Trends in Distance Education and Open Learning: Policy Papers

DRAFT

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This new on-line publication, Trends in Distance Education and Open Learning: Policy Papers, has been initiated by the Working Group on Distance Education and Open Learning (WGDEOL) of the Association for the Development of Education in Africa (ADEA). The aim is to meet the growing demands of policy makers, practitioners, educators and learners especially in Africa where although e/open-learning is becoming popular it remains at its infancy stage\(^1\) with a wide variety of practices. The silver lining is that there is appreciable enthusiasm amongst African experts for developing the potential of e-learning\(^2\).

Africa is facing several challenges. The donors are reducing their aid to education by nearly US$20 billion annually\(^3\). Consequently, the lack of funding has resulted in fewer classrooms, poorer quality of education, acute teacher shortages, insufficient number of books as well as larger number of children who are out of school. These effects are more strongly felt in Africa especially Sub-Saharan Africa. An additional 1.9 million teaching posts need to be established to achieve universal primary education by 2015; more than half of them are required in sub-Saharan Africa, where pupil/teacher ratios are high. About 17 percent of the world’s adults – 796 million people – still lack basic literacy skills\(^3\). Nearly two-thirds are women. Lack of literacy skills can have severe consequences like in Malawi, 60 percent of mothers with secondary education or higher were aware that drugs could reduce transmission risks, compared with 27 percent of women with no education\(^3\). Well educated citizens also acquire other essential skills for a flourishing multi-cultural society like the skill of living peacefully with other people. In such a situation how do we implement the directives of Article 26 of the Universal Declaration of Human Rights which calls upon the world leaders to make fundamental

\(^3\) EFA Global Monitoring Report 2011
education free and elementary education compulsory⁴? It is advocated that DEOL can help.

There have been several phases in the development of online-learning. The first phase was closely related to establishment of the Computer Based Training Systems created in 1984 which was followed by the CD-ROMs that were used to train people. In the second phase on-line learning was mainly concerned with the delivery of text-based programmes with negligible web-based discussion and chat rooms. Use of email and the Internet focussed on interaction through text-based exchanges that also allowed file sharing through attachments. In the present phase the focus is on virtual reality that allow effective interaction in virtual classrooms setups as well as on mobile telephones for ubiquitous distance education.

The definition of e-learning has also evolved. In late 1997, learning guru Elliott Masie⁵ said, “Online learning is the use of network technology to design, deliver, select, administer, and extend learning.” In 1998, Jay Cross⁴ wrote, “eLearning is learning on Internet Time, the convergence of learning and networks. E-Learning is a vision of what corporate training can become. E-Learning is to traditional training as e-Business is to business as usual.” In 1999, Cisco stated that, “eLearning is Internet-enabled learning. Components can include content delivery in multiple formats, management of the learning experience, and a networked community of learners, content developers and experts.” According to Eke (2010), “e-learning is generally seen as either learning via the Internet or any other electronic means or gadgets. E-learning comes in different formats and categories.”

Another noticeable change is that previously DEOL tutors were selected among those tutoring in conventional education who did not know much about the mechanics of DEOL; however, currently we are witnessing an increasing number of professional DEOL experts.

⁴ http://www.un.org/Overview/rights.html
The anytime-anywhere characteristic of DEOL has the potential of making education more accessible especially to marginalised groups in rural areas as its content can be delivered through radio, video, CD-ROM, desktops, notebooks, TV, web, videoconferencing, wired networks, wireless networks, satellites, e-mails, blogs, micro-blogs, twitter, wiki, i-pods, i-pads, podcasting, RSS feeds, mobile phones, virtual classrooms, proprietary platforms such as Friendster and shareware such as moodle and drupal.

However, there are several challenges like lack of infrastructure and computer skills, low bandwidth, unreliable Internet and telephone connection, limited access to e-library, limited number of computers, non-uniform electricity supply, lack of trained teachers and e-learning content.

The first paper in this series is on the use of mobile technology for teaching and learning based on a research study. It does not only explain the use of mobile technology but it illustrates it use through several insightful case studies.

In the current increasingly technology-oriented, wired and fast-moving world, everything is becoming global and we continuously need fresh thinking as the past is not sufficient to illuminate the future. It is expected that this publication will not only add to the insights and experiences of the readers but it will also help them to reflect on the new trends in DEOL. It is vital that we share the publications while promoting the appropriate environment that allows us to co-create more of these. We hope that more policy makers start to look seriously at open and distance education practiced in Africa.

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Use of Mobile Learning in Educational and Training Settings
Use of Mobile Learning in Educational and Training Settings

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Executive Summary

The study presented in this report makes an assessment of the current progress in mobile learning across the globe and proposes a comprehensive framework for the successful implementation of any m-learning project in the context of the African educational needs. It is known that the mobile technology is bridging the digital divide faster than desktop PCs and that highest rate of mobile subscriptions during the past decade is in Africa. There have been numerous initiatives and pilot projects on the continent with satisfactory outcomes, but on a smaller scale. Many of the educational issues such as massive training of primary educators remain unanswered or unaddressed from a mobile learning perspective. Therefore the scope for the introduction of m-learning at different stages of the curriculum and in blended manners is immense. From the case studies scrutinized, it is obvious that some projects can be easily replicated to some African formal or informal education or training settings, however, the specificity of the each country can bring innovative educational scenarios that can be converted into m-learning projects and the framework described at the end of this report could be very useful. Similarly to any technology driven project, the emphasis on learning and pedagogical aspects should not be distracted. How far components can be re-used and the appropriate choice of technology have a definite impact on the cost effectiveness of any m-learning project. This research has shown that m-learning should be viewed as a paradigm shift rather than a simple extension of OEDL and is actually in its second generation globally. The benefits from this mode of learning had been poorly tapped in and the numbers of educational constraints that can be tackled with m-learning remain very much unexploited on the continent although it goes along with business opportunities in the education sector.
Policy Brief Document

This document lays down draft policies in view of the implementation of mobile learning (m-learning) in formal and informal educational and training settings following a research study contracted out by the Association for the Development of Education in Africa (ADEA).

1. Education Access & Reach
   (i) Institutions need to identify and imagine educational scenarios whereby m-learning can add value to the current educational goals and objectives. For instance, the blending of m-learning with current modes in DEOL should be envisaged.

   (ii) M-learning must be adopted and adapted to broaden reach and access to a larger population in rural areas.

   (iii) Train the trainer courses on a massive scale with m-learning should be elaborated.

   (iv) m-learning must be made accessible to the vulnerable groups though community centres with the assistance of the private and public operators.

2. Integration of m-technology in curriculum
   (i) Integration of m-technology for teaching and learning purposes must be initiated as from the Primary level, given the acquaintances of younger generation with the mobile phone and the internet.

   (ii) At the secondary level, universal subject on ICT including mobile communications should be present.
(iii) Use of mobile applications and Campus WiFi should be part of the universities infrastructure administrative and academic tools.

(iv) Candidates eligible for foundation courses for a pathway towards mainstream university programmes should be assisted with mobile technology in order to increase their chances towards success. This initiative will boost the tertiary intake figures.

3. **Mobile Content Development**
   (i) Necessary infrastructure and human resources are to be indentified to create capacity building in mobile content development.

   (ii) Open source technology should be favored for projects to be cost effective and sustain economy of scale.

   (iii) M-learning projects must create new business models and opportunities and linkages and ventures with market leaders are to be encouraged.

4. **Mobile Broadband and Multimedia Services**
   (i) Regulators and the Internet think tank need to ponder on how to bridge the Broadband divide.

   (ii) Special consideration must be given to capabilities to broadcast Multimedia services.
5. **Choice of Technology**

(i) Appropriate choice of technology in the implementation of m-learning projects will impact on the ROI and learning outcomes.

(ii) The knowledge transfer and adoption of emerging technologies, such as tablets is crucial to ensure a world class standard of the education.

(iii) Satellite technologies like the VSAT and other domestic services can be very useful to Africa in terms of coverage and pricing competitiveness.

6. **Research and Innovation**

(i) Innovation and entrepreneurship in educational mobile apps. must be fostered via incubators and competitions.

(ii) Local universities and applied research centres should come up with commercial apps. for mobile education through a strong South-South collaboration with other African universities and centres of excellence. Such initiatives will undoubtedly generate low cost products for the African continent.
Introduction

Mobile Learning often referred as m-learning is a very broad and multidisciplinary topic encompassing technology, education, society, economy and many more that need to be addressed from diverse angles and perspectives. The ever changing landscape of the educational sector in Africa and the needs in terms of delivery and support will pressure institutions and universities towards the use of mobile technology for sustainable and innovative educational experience for students and teachers.

The study presented in this report take into account recent advances, research findings and success stories internationally and in the African continent with the aim to come up with a Framework for the Implementation of Mobile Learning and Training.

While remaining focused on the requirements of the terms of reference described earlier, this report encloses substantial amount of issues and information necessary towards a pragmatic outcome and concrete answers to the objectives set. Part I answers to the objectives: Explaining what mobile learning is; Presenting the current status of mobile learning as well as latest research; Outlining the challenges faced by when designing and implementing mobile learning. Part II relates to the objectives: Compiling advances, initiatives and applications in mobile learning. Part III responds to the objectives: Documenting case studies of how mobile learning is being used to teach and train in different places worldwide; and discuss the future of use mobile learning in education, training and informal settings.

