests. For example, after long media buffering delays through Internet bottlenecks, we decided to add a buffering progress message. Some noise artifacts were solved when our skin developer eliminated certain inefficiencies in the Javascript code.

At the end of the third week, the skin was beta released for batch and on-the-fly rendering of rich-media content for pocket PCs. During the whole process we did not have to change anything in our GML specification, nor did we feel the urge to do so. The advantages of separating content and format were evident all the way down to the developers' roles. This clean cut division of specialized labor allowed us to build a robust port to a brand new platform in three weeks flat from the time the Pocket PC arrived to our office.

## 5. Conclusions

The experience described in this paper has led us to appreciate the advantages of our approach for digital preservation, portability to different platforms, and ease in the division of labor.

First, two well-known threats to digital information are deteriorating media and obsolete hardware. Preventive measures include periodic re-copying, LOCKSS ("lots of copies keep stuff safe"), and maintaining required hardware in working order. However, even if one can successfully read the data off a 20-year old floppy disk, there's still the question of how much one can do with that data. If one is limited to running old applications (say, Visicalc) one is also limiting the usefulness of the data (for example, the ability to include newer data, to create graphs or interact with other applications) unless it is migrated to a modern format (such as Excel.) The GLIFOS-media system offers clear advantages related to preservation. First, GMplayer does not rely on "marks" embedded into the video or audio files. Thus, if the media needs to be re-rendered (e.g., for a new codec) it is not necessary to re-mark the new file with indexing points. Second, one must assume that a new set of tools may emerge at anytime, and if this happens, the most valuable asset one needs to hold on to is data. In the case of rich-media, this includes first and foremost all indexing, transcription, and synchronization information. The GLIFOS-media system uses XML to store all data and metadata. XML files are simple text files, and their structure is human-readable, therefore no applications are absolutely required in order to exploit the data, and the data can be easily migrated to new, desired formats. In addition, the GML files contain its own metadata, down to the level of detail desired by the producer, thus no separate metadata system is needed.

Regarding portability, we believe this experience is a step in the right direction in porting our content to mobile platforms. First, since the UFM is a WiFi campus, a reliable, fast, and inexpensive platform is in place to test our functionality. Second, the functionality of PDAs may end up being subsumed within mobile telephony, but at the same time mobile telephony is improving its bandwidth, functionality and screen resolution.

All of these factors help lower the cost of managing the content and extending its lifespan. Although XML offers a very useful and novel platform, it does not by itself guarantee good specification design, in the same way that using a relational database management system does not guarantee a good database design. Methodologies specific for the particularities of XML are needed.

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**Title of paper:**

“EDUGAMING PCs AND QUICKPDA –eBOOKS: A new model for surpassing fragmentation in mobile learning on e-health”

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**Abstract:**

Many medical e-books are but digitalized versions of their written counterpart, with their interactive component limited to a “click” and “scroll” function, known as “fancy next-clicking e-books”. Their potential as valuable tools in life-long-learning processes, and its instruccional technology’s requirements are limited. On the other hand there is still fragmentation in trying to close the gap between learning applying x-rays films in medical training and learning games during medical practice.

The objective of this paper is to try to address these limitations which are the result of fragmentation on e-health, because of the amount of new information and number of communication devices.

We present an instruccional technology fusion strategy of edugaming on PC’s and QUICKPDA e-books in our hospital environment. Our development has been applied during the first two years of radiology residence. Measurements of retention and learning were assessed using a virtual platform of LMS (Learning Management System).

The design, learning theory justification, and preliminary results are presented. We discuss evaluation of the model and the future of mobile learning on e-health.

**Keywords:**

Mobile technology, Instruccional Technology, Lifelong learning, e-health, fragmented learning process, medical.

## **Getting over mobile fragmentation on e-health environments.**

On health environments there is also a fragmented learning process due to several mobile learning objects known as a “fancy next-clicking e-books”. Most of the information on these formats are sometimes difficult to integrate during medical practice because of its lack of instructional technology design and the limitation for including radiological teaching images (chest x-rays) to be played on a mobile device’s screen.

These problems have to be address in order to secure a successful arrival of mobile learning on e-health. Therefore, it was necessary to create a well tailored learning/knowledge theory that differs from classical “linear transmission of knowledge”, robust enough to support and overcome m-learning fragmentation. This paper depicts the main principles of our e-learning theory with its new promising design solutions of m-learning that contributes to the overall medical user experience. In this matter we included an interactive complementary e-training module that emulates sometimes a virtual machine (VM), to “let know to the student how and when” apply a mobile quick-reference tool. For this we decided to apply andragogy principles, and others learning tools to improve and secure our learning memory and prediction system in radiology.

## **Introducing edugaming into Continuing Medical Education**

This interactive e-book, is accessible over the web and suitable for Continuing Medical Education. Also, its interactivity uses e-learning games (edugaming) in addition to the traditional multiple choice and true or false formats, accessible at the end of each chapter to make fun and enjoyable the learning process

Our development has been applied during the first two years of radiology residence. Measurements of retention and learning were assessed using a virtual platform of LMS (Learning Management System) in Moodle. In this regard we emulated the same look and feel radiological x-ray cases in a question format, to demonstrate if the radiology resident was able to find correctly relevant imaging findings.

The design, learning theory justification, and preliminary results are presented. We also discuss this evaluation of the model and the future of mobile learning on e-health.

## **LEARNING OBJECTIVES**

1. Understand the changes needed to transform e-reading textbooks into useful life-long-learning tools.

2. Introduce a revolutionary way of making e-books.
3. Overcoming the fragmentation of m-learning on medical educational PDAs.
4. Introducing learning by playing on a mobile learning health environment.

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