The scope of work is addressed in summary form in the sections Research Gaps & Directions, Best Practices and Recommendations. The report ends with a general conclusion and appendices with facts and figures in mobile technology and m-learning deployment.
Extract of the Terms of Reference (ToR)

It is important to identify challenges organisations face when implementing mobile learning and what can be done to make it successful as well as explore theoretical models for developing and implementing it. Moreover, employees in businesses who have mobile that they use for work related tasks must be encouraged to use the same technology to access learning materials for application on the job. Thus as more businesses start using mobile technology for learning, they will need to know about the best practices when implementing mobile learning, and this study provides valuable information in this regard.

1. Goals

A framework for the implementation of mobile learning and training

2. Objectives

This study aims at:

- Explaining what mobile learning is;
- Presenting the current status of mobile learning as well as latest research;
- Compiling advances, initiatives and applications in mobile learning;
- Outlining the challenges faced by when designing and implementing mobile learning;
- Documenting case studies of how mobile learning is being used to teach and train in different places worldwide; and
- Discuss the future of use mobile learning in education, training and informal settings.

3. Scope of Work

Analyse and examine the research findings, issues and challenges related to the use of mobile learning in informal, educational and training settings at both international and continental level.

At the substantive level, the research team will gauge the extent to which:

- mobile technology is deployed in an education, training and informal settings;
- mobile, wireless, and handheld technologies are used to improve conventional e-learning;
• how these technologies are linked to Virtual Learning Environment (VLE);
• mobile technologies can be flexible replacements for static desktop technologies;
• mobile technology can be used to support collaborative learning and training;
• mobile technologies are used for informal, personalized and situated learning;
• video capture on mobiles can enhance learning;
• mobile technology is being used to increase customer satisfaction, productivity, efficiency and effectiveness at the workplace and business through the compilation of case studies;
• mobile technologies can be used to address environmental and infrastructural challenges to delivering and supporting education where conventional e-learning technologies would fail through the compilation of case studies;

The research team should also
• define mobile learning in an education, training and informal settings;
• define the necessary conditions required to use the mobile technology; and
• develop the necessary framework of mobile learning linking it with those of the educational, training and blended learning.
Part I: Integrating Mobile Technology in Education

Integration of technology into curriculum has not always been a simple task. M-learning started around 2001 and it’s still being implemented in short term pilot projects with little consideration about completion or award, in a very informal manner. Therefore, we see integrating mobile technology in formal educational curriculum as a very important aspect in implementing mobile learning future projects. The 3 types of integration are briefly described here.

Media integration, in terms of information flow and conservation of results across different media used in the learning setting; Process integration, i.e., the technical facilitation and support for learning processing involving participants in different roles; Knowledge integration, in the sense of a broader structuring, systematisation and “defragmentation” of knowledge. (Mike Sharples, Big issues in m-learning)

1. Definition of mobile learning

There are many definitions of mobile learning in the literature but as technology and education delivery themselves have been undergoing rapid changes in the past decades, for instance the combination of the Internet with mobility has prompted researchers to have different appreciations about the real definition of mobile learning.

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).

Mobile learning (or m-learning) is defined by Clark Quinn [Quinn 2000] as... the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment. E-Learning independent of location in time or space.

A wide definition of mobile learning (commonly referred to as m-learning) is the ability to learn independently of place and time, facilitated by a range of mobile devices.

According to Wikipedia Definition; M-learning is the term given to the delivery of training by means of mobile devices such as Mobile Phones, PDAs and digital audio players, as well as digital cameras and voice recorders, pen scanners etc. M-learners are seeking lessons in small, manageable formats that they can undertake when it suits them. M-learning is often considered as a subset of e-learning being itself a subset of a broader concept of distance education or again simply a technological extension of e-learning.
The learner’s mobile device can be a laptop, a micro computer, a cell phone, a tablet PC or a pad, a game device, an audio or video player, a PDA, a wearable, an ad hoc network, in any technology that keeps the user connected and moving together. The incredible thing about mobile device is that most of the people have one, it’s private, it’s social, most of the time it’s on and we carry it everywhere (Judy Brown). A survey has shown that almost 24% of users would be more anxious to lose their mobile phones rather than their credit cards.

2. The mobile learning system

The mobile learning system or echo-system comprises the different stakeholders and components such as end users’ devices, content servers, public networks, institutional support, etc. The figure I.1 shows a model of a m-learning system where mobile learning is the central system related to interface, connectivity, applications and variables, factors that need to be addressed in the formulation of a m-learning project.

Mobile technology as other ICTs is an enabler in the transition from educational institution centred learning provision to learner centric learning provision.
3. Context Awareness

The concept of access to information anywhere, anytime and to anyone is commonly referred as pervasive or ubiquitous computing.

Just as resources and computational nodes are pervasive, mobility introduces context awareness of the learners; this dimension has generated ample research in terms of context awareness applications and computing paradigms.

A learner can learn independently of the location with m-learning, similarly he/she may also drive the maximum benefits of the context in terms of space, time and topics.

Topics such as archeology and geography have been proven to very effective with PDAs and smartphones.

Context has been defined by a number of researchers. Mark Weiser’s now legendary article defined ubiquitous computing for the first time. Context is a general term and can be categorized into three categories in the realms of mobile computing — computing context, user context, and physical context.

1. Computing context (what resources you have) — such as network connectivity, communication costs, and communication bandwidth and nearby resources such as printers, displays, and workstations
2. User context (whom you are with) — such as the user’s profile, location, people nearby, even the current social situation
3. Physical context (where you are) — such as lighting, noise levels, traffic conditions, and temperature

In order to capture fully a context given a complete sensor network infrastructure is needed. Furthermore, a learner may sometimes change context during a learning activity; how far the learning activity is seamless in situations of context change remains a communication and computing challenge.
4. M-learning Frameworks

Framing m-learning has been widely discussed by many researchers in attempt to formalize the methodology for implementation.

The three circles represent the device (D), learner (L), and social (S) aspects. The intersections where two circles overlap contain attributes that belong to both aspects. The attributes of the device usability (DL) and social technology (DS) intersections describe the affordances of mobile technology (Norman 1999). The intersection labeled interaction learning (LS) contains instructional and learning theories with an emphasis on social constructivism. All three aspects overlap at the primary intersection (DLS) in the centre of the Venn diagram. Hypothetically, the primary intersection, a convergence of all three aspects, defines an ideal mobile learning situation.
Figure I.3 shows how the four M-learning design requirements; learning objectives, learning experience, M-learning contexts, and generic mobile environment design issues, interact. As an example of these interactions, consider M-learning for dynamic complex situations, such as rescue services or intensive care. These require the collective learning objectives, particularly developing team skills. This learning objective would be supported by the learning experiences conflict, competition, challenge, and opposition and social interaction. These learning experiences would require the corresponding M-learning contexts; including activity, spatio-temporal, facility and collaboration, which in turn would map in a context specific way to generic mobile design requirements.

The framework was tested and applied on four successful M-learning environments that had differing characteristics. These were; Ambient Wood [9], Thinking Tags [19], Uniwap mobile teacher training [20] and Mobile Learning Organiser [21].
Define the education components and services, required by the mobile learning system. These components and services depend to the type of course.

- Identify the existing wireless network capabilities and boundaries. If there are different networks, select the one, which is most appropriate for the education components and mobile devices capabilities.
- Determine the types of mobile devices, which are intended to be utilized in the system.
- Distribute the education components and services based on network capabilities and usability requirements of each mobile device.
- Write scenarios, which express the mobile learning system. In the scenarios all the components are distributed to appropriate devices with consideration of their capabilities and the usability requirements.
- Design prototype based on the scenarios. It is important to follow the usability guideline for each device very carefully.
- Test and validate the concept and service distributions to different devices.
Based on the three dimensions technology employed, policy deployment and pedagogic influence, the author (Smith, 2003) has defined the ‘Triangle of Ubiquity’, as illustrated in figure I.5. The technology dimension draws on the work of Brown and Pettito [2] who suggest a hierarchy of ubiquitous computing. This attribute measures the degree of portability, sophistication and homogeneity of the pool of computers deployed. For example, some institutions require all students to have a laptop computer, a few issue handheld personal digital assistants, and some provide round-the-clock, 7-day access to open access rooms of workstations. The common theme is that education can proceed on the assumption of a common set of facilities, with access to networks and the Internet being available to all students and staff within a particular group. When this available, there is the potential to transform the learning and teaching environment.
Means-ends Objective Network (Gray boxes highlight the instructors concerns) (Sheng, Siau, Nah, 2010)
The overall objective for mobile applications and technology in education is to maximize the values of education. We identified eight fundamental objectives in this study – maximize convenience of education, maximize efficiency in learning, maximize effectiveness in learning, maximize usability of mobile education services, maximize security of student/instructor information, maximize individual privacy, minimize cost of education, and ensure academic honesty. These eight objectives represent the fundamental values of mobile applications in education from the students’ and instructors’ perspectives and determine the “principles” (Keeney, 1992) for assessments concerning the use of mobile technology for education. These objectives are the fundamental reasons that drive mobile application development for education purposes.
5. Interoperability with VLES

As it was mentioned earlier, many educationalists advocate and view mobile learning as part and parcel of blended learning. How does mobile learning interoperate with virtual learning environments? This is critical for successful mobile technology integration into education.

Almost all learning management systems (LMS) such as Moodle and WebCT are equipped with mobile accessibility features. Current commercial LMSs are listed in Appendix 3. Developing middleware and application programming interfaces (API) of applications integration in mobile systems is not a technological “prouesse” and should not be considered as barrier to mobile learning. On the other hand the pedagogical aspect of m-learning remains a more pertinent element to address.

The instructional designing of the mobile content should be user friendly, adapted to the mobile format with few navigational functions ensuring privacy of the learner and ensuring at the same time collaboration and interaction; to summarize, a fit for purpose m-learning extrapolated from existing VLEs. For example an off line player with slides show and audio content pre-downloaded from a web service or a m-portal for education will be an intelligent manner for m-learning to integrate a web based or even an enterprise VLE. The content may be synchronized with the m-portal for upgrades and download of new courses.

The modern network infrastructure is quite heterogeneous with different telco technology and operators and m-learning portals are very common today to act as gateways for content management systems (CMS) towards mobile devices. The Wireless VLE of tomorrow according to Ericsson by Desmond Keegan is illustrated in figure I.6.

Figure I.6 Wireless Virtual Learning Environment
6. Pedagogical issues

The challenge for further development of mobile learning lies more within pedagogical and organisational aspects than with technological ones (Keegan from Ericsson, 2001). Social constructive theory (Brown & Campione, 1996); the learners have to act and reflect in a learning environment. From constructivism towards connectivism was proposed by Georges Siemens. Conversation theory (Pask, 1975); learning to be successful requires continuous 2-ways conversations and interactions. Learning as a process of cognitive and social development (Vygotsky, 1978) in which social interaction is mediated by cultural tools, such as language and technology.

Learning Theories

<table>
<thead>
<tr>
<th>Area of concern</th>
<th>Behavior</th>
<th>Mind and brain</th>
<th>Knowledge construction</th>
<th>Networked connections</th>
<th>Embodied actions</th>
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<td>Behaviorism</td>
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<td>Enactivism</td>
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Figure I.7

The difficulties encountered in pedagogical issues are the absences of theoretical perspectives although there are two existing frameworks in learning namely Authentic learning (Herrington & Oliver, 2000; Herrington & Herrington, 2006) provided the basis for the pedagogical activity while action learning (Revans, 1982) was adopted as the framework for professional development. Both theories reflect constructivist epistemology emphasizing group collaboration in the creation of further knowledge and understandings.

There is danger in overemphasizing the importance of technology and under-estimating the pedagogical, organizational and quality assurance measures needed to address these issues. With the proliferation of Open Universities mainly in Asia and the Middle East, some programmes standards remain questionable. As far as assessment is concerned, mobile testing centres already exist for professional certifications, for instance the Virtual University Enterprise a prometric testing provider offers the option for mobile testing center on laptops.
7. Formal and informal training settings

Formal learning is all about recognition and accreditation (award and qualification) from authorities and institutions whereby the content has a clearly defined syllabus and pedagogy.

Below is a framework in an attempt to define a roadmap for support in informal settings. In the context of life long or continual learning, learning in informal settings is most of the time the ideal way to complement over and above the qualifications obtained through formal learning.

![Figure I.8, the conversational framework for supporting learning in informal settings (Laurillard, 2007).](image)

However, m-learning in informal settings is highly contextualized and individualized. As a mobile learner learns in all circumstances and places; the environment in the case of informal settings being private and without specific learning outcomes and assessment predefined.

Research on informal and lifelong learning recognizes that learning happens all of the time and is influenced both by our environment and the particular situations we are faced with. Informal learning may be intentional, for example, through intensive, significant and deliberate learning ‘projects’ (Tough 1971), or it may be accidental, by acquiring information through conversations, TV and newspapers, observing the world or even experiencing an accident or embarrassing situation. Such a broad view of learning takes it outside the classroom and, by default, embeds learning in everyday life, thus emphasizing the value of mobile technologies in supporting it. An example in this category is the system
8. Design principles

Design principles for mobile learning
From analysis of the data, the following characteristics are recommended for the incorporation of mobile learning into a higher education learning environment:

1. Real world relevance: Use mobile learning in authentic contexts
2. Mobile contexts: Use mobile learning in contexts where learners are mobile
3. Explore: Provide time for exploration of mobile technologies
4. Blended: Blend mobile and non mobile technologies
5. Whenever: Use mobile learning spontaneously
6. Wherever: Use mobile learning in non traditional learning spaces
7. Whomsoever: Use mobile learning both individually and collaboratively
8. Affordances: Exploit the affordances of mobile technologies
9. Personalise: Employ the learners’ own mobile devices
10. Mediation: Use mobile learning to mediate knowledge construction.
11. Produse: Use mobile learning to produce and consume knowledge.

The factors impacting on design are:

- Ubiquity
- Bite sized
- On demand
- Blended with other VLEs
- Collaborative or individualistic
- Location based or not
- Context awareness or not

Design of mobile content or interface is usually driven by the inherent specifications of the mobile learning device and the technology adopted. For instance WAP has its own limitations compared to J2ME, Android or the ipad. Technological limitations such as small screen, tiny navigation buttons, low memory, little storage area and short battery life time have shaped the duration and format of mobile course content accordingly.
9. Teachers training

Can mobile learning and training answer to the high demand of continuing learning in primary and secondary teachers in Africa? If yes, which model is to be adopted?

There have been much discussion on the main development technology, development language and development environment of remote teaching system design based on mobile learning,(Parson et al, June 2007).

The UniWAP mobile teacher training project; the main aim this project was to assist in teacher training through relatively simple technologies, SMS and digital pictures, to enable students to create digital portfolios in a central database built from materials created in a field (Seppala and Alamaki, 2007). Trainee teachers were able to share their experiences with each other through messaging.

Another research study carried for continuing education and training of teachers on rural areas based in m-learning in China (Jingdong and Zhen, 2009) has revealed the importance and advantages of m-learning for teachers’ training, which are personalized training, economic and continuity, the experiments conducted had been SMS applications coupled with WAP on mobile terminals. The key issues identified in this research were firstly the need for proper integration of m-learning within other VLEs inclusive of extracurricular broader services such as social educational services like weather temperatures which make sense in China, secondly the need to have higher multimedia functionalities other than SMS with more advanced cell phones, and thirdly the mobile technology to be adaptive to complement the core study acquired in traditional classroom settings.
10. Constraints and Barriers

Notably, these barriers are mainly organisational, rather than being due to negative student attitudes or failure of technology. Newton (2003) suggests that the most prominent e-learning barriers are:

1) increased time commitment;
2) lack of extrinsic incentives and rewards;
3) lack of strategic planning and vision;
4) lack of support; and
5) philosophical, epistemological and social objections.

Some constraints and issues involved in developing M-learning include:

- Infrastructure costs – who provides mobile access devices and pays mobile phone contracts and billing, institutions or learners themselves? Cost of developing wireless LANs.

- Increased admin and support – initial set-up, maintenance and troubleshooting mobile access devices demands a significant amount of support. Mobile access devices tend to be less reliable than desktop PCs. Loan and tracking mechanisms possibly need development and administration. Significant extra training and development may be needed to support learners (and staff) using mobile access devices.

- Managing learning resources – are dedicated learning resources going to be produced for mobile access devices or are existing resources, perhaps within a VLE, going to be ‘re-purposed’? Many websites and VLEs are inaccessible to mobile access devices.

- Accessibility – as well as being potential assistive technologies, mobile phones and PDAs currently have small screens and device controls and can support a limited range of accessibility software.

- Increased demands on tutors - 24/7 access to learning resources may lead to increased demands on tutors. There may be a need to formally recognize tutors’ time on-line and negotiate their availability/turnaround times.
11. Social Aspect

The paradox of the ICT technology and to a large proportion for mobile technology is that it allows a learner to communicate whole day with very distant users that sometimes the learner has communicated little with people in his/her neighborhood. It is also well known that there is a lack of socialization in distance education.

There has been a deep research conducted on Mobile Phone identity in Europe, namely in France and Finland whereby the relationship and profile of the youngsters with the mobile phone was studied. Results have shown that ...

Other studies have demonstrated that mobile technology may bridge the digital divide very much faster than traditional PC, and this is very true in the African continent, mobile phones were made available to most people before fixed line phones or the desktop PC. One research study in Europe has shown that mobile phones with multimedia and gaming can keep the interest of slow achievers high and even enable them to join mainstream programmes at tertiary level.

There is a research avenue to investigate how m-learning integrated in the foundation access courses for undergraduate programmes can increase the percentage of success rate and subsequently the intake at tertiary level. It is known the highest percentage of dropouts occur after around 5 years of secondary schooling, i.e after the Senior Certificate examinations. The unsuccessful students are youngsters in the age of 14 to 16. With appropriate content, support and mobile device, a second chance for these students to join tertiary education should be very probable.
12. Future models and educational scenarios

Mobile learning in the 21st century: benefit for learners, Copyright © 2004 Geddes S.J.

Future model 1. The travelling salesperson
A salesperson boards a plane to travel across the country for a meeting with a large client. Just after takeoff the salesperson receives an email on their PDA detailing a competitors’ just released product. The salesperson then alters the sales pitch to take into account this new information and prepares to answer questions on the topic. After landing the salesperson stops at the hotel to freshen up and receives news broadcast on the television, inside the bathroom mirror, indicating an unfavourable change in economic, MIT Technology review has announced that Boeing is planning on making broadband wireless Internet contentions available on flights. The sales person, then in the taxi on the way to meet the client, conducts further research into this change and prepares to alleviate the clients’ concerns. This constitutes learning which is not only ‘just in time’, but is also ‘just in existence’. Through reflection on this learning (metacognition) the learner can transfer these lessons to long term knowledge and associate them to relevant existing cognitive structures.

Future example 2. The traffic accident
A group of emergency services personnel are on route to a traffic accident. Their PDAs retrieve information on the traffic accident provided by the cars involved. The PDA is aware of the location of the accident and starts uploading data on the accident and the location. All PDAs are aware of their users and start uploading relevant information in preparation. A police officer is provided details on the best method of securing the accident and detouring traffic based on the accident and the local environment. A fireman is provided details on the types of vehicles and fuels being used, the location of the nearest hydrants and general vehicle accident information. The ambulance drivers on route are receiving information on likely injuries, methods of treatments and the best route to the nearest hospital based on the local traffic conditions, including the police planned detour. Additionally, the two ambulance drivers include one who posses high levels of logical intelligence, while the other posses high level visual intelligence (Gardner 1993), the devices format the information in accordance with their requirements.

Future example 3. The broken lesson
A busy executive awakes one morning and commences an eLearning lesson for work. Halfway through the lesson the executive stops and heads off to work. While on the train, the executive takes out his mobile device, which is aware of the last lesson being conducted, provides a brief transcript of content covered, then continues with the lesson. Before the lesson can be finished the executive heads off the train and starts walking to work. At this point in time a formative assessment was about to commence, so the executive transfers to voice mode, listens to the questions and answers them orally. After the assessment the lesson continues orally while the PDA records graphics that the executive has not been able to see. A particular subject interests the executive so he asks
the PDA to source further information on the topic. The PDA comes back with a list of papers of which the executive selects one, the PDA converts the text to voice as the executive continues to walk to work.
13. M-learning opportunities & applications

The degree of innovation brought by mobile technology is unprecedented. A smart phone is more a mini computer than a phone, and telephony may be not the primary service on a phone. The good thing is that the mobile phone or device was initially designed for telephony services, that are for audio communication, so much so that voice has been proven to the most effective mode of communication for learning and teaching, some strongly argue that voice is the killer m-learning application.

The number of applications and services possible with the coupling of the Internet and a smart phone or a light tablet PC is limited by one’s own imagination. For instance, the mobile gaming industry is in itself a multi billion dollars market. Already an average of more than 65% of the subscribers connect to the Internet via a mobile device in African countries like South Africa and Mauritius, the same statistic is predicted on a global scale for 2013.

Below is an exhaustive list of off line and on line relatively simple applications for support and collaboration in any m-learning system.

- Context/Location based; Alerts; Field navigation; Quiz; Remote control: Review Survey; Geo-blogging; Audio recording; On -demand; Reporting; Simulation; Conferencing; Check list; Decision making support; Assignments; Presentations; Bar code reader ;Camera; Augmented learning; Coaching; Games for learning ;Transcription Poll; Video recordings; Feedback; Note taking; Self assessment; Capture & Share documents; Translation; Just in time applications; Security ID.

Some ipad applications are presented in Appendix3.
14. Enterprise Mobile Learning

Enterprises have for long derived the benefits from Learning Management Systems (LMS) generally web based intranets, whereby learning takes place within the premises of the organization embedded in the working hours. With today’s workflow mobility, companies need to extend the LMS to mobile workers just as ERPs functionalities are being extended to hand held devices. One major issue that arises in enterprise mobile learning to the CIO is whether to supply employees with mobile devices which can be managed and controlled via a software or allow employees to bring their personal devices within the workspace. Companies with large enterprise systems or integrated information systems are reluctant to for personal devices for legal, financial and technical motives and more and more for security reasons, as with the mobile device the enterprise system boundaries are more vulnerable as intrusion within the enterprise system may happen at a mobile device endpoint. Therefore, they will prefer restricted access in terms of hardware and software for the handheld devices, this would costs cheaper. However according to research studies in North America, it has been found that it is not a best practice to prevent employees from bringing their personal devices in the workplace. The company’s policy on mobile usage needs to address the device deployment strategy.

The rapid flows of information within the enterprise enabled by mobile and wireless technology add values to the services and learning takes place in an informal manner. If the strategy of an organization is to capture, assess and formalize the learning or training, for example to be included in promotion exercises then an appropriate infrastructure and framework should be considered. For long public as well as private enterprises have looked upon training as expenses rather than investments, the ROI on enterprise mobile learning is a critical success factor for any enterprise to succeed in m-learning for its corporate lifelong learning. On the other hand, employees may be reluctant to adopt supplied mobile devices by the company, given that the latter would be able to track them outside the office anywhere, anytime.
Transition helps organizations in the shift towards mobile learning Transition Associates
| Tatsfield, Kent

With the advent of more powerful handheld devices such as the iPhone, iPad and Android smartphones and tablets, organisations are starting to wake up to the possibilities of mobile learning (m-learning). These low-cost devices are enjoying rapid adoption - and the possibilities of learning that can be truly taken anywhere is highly appealing. But the problem, according to Transition’s Miles Corbett, is that learning developers and learning departments aren’t geared up to take advantage of this shift in computing. "Only a couple of years ago," says Corbett, "m-learning was little more than a pipedream, because mobile devices weren't actually powerful enough to deliver a rich learning experience. The arrival of iOS and Android devices has turned that around."

Lectora Inspire is a fully integrated e-learning and m-learning development environment - shipping with special versions of Camtasia (for screen video capture), Snagit (screen stills capture) and Flypaper (Flash creation, without Flash). "It's quite literally all e-learning and m-learning developers need," says Corbett. But the development toolset is only part of the story - organisations also need a learning management system, which is where CourseMill comes in. Created by Trivantis, the developers of Lectora Inspire, CourseMill provides a simple way for organisations to deploy, track and measure learning - even on mobile devices.
Part II: Current and Emerging Applications & Technologies

1. Appropriation and Technology Selection

Figure II.1: Technology selection (Attewell, 2005, p. 3)

Figure II.1 depicts five groups to be considered in the choice for the technology in any mLearning project. These are the transport options (or connectivity), the delivery options (or communication protocol), the development languages for the mobile course content, the media options and the platform options (or the mobile operating system which normally depends on the device brand).

It’s not that you have to become a mobile technology expert in order to embark on implementation of mobile learning. Manufacturers such as Ericsson, Nokia and others have designed certain specific products with m-learning features and capabilities. An evaluation framework developed by (Economides and Nick Nikolaou, 2006) considers the usability criteria (user interface, presentation & media, navigation, physical), the technical criteria (performance, sensory systems, compatibility, security, availability, reliability & maintainability) and the functional criteria (communications, information & knowledge, organization & management, entertainment & amusement).

A device deployment strategy is critical for successful m-learning project taking into consideration cost and pedagogical aspects. More is discussed in the proposed framework at the end of the report.
2. Mobile Technology Economics

The ICT growth has been driven substantially by mobile technology and the Internet. By the end of 2010, there will be an estimated 5.3 billion mobile cellular subscriptions worldwide, including 940 million subscriptions to 3G services.

- Access to mobile networks is now available to 90% of the world population and 80% of the population living in rural areas.

- People are moving rapidly from 2G to 3G platforms, in both developed and developing countries. In 2010, 143 countries were offering 3G services commercially, compared to 95 in 2007.

- Towards 4G: a number of countries have started to offer services at even higher broadband speeds, moving to next generation wireless platforms – they include Sweden, Norway, Ukraine and the United States.

- In the developing world, mobile cellular penetration rates will reach 68% at the end of 2010 - mainly driven by the Asia and Pacific region. India and China alone are expected to add over 300 million mobile subscriptions in 2010.

- In the African region, penetration rates will reach an estimated 41% at the end of 2010 (compared to 76% globally) leaving a significant potential for growth.
- The relative price for ICT services is highest in Africa, the region with lowest income level.
As per figure II.2, 2 billion people across the world are on the Internet, but very few in Africa. While 71% of the population in developed countries are online, only 21% of the population in developing countries are online. By the end of 2010, Internet user penetration in Africa will reach 9.6%, far behind both the world average (30%) and the developing country average (21%).

![Figure II.2](image)

The figure II.3 below shows from a US perspective the reach of mobile learning applications and services. It is interesting to note that in the early stage 2008, mobile applications were among health, guides and games designed for children. Recently, we have seen the apparition of mobile learning services on subscription basis from international carriers, telco service providers and device manufacturers with large subscriber bases. Latest services are IT certification content, consumers “how to” content, location based services with augmented reality as added value.
We can observe also that the first generation of mLearning products coincide with the 3rd generation of mobile communications and the 2nd generation of mLearning products with the 4th generation of mobile communications. The technologies for the 2nd generation mLearning are described later in Part II.

3. **Broadband & Bandwidth issues**

There is a continuing broadband divide, mostly in developing countries.

- There has been strong growth in fixed (wired) broadband subscriptions, in both developed and developing countries: at the end of 2010, fixed (wired) broadband subscriptions will reach an estimated 555 million globally (or 8% penetration), up from 471 million (or 6.9% penetration) a year earlier.
- Despite these promising trends, penetration levels in developing countries remain low: 4.4 subscriptions per 100 people compared to 24.6 in developed countries.
The total outbound pipe is in the order of GB (~ 5 GB); with more undersea cables with optical fibres and redundancies, the African continent will comfort its international bandwidth, thus enabling the creation of clouds infrastructure and transmission of rich multimedia content.
4. Mobile Media & Rich Content

Podcasting is a method of publishing audio files (usually MP3s) to the Web, which are then made available through subscription and automatically downloaded to a personal computer or portable MP3 player. One obvious use of podcasting in an educational context is to create an archive of class lectures that students can listen to at their convenience. However, given the distinctive features of podcasting, its potential goes far beyond reproducing course materials and making them available for review.

Vodcasts; stands for video casting somehow similar to video streaming. Modern 3G and 4G cellular networks have the capabilities to broadcast multimedia content.

Currently around 25% of the content on cellular networks are multimedia content in form of MMS, IPTV, podcasting, videocasting, video streaming and audio files. With 4G and the IP Multimedia Subsystem (IMS) architecture the telecom infrastructure shall be more multimedia friendly and it is forecasted than almost 45% of the transmitted content would be multimedia.

It is known that the younger population prefers digital images and games as media for learning. With the cocktail of technologies like IPv6, 4G, Web 2.0, IMS, huge bandwidth and sophistication of the mobile device, the market for mLearning multimedia products is already here. Malaysia is leading country in multimedia products. The set up of center in multimedia by the Malaysian government has been a genius strategic move in the context of supporting education with technology.

SMS for long time had been the mobile killer app., however, for mLearning purpose higher functionalities with multimedia interfaces are to be sought after.
5. Wireless Technologies

The telecom infrastructure has equivalent technology for both fixed and wireless networks. In Part III, we showcase mLearning projects with mobile technology for LAN and offline (Ex: use of smartphones in classroom and in the school yard set up) as well as in WAN where the cellular network is mandatory for collaboration and interaction. The wireless technology called the transport option in the technology selection framework presented at the beginning of Part II forms part together with the device selection.

Although there is a high penetration of Internet in developing areas, there are areas still uncovered. The example of Warren Park Primary School in southern UK shows how wireless access is being extended from the school WiFi though antennas and transducers to the local community. In doing so, the students can continue with the process of learning at home, given they are provided with netbooks on 24/7 basis. Results have demonstrated this initiative considerably improve the basic skills.

On the same hand, the proliferation of Wireless User Groups (Wugs) in South Africa has broadened access to local communities and promotes informal learning through collaboration and interaction. WiFi spots are not expanding fast enough in Africa; campuses are now witnessing and experiencing the power of wireless networks for teaching, learning and administrative purpose.

The advent of new geostationary satellites like for instance RedSat satellite for the sub-Saharan region which will focus on domestics services can provide amongst other services backhaul and low cost bandwidth to close the gap due to the lack of sufficient fixed (wired) broadband in Africa.
6. Future 4G networks

The International Telecommunication Union (ITU) defines "4G" as network technology with throughput of 100Mbps for wide area/mobile use and 1Gbps for hot spot coverage to be applied in new spectrum bands with 100 MHz channels. IP Multimedia Subsystem (IMS) is a horizontal architecture for offering IP Multimedia Applications; IMS supports different access networks, such as: WCDMA, GPRS, CDMA2000, Wire-line Broadband, WLAN. WiMAX and LTE offer new opportunities with higher data rate up to 1 Gbps at low cost. However there are currently some technical limitations vis a vis IP infrastructure networks where WiMAX cannot support quadruple play, in other words supporting mobility, data, audio, video concurrently. Unlike WiMAX which is licensed by the authority WiFi operates in unlicensed spectrum. The new feature in WiFi is the Very High Throughput (VHT).

The figure II.6 shows the various wireless technologies where 4G is said to be deployed in the US by 2010-2012. 4G is a significant breakthrough for mLearning as not only it has the potential for real time video but streaming but places the user/learner at the centre of the system. Physically it can smoothly interface with the 3G and UMTS networks.
7. CSIRO breakthrough

Broadband coming wirelessly to the bush

A major CSIRO breakthrough in wireless technology designed to bring broadband to people living beyond the optical fibre network, will be unveiled in Sydney tomorrow.

3 November 2010

The first half of CSIRO’s Ngara technology will enable multiple users to upload information at the same time, without reducing their individual systems’ data transfer rate of 12 Mbps.

“Someone who doesn’t live near the fibre network could get to it using our new wireless system,” CSIRO ICT Centre Director Dr Ian Oppermann said.

“They’d be able to upload a clip to YouTube in real-time and their data rate wouldn’t change even if five of their neighbours also started uploading videos.

“But the really impressive part is the spectral efficiency our team has achieved.”

The radio spectrum is a finite and highly valuable, natural resource.

"Even with just half of our system completed, CSIRO is already helping define the future of wireless technology."
Dr Ian Oppermann, ICT Centre Director

CSIRO’s spectral efficiency is three times that of the closest comparable technology and the data rate is more than 10 times the industry’s recently declared minimum standard. Spectral efficiency is about packing as many bits of information as possible into the channel (frequency range) allocated for its transmission. CSIRO’s 12 Mbps, six-user system works in the space of one television channel, which is seven megahertz (MHz) wide. CSIRO is achieving spectral efficiency of 20 bits per second per Hertz (20 b/s/Hz).

“Even with just half of our system completed, CSIRO is already helping define the future of wireless technology,” Dr Oppermann said.

Wireless Research Director for Gartner, Robin Simpson, said the most promising aspect of CSIRO’s Ngara technology is that it aims to re-use old analog TV channels.

“This means any rural property or business that can currently receive TV signals could in future connect to high-speed internet just by using a new set-top box,” Mr Simpson said.
CSIRO is currently completing the research and testing of the downlink part of the system, which will also run at 12 Mbps per user. 

Ngara is a word of the Darug people meaning to listen, hear and think. The Darug people are the traditional owners of the land on which the ICT Centre’s Sydney lab sits. This project is supported by the Science and Industry Endowment Fund.
8. Satellite Communications

Low cost satellite-based access to the Internet could respond to the current access crisis in the region and provides an opportunity for last mile connectivity to rural people. The vast inaccessible terrain makes it difficult and costly for rolling out traditional wireline networks and implementing advanced fiber optics links in heartland areas. The lengthy time needed to rollout traditional technologies makes low-cost Ku/Ka band satellite services attractive particularly to smaller organization, households, personal users, small and medium enterprises and public organizations.

Access to VSATs is prohibited in some countries. In other nations hefty licensing fees are levied. Policies for low-cost 'consumer grade' satellite services for Internet access are not clear in many nations. Recent surge in the use of Voice over IP by average consumers and continued falling of PT&T revenue streams have complicated the matter. Government policies did not keep up with technological developments, and most countries are still protecting their monopoly national telecom operator at the expense of affordable and universally accessible services. Much of the restrictive policy owes to general lack of understanding of the technology and its impact on the society.

In countries where private satellite services are allowed, the license fees are usually excessive for consumer-grade Ku-band VSAT when compared to what consumers in the developed countries pay for these services. The tariffs were ideal for the older satellite technologies which were far more expensive to operate, largely confining their use to a few large multinational companies. At the moment, lofty license fees are the major obstacles to Internet development in Africa, where up to 35% of ISP expenditures goes to VSAT license and monthly charges. Licensing fees in Africa range between $5000 and $10,000 dollars a year per terminal on an average for a 128 Kbps link. Although is a significant progress in reducing both licensing and monthly fees, there are high potentials for mass deployment of equipment costing $1000 and Internet bandwidth at $200/month or less.

Technically, every inch of Africa is covered by VSATs. The major operators like New Skies, Intelsat, PanamSat, EuropeStar, Eutelsat, Thaikom and Anatolia/KaliTel have a variety of different footprints over parts of Africa to supply voice, broadcasting and data circuits to a variety of customers, who then could resell to end users, create Virtual Private Networks. Recent launch of satellites by Intelsat, Panamsat and New Skies has also extended the amount of available bandwidth for sub-Saharan Africa.

Significant experience and interest has also been gained in the installation, maintenance and subscription services over the last ten years. Among the companies that are currently providing services are, Afsat (headquartered in Kenya), MenaSat/GDBC (based in Egypt), IVSAfrica (based in Spain), Web Sat (a branch of Dublin Ireland based Armstrong Electronics), Thaicom Internet (part of the Thai group Thaicom), Bentley-Walker (UK),
Linkserve/Linksat (Nigeria), Qkon (South Africa), Sentech (South Africa) and Transtel (South Africa) and GS Telecom. Afsat and GS Telecom have been operational for sometime and had accumulated a good experience in rolling out services in most complex policy and regulatory environments. GS Telecom who specialises in mobile connection has full VSAT operator licences in Nigeria, Ghana, Cote d’Ivoire, Tanzania and Mozambique and has obtained end-user authorisation on behalf of its customers in a further 22 countries. Afsat is also in the process of building a similar continent-wide service.
9. The Market, Products & Services providers

mLearning commercial service providers are listed in Appendix 3.

The pie charts in figure II.7 clearly point out that the tendency from 2006 to 2011 is largely in favor of content products and slightly for services at the expense of technology and the needs also have shifted from higher education to governmental institutions. This is a USA projection which may not necessarily corroborate with other continents. The analogy with e-learning products is parallel; at the outset Internet access and technology were major barriers but content products had generated more income for commercial companies. Off the shelves mLearning products with the content that can be plug into a local network infrastructure and as far as possible technology independent will certainly find a market. The types of products on the market from Ambient are depicted in figure II.8.
Ambient Insight’s **learning technology product taxonomy** is based on pedagogy and information architecture principals. We track eight types of learning products, one of which is Mobile Learning.

**Mobile Learning Products**
- Handheld decision support
  - Software tools
  - Technology services
  - Content services
- Location-based learning
- Device-embedded learning
- Packaged content

**Mobile Learning Products Specific to Healthcare**
- Emergency medical decision support
- Clinical decision support
- Educational “podcast” services
- Content services
- Medical and healthcare reference
- Mobile CME and exam prep

Figure II.8
10. Challenges & Constraints

Common technical problems

Support for multiple OS versions (BlackBerry)
An emulator is not always consistent with the actual device
Small screen dimensions for displaying content
This will eventually improve as legacy smart phones shelf life quickly approaches
Limited battery, memory, and storage space
Limited support for Flash player
Windows Mobile 6.5 & Android 2.2 only
Limited connectivity
Limited video support
Varying formats supported; this will also improve in time
No support for popup windows and framesets
Files must be optimized for quicker load times
This is starting to improve with new era of Smartphones
Lack of authoring tools to create mobile SCORM content (looking for use cases)
SumTotal Toolbook, Lectora Trivantis, Articulate (flash-based)....others?
The price for fixed broadband access remains prohibitively high in most developing countries, effectively limiting access to the Information Society.

In a WAP communication restricted memory and bandwidth will limit the downloading of course content in mLearning systems. Other technologies like J2ME allows to apps. to run offline.

Cost and the practical limitations of current infrastructures have prevented DSL and cable technologies from reaching many potential broadband users. Generally, DSL only extends about five kilometers from the central office switch and many existing cable networks do not provide a return channel. Converting these networks to support high-speed broadband or deploying wired infrastructure to new areas with low subscriber density is generally commercially unfeasible and requires years of disruptive installation. All of these factors more acutely affect developing countries where infrastructures aren’t as advanced or don’t exist.
The Challenges of the CTO/IT Dir
• Providing a Safe Online Learning Environment
  – CIPA compliance – filtering inappropriate material
  – Enforcing AUPs – reporting on user’s online activity
  – Protecting hardware and content on and off network
  – Invasion of privacy issues – PA web cams
• Equality for All Students

Barrier to adoption of student owned mobile devices
– Network compatibility: AV, OS, processing, monitor
– Mobile devices for students that don’t own one

Other Issues
• Budget Constraints: Upfront Costs have been traditionally prohibitive
  – Smaller, less expensive devices available
  – Lease options help defer capital investment
• Battery Life
  – If handheld dies, student is left out
  – Extended battery life and faster recharging
• Durability: Costs of Rep. Maint. & Support
• Professional Development for Teachers
11. Broadening Access to rural areas

It is known that inaccessibility to information and the Internet is a major hindrance to promote m-learning in rural areas in countries like China and in Africa. The tragedy is that in some countries access to electricity is very limited, for instance in Uganda almost 80% of the population is covered by mobile communications but around 7% has access to domestic electricity supply. Given that the short life cycle of the mobile battery is a big technical constraint, therefore, it’s essential to provide offline and online mode of m-learning content.

The future trend about m-learning is about real time collaborative learning through the cloud, here bandwidth and access to Internet matter. The coupling of the mobile terminals with radio transmission can solve the issue of reaching remote populations. It can be seen in various national ICT strategic plans in developing countries that policies regarding access to computers and the Internet are laudable.

Research and advancement in mobile technology like the one described earlier for CSIRO is a solution to broaden access. Innovative ideas such as using 1.5 v batteries to charge the mobile phone battery or again the boda phone on motorbikes to charge mobile phones in Uganda may be sufficient for telephony or SMS applications, but when it is about multimedia apps which are very resource intensive, the battery power is consumed at an exponential rate.

Any advancement in the distribution and provision of electrical energy will surely contribute to advancement of mobile learning in rural areas.
12. Cloud computing

The traditional approach to IT is not working. The current model of building application and server silos does not meet the dynamic needs of an organization in a competitive marketplace. Today IT is expensive, unresponsive and consumes vast amounts of capital, delivering resources which in the end are grossly underutilized. Most servers are utilized only 20% or less. This approach of throwing expensive assets at every business need, is inflexible, time consuming and costly. This would be analogous to deploying a small generator to supply each of your offices with electricity. In the future, IT must offer a competitive service model delivering infrastructure and computer resources in plug-play and bill-me-for-use service. This is where cloud is taking us.

Cloud computing is an IT delivery model that provides infrastructure and computer resources as a service. By implementing a private cloud, IT leverages the power of sharing to maximize the utilization of compute, networking and storage resources within an organization. The result is more rapid and efficient delivery of IT services, faster time to market, and reduced IT capital and operating expenditures. Moreover, the cloud is accessible anywhere at anytime with a hand held device.

There are currently 3 types of services provided by private clouds.

- **Platform as a Service (PaaS):** The development environment or platform is here remotely accessed for the development of applications and services.
- **Software as a Service (SaaS):** The software application is remotely accessed.
- **Infrastructure as a Service (IaaS):** The hosting and server infrastructure resides in the cloud

Server virtualization is a key building block to cloud computing that enables application isolation, mobility, and partitioning of individual servers in the cloud. Applications are placed into virtual machines (VM’s) which simplify the provisioning and configuration of application environments in the cloud, allowing for easier reconfiguration of resources to meet business demand.

The advent of public and private clouds will lower substantially the cost of ownership and ROI for the educational institutions in terms of server infrastructure, maintenance, security and so on. Nevertheless the two main concerns are data security and adequate bandwidth.

Security and privacy are important features in mLearning if an institution intends to move towards formalization in terms of curriculum, assessment and ethics. All institutions want their curriculum to be protected from plagiarism and discourage cheating in assessment. Cheating with mobile phones is very common during examination sessions. If an institution
wishes to conduct mobile testing or online assessment via mobile devices authentication of the candidate via public key infrastructure is helpful.

With the recent waves of cables from WikiLeaks, the debate on cloud security has resurfaced. The same concern is expressed with Web 2.0 websites which are generally hack able. New brands of mobile phones give ready direct connection to these social networks. More about Web 2.0 is discussed in the coming section.

Moreover, viruses or malwares on mobile devices are today conceivable and acknowledged by the carriers and telco industry. Over billing and denial of service (DoS) are most vulnerable threats on mobile phones.
13. Web 2.0

Web 2.0 technology are commonly known for social networks websites like Facebook and Twitter, these are today emulated for business and educational purposes. The fundamental concept of Web 2.0 is the social networking where the web acts as a platform and grows with the collective input from the users. These sites are coded using dynamic programming languages such as AJAX and other scripting languages for lightweight programming that is with a minimum number of page refreshments, as they deal with large chunks of audio and video files. Generally a Web 2.0 site comprises of widgets, podcasts, webinars, vodcasts, mashups, RSS feeds and interconnects with other sites via open source APIs.

One major advantage of the Web 2.0 technology is that the web site and relevant applications can be fully implemented using open source development tools and servers operating systems for hosting. The business community was late to recognize the benefits of this technology as it happened with WAP. However, there is strong belief among researchers that given the paramount success with youngsters on social networking sites, Web 2.0 can boost up VLEs and create new educational experiences, it is also admitted that this technology has not been fully exploited for learning and specifically for mobile learning. With the advent of mobile broadband provided by 4G networks and other WiMAX and LTE, Internet access, and more powerful handheld devices such as the ipad, there is a huge potential to design learning materials and educational scenarios following Web 2.0 characteristics.

Some Web 2.0 characteristics:
- RSS Feeds: Really Simple Syndication feeds for content syndication in web 2.0 technology.
- Mashups: combination of information and content originating from distinct sources,
- Webinar: online seminars on the web.
14. In memory analytics

In memory analytics or database is a breakthrough in business intelligence in ERPs where for example managers look for instantaneous reports on their smartphones and PDAs within sub seconds following let say sales transactions for decision making. This technology is practiced by ERPs vendors such as SAP, and it is proven to boost the computational power in reporting services a million time by running the query completely at the level of the main memory solely without making use of the primary storage.

It has been pointed that in today’s formal settings at mainly in higher education institutions there is tremendous amount of administrative tasks. For instance case management of students is a very fastidious task that requires information throughout the life cycle of a student. As institutions are more conscious today to have an integrated management information system for efficient administration, it could be beneficial to extend the school ERP or campus ERP to mobile devices.

At present, in memory analytics applications are visible only in enterprise systems. The application of this new technology in the field of m-learning is to be investigated and explored.

Analytics (referred to as “business intelligence” by some) is a tool that higher education can use to respond to calls for increased accountability and improved outcomes. U.S. higher education has used simple analytics for admissions, building models that use data from standardized tests and transcripts to predict which applicants are most likely to succeed. Applying the same principles to enrolled students, institutions can construct data-driven models that correlate patterns of behavior with student success (e.g., course grades, college graduation) and endeavor to identify students who are at higher risk not to complete a course or degree. Once at-risk students are identified, a wide range of proactive steps can be taken to improve their odds of success.

The analytics process begins with the identification and collection of data, often from disparate sources, within or outside the institution, including course management systems, student information systems, and other data sources. The data are analyzed and predictive models constructed that allow the institution to intervene with students who are likely to experience academic difficulty.

For example, a course management system (CMS) (or learning management system) might collect highly detailed data about student use of the resources. Correlating these data with outcomes (e.g., student grades in the course) can reveal patterns that can predict which students are more or less likely to achieve specific levels of success. Based on policies set by the institution, an analytical model can monitor student activity in the CMS and take particular actions when certain triggers are activated. If, for instance, the system
determines that a student has not logged in to a course website three weeks into the academic term, it could send an e-mail to that student to confirm that he is in fact enrolled and advise that, historically, students who do not take advantage of the course website are several times less likely to earn a passing grade than those who do. Other triggers could prompt more aggressive interactions, including phone calls or personal visits from faculty or staff.

Analytics has the potential to take advantage of the vast amounts of data that institutions collect to provide additional support for students and improve teaching by helping faculty understand where their efforts are best applied. It also helps institutions demonstrate they are doing all they can to ensure students succeed in an era of growing accountability.
15. Augmented Reality & Learning

Augmented reality is about adding virtual content to real life or to a virtual reality. For instance, we can use the mobile camera to have more intrinsic details like the temperature & humidity, etc of a specific location. Augmented learning combined with context awareness is considered as the future trend in m-learning.

**Mobile Augmented Reality Applications Project:** A prototype Nokia camera phone, equipped with sensors and software called MARA, can superimpose virtual information and hyperlinks onto a real-world scene.
Part III: Case Studies & Projects

1. Deployment of tablets and ipads

The new mobile device on the market, the Apple’s ipad is seen as a very efficient handheld device which can overcome many of the main limitations in smartphones or PDAs for m-learning purpose. The potential offered is far from Blackberry’s mail service, this was quickly recognized by enterprises. Tablets are known to contain only core functionalities, thus require fewer resources and at a lower cost than current laptops and notebooks. The Ipad and ipod offers more powerful computational power with multimedia and hypermedia support.

This [Victoria Education iPad trial](#) should be worth watching. "As part of its continued focus on optimising technology in schools, the Victorian Government, with support from Apple, is examining how iPads can be best used in schools. In a classroom with 1-to-1 devices such as the iPad, contemporary ways of learning can be optimised. ICT-rich learning and teaching opportunities can increase student participation, engagement and achievement."

These questions aim to challenge teachers thinking about curriculum planning and implementation.

- How can I integrate iPads to support powerful learning in my classroom?
- How can using an iPad change the way I teach?
- How can I ensure that the way I teach with ICT promotes deep learning?
- How can I increase my skills when using the device and applications?
- How can I ensure ICT is integral to my teaching and learning program?

The list of colleges and schools testing and deploying iPad tablets can be found in Appendix 1.
2. Asia

A research project was set up to probe and analyze how teachers utilize mobile technologies for teaching and learning at their scheduled classes in Hong Kong. There were 10 schools participating in the project. Five of them are primary schools and the rest are secondary schools. The project was divided into two phases: planning and implementation. In the planning phase, the researchers developed a set of instruments for the evaluation purpose of this project. The instruments include questionnaire and semi-structured interview questions to solicit students’ and teachers’ perception of using mobile technologies for teaching and learning. Representative teachers from the participating schools were asked to submit a detailed implementation plan on how to apply mobile technologies in their classes. In the implementation phase, pre- and post-tests on subject knowledge, classroom observation, questionnaire survey and semi-structured interview will be carried out to evaluate the effectiveness of using mobile technologies in formal class teaching.

Countries taking the lead in such matters include South Korea, Malaysia, Singapore and Hong Kong. South Korea is radically overhauling K-12, special needs and gifted children’s schooling and trialling ubiquitous online learning (u-learning) for after-school as well as classroom learning (Korea.net, 2005). Hong Kong’s Digital 21 Strategy includes plans to provide all Hong Kong schools with free wireless broadband connectivity and all pupils with access to ICT at home and in the classroom. The Malaysian Ministry of Education plans to use technology in support of curriculum change and for all schools to become ICT-enabled Smart Schools by 2010 (Lallana, 2003; Bakar and Mohamed, 2008).

In Bangladesh, a study entitled “Learning communities enabled by mobile technology: A case study of school based in-service secondary teacher training in rural Bangladesh” carried in December 2007 by Sarah Lucas Pouzezveara and Rubina Khan.

The study equipped two subject trainers, a training coordinator, and a cluster of 10 schools with “smartphones” (with video, speakerphone, and three-way calling capabilities), for use by 20 Bangla and math teachers in 10 schools of the Barisal region in southern Bangladesh (for a map indicating the study area, see Appendix 1 of this report). The existing training curriculum was revised from a 2-week, face-to-face workshop to a 6-week distance-mode training based on printed materials and practical application of training content with peers. The phones were intended primarily to enhance communication, motivation, and multimedia delivery.
The objective of the study was to develop a case study on the use of mobile connectivity in support of distance education and to determine whether:

• it is an effective mode for teacher training and improvement in classroom practice
• it is a suitable mode to reach rural and remote teachers, including women and disadvantaged groups
• it presents other benefits in terms of education administration (including student assessment and costs) and pedagogy.

The study also sought to determine the costs of this model, and the features of the smartphones that would be most useful as a support to distance learning.
3. M-learning projects in Africa

M-ubuntu
Literacy Through Mobile Phones

M-Ubuntu uses inexpensive, low-threshold mobile phone technologies to empower teachers to address Africa's literacy crisis. M-Ubuntu is applying the Zulu concept of Ubuntu - best translated as "I am because we are." to this challenge. At the heart of the pilot project are two teams of reform-minded teachers and their enthusiastic learners. Spectrum near Johannesburg contends with crime & other social dislocations accompanying urbanization. Ramosadi located near Botswana, struggles to serve orphans. Developed with and for students and fellow teachers, M-Ubuntu is connecting South African teachers with m-literacy coaches in the United States and England to help them open new vistas to learners on the wrong side of the literacy and digital divide. Through M-Ubuntu teachers are using recycled smart phones to bring the power of handheld computing to their classrooms. Our focus is on project-based learning, access to the best in South African and global literature, and the development of critical reading, writing and thinking skills. The pilot phase of the project, 2009-2010, involved 20 teachers and 600 learners. Future plans call for expansion to additional teams of teachers in Africa and possibly beyond.

Building capacity to use mobile technologies
PROTEGE QV, a Cameroonian NGO working for “Promotion of Technologies that Guarantee Environment and a better Quality of Life” conducted capacity building in 2005 for leaders of 20 rural women’s associations to explore the potential of SMS for networking and communications. The training covered:

- Defining information: oral and written communication
- Defining the types of information sharing activities within network associations
- Discussion of different communication practices and media, with their relative strengths and weaknesses (including face to face, post, radio, internet, newsletters)
- Introduction to the options offered by mobile phones, technical support for writing and sending SMS to individuals or groups, and tips on using SMS to communicate within networks.

Protégé QV have noted that since the training the women not only use SMS to communicate within their networks, but also with the head office of the NGO, which is 400 km from some of the rural areas where the associations operate, in order to access support materials, information on training and advice on follow up activities.
Mobile Phone Learning on the Move in Africa

Researching information on drip irrigation using a multimedia phone in Kenya. © Patrick Ominde Amkoywa

As Africa’s mobile telecommunications continue to expand rapidly, the continent’s education systems are seeing major developments in the learning process for school children, students, apprentices and technicians. This year’s eLearning Africa conference in Lusaka identified the main trends.

By Talent Ng’andwe

More and more African nations are embracing full-scale regulatory reforms and market liberalisation in a bid to attract more investment in the Information and Communication Technology (ICT) sector and exploit the potential of low-cost technologies. Their efforts to improve access to the Internet are slowly paying off.

Laptops and desktop computers have been installed in some schools and they can be shared during lessons. However, questions are being asked about the cost and sustainability of the laptops and desktop computers: Are these investments justified when the road network remains poor, energy supply unreliable and there is still no fixed line infrastructure?
Nearly 30% of All Africans Subscribe

Masais in rural Zanzibar talking on their mobile phones © Martin Konzett

In the meantime, the African continent has stunned the world by leapfrogging several stages of traditional telecommunications development. The mobile phone has become commonplace even in many of the poorest countries. By 2009, about one third of the African population had a mobile phone subscription – as opposed to only 8.7% using the Internet through desktop computers (Internet World Stats). With approximately 360 million cell phone subscribers, Africa has surpassed the USA (270 million subscribers), according to the UN Information Economy Report 2009. And there is still great potential for further development.

Will future African students, therefore, be learning from the telephones in their pockets rather than from the laptops in their classrooms?

Nine Key Issues for mLearning in Africa

In his presentation at the eLA conference, Paul Birevu Muyinda from the Makerere University in Uganda said that mobile phone learning (mLearning) was expected to grow rapidly in African institutions of higher education because, in the majority of these institutions, over 90% of the learners owned mobile phones and 100% used at least a mobile phone service. “These figures augur well for institutions of higher learning in Africa wishing to adopt and implement mLearning,” he said.

Muyinda and his colleagues from the Makerere University have proposed a mobile learning adoption and implementation model for Africa (MLAIMA). It evolved from answers to the question “What are the key issues for African countries’ adoption and implementation of mLearning?” The answers formed the basis for constructing the model using the Design Research methodology.
Nine aspects were identified as being key to mLearning adoption and implementation, among them mLearning policies, strategies and guidelines, and mLearning resources and sustainability. The team says that MLAIMA enables the democratisation and permeation of learning in city and non-city locations, but the model is yet to be validated in an educational institution.

**Audio Files for Repeating Course Content**

A mobile phone with a battery charger, enabling nomads in West Africa to stay in touch
© Ibrahim Aboubacar Hama

Paul Birevu Muyinda’s views were echoed by Robert Pucher of the University of Applied Sciences Technikum Wien, Austria, who says that mLearning has become a very valuable method in teaching. Almost all students already own such a device. Using these in their studies could save time and money.

“Learning without remembering is useless, and remembering facts very much depends on repetition. Most people need around three to four repetitions until facts are remembered for a longer period,” said Pucher. This is where audio files could be useful, as they allow students to repeat course content at any location or even while on the move. Such files can be downloaded easily onto most mobile phones or mobile mp3 players.

However, Pucher emphasised that simply listening to an audio file in most cases would not enable a listener to memorise the content – audio files should be used as a complement to traditional learning material.

**Mobile Phones Aid Health Workers in Remote Areas**

Peter Kisare Otieno, a researcher at the African Medical and Research Foundation (AMREF), Kenya, pointed out that mobile devices could also be used by students to create content and not only to access it.

His organisation currently uses mLearning to update nursing students about face-to-face sessions, exam dates and other administrative tasks in the school. But it has also started a programme where health workers in remote areas can post difficult cases on the HIV Anti Retroviral Treatment website, thus starting a forum which is moderated
from the AMREF office. Other initiatives which have recently been piloted enable health workers to download tests and reference material in the form of Java applets.

Richard Niyonkuru, Monitoring and Education Advisor for ICT projects in Rwanda’s Ministry of Education, says the younger African generations need new skills to take advantage of the power of technology. “The radical transformation we are talking about cannot be brought about by the labs, by mere access to computer terminals for a few hours or the use of application software or animations,” says Niyonkuru. In his opinion, the ‘revolution’ will be brought about by ubiquitous access to mobile computing - at home, in education and in the communities. June 28, 2010.

4. European Projects

The Mobile Learning Network (MoLeNET) is a unique collaborative approach to encouraging, supporting, expanding and promoting mobile learning.

It is ‘certainly the UK’s, and probably the world’s, largest and most diverse implementation of mobile learning. 115 colleges and 29 schools are, or have been, involved in MoLeNET. Approximately 10,000 learners were involved in 2007/08 and around 20,000 learners will have been involved by the end of the 2008/09 academic year together with more than 4,000 staff.’

The LSN and consortia led by Further Education colleges have together invested over £12 million in MoLeNET. Tribal has been involved with MoLeNET (the Mobile Learning Network) from the very beginning, many of the successful MoLeNET projects have included Tribal’s MyLearning author and the SMS Quiz author.

The MobiLearn Project

The Mobilearn project, with partners from nine European countries, the United States and Australia, has a similar vision [Mobilearn 2003]: A new m-learning architecture will support creation, brokerage, delivery and tracking of learning and information contents, using ambient intelligence, location-dependence, personalization, multimedia, instant messaging (text, video) and distributed databases. Field trials cover “blended learning” (as part of formal courses); “adventitious, location-dependent learning” (during visits to museums); and “learning to interpret information sources and advice” (acquiring medical information for everyday needs). The high connectivity and functionality may lead to new group behaviors, akin to the SMS phenomenon.

Do these visions make sense? Do they have a chance of success? These questions are difficult to answer. In general, predictions of the effects of technology are far too ambitious in the short term, far too modest in the long term, and miss the real point. E-learning itself is just getting off the ground and is still tied to traditional pedagogical models, while many
fundamental issues concerning the ownership and distribution of content need to be solved before m-learning can take off.

The Mobile Technologies for Mobile Learning (MoTFAL) Project
The MoTFAL project involved collaboration between schools in Greece and Spain. The students from Spain would take digital camera enabled PDAs (in the future this will include video) into archaeological sites in Spain. The students in their classroom in Greece would text requests for information and photos to the Spanish students who would then comply and respond. The students would also describe distances and send photos with students in front of artefacts to provide an idea of size. This process would then be completed in reverse.

The main advantage here is collaboration between the students, with the sharing of information and questions resulting in both parties asking and answering questions they may not otherwise have thought of. There is certainly the possibility of an increase in appeal with the interactive nature of the media compared to a text book, and the ability to provide some context by observing people in locations.

5. The CATIA Project
This section includes information on licensing and the use of satellite-based Very Small Aperture Terminals (VSATs) for social and economic development in Africa. It has been prepared by the team working on a project called Catalysing Access to ICT in Africa (CATIA) and funded by the International Development Research Centre, the Department for International Development, and others working in this area. The Project seeks to promote access to VSAT solutions through the development of a regional consensus and an information system that facilitates the implementation of effective satellite regulations.

The Global VSAT Forum and is honoured to lead the satellite project and, together with support from our distinguished partners, is pleased to present for your reference the VSAT regulatory information contained in this section.

6. K-12 & Vocational Training
Tech Leaders in K-12
• 2002 – Maine: First Statewide 1:1 Initiative
  – Apple MacBooks for every middle school student
  – Cost of $40M for first 4 years + $13M thereafter
  – Spearheaded by Governor, Angus King
  – Economic Development, tech-literate workforce
  – Fall 2009 – 55% local districts funding H.S. 1:1
  – Students love visual and collaborative learning
  – Remains as the only statewide program
Future of Open Source in K-12
Open Technologies Leadership Initiative, on the maintenance and user training that comes with using open source solutions.
Source T.H.E. Journal May, 2010

MALL (Mobile Assisted Language Learning) case studies in Nan Chiau Primary School, Singapore. The first case study was a mobile-assisted classroom-based English lesson for Primary 2 class, i.e. 8 years old students with the aim of reinforcing students understanding and proper use of six prepositions. Students were provided with PocketPCs on a 1:1 basis and asked to take photographs of people and objects outside the classroom to show the use of the prepositions. The second case study called “Move, Idioms” was a pilot study of a seamless learning design for a Primary 5 class in which students study and apply 29 common Chinese idioms. Students were provided with smartphones on 24/7 basis during the whole 9 week period of study. They were encouraged to make sentences with their learned idioms and post them on wikis.

These 2 cases present combination of formal (in-class) and informal (out-class) settings with teacher facilitated and sometimes more student centric of student-initiated where the responsibility of learning lies partly with the student. The results from the 2 cases according to the authors (Wong and Looi, 2006) were quite promising.

A technique of mobile learning for relating paper maps and electronic information resources using radio frequency identification (RFID), mobile device and Wi-Fi technology. The system combining paper maps with electronic guide resources. Information about a training problem or region is accessed by waving a handheld computer equipped with an RFID reader above the region of interest on a paper map. Mobile device have been used as tools for navigation learning and mobile-learning information. It presents the prototyping efforts, including vocational education and training problems learned about using RFID for mixed media interfaces.
This system given the advantages of handheld technologies, the exponential growth of its use in vocational training and the computing and data management capabilities of the PDA it would seem a logical and powerful tool to support the mobile use of portfolios in the training program learning environment. (Horng and Sun, 2010).

The K-Nect project

Project K-Nect is designed to create a supplemental resource for secondary at-risk students to focus on increasing their math skills through a common and popular technology – mobile smartphones. Ninth graders in several public schools in the State of North Carolina received smartphones to access supplemental math content aligned with their teachers’ lesson plans and course objectives. Students communicate and collaborate with each other and access tutors outside of the school day to help them master math skills and knowledge. The smartphones and service are free of charge to the students and their schools due to a grant provided by Qualcomm, as part of its Wireless Reach™ initiative.

- On the K-Nect project, when asked what sorts of technology students would like to see in the classroom, 90% of them preferred mobile devices.
- On the K-Nect project, students also wanted access to social networking facilities such as blogs and instant messages on the devices.
7. The KLIV project

The KLIV Project.
Malmo Hospital and Malmo University in Sweden are conducting the KLIV project. It involves employees at Malmo hospital accessing videos on how to use various pieces of equipment in the hospitals intensive care unit (ICU). The process for developing and employing the videos follows a five-step procedure.
1. The employees determine what equipment requires video assistance for ease of use.
2. The employees discuss the video requirements and plan the shoot.
3. The employees make videos of the equipment being used, detailing sequences and any complex steps involved.
4. The video is reviewed informally and then formally.
5. The video is either then remade, or deployed into the hospital for use by employees. Bar codes are placed on any equipment in the ICU with videos available. The employee approaches the piece of equipment and scans the bar to receive the appropriate video demonstration without needing to remember the name of the equipment.

The primary advantage here is faster and easier access to information, although the entire process is learner centred and promotes collaboration in that as a group they collaboratively decide what videos need to be made, and then they make and informally review them.
8. The Ubi-Learn Project

The general objective of the project Ubi-Learn is to design a complex learning “dispositif” as defined in Peraya (1999), taking into account the dimensions of ubiquity and mobility. Ubi-Learn leans on the emergence of a new shape of computer systems called Ubiquitous Computing as mentioned in Weiser (1991) or ambient Computing. The miniaturization of components and elements of Human-computer Interfaces, associated to the development of the connectivity (networks wireless telegraphy, network P2P, etc.) allows to think to interactive environments where the interaction is completely distributed in a big quantity of communicating objects. In the field of the education, we think that effectively the development of the advanced mobile telephony (GPRS or UMTS) and local networks wireless telegraphy (Wifi or Bluetooth), have already begun to transform ways of learning, and bring to the creation of adapted info structures.

If several scientific works have already allowed the investigation of these technological fields, it’s necessary to notice that they have not yet allowed find out new educational modalities, which would really taking advantage of the mobility presented in Laroussi (2003).

RESEARCH ISSUES
We try through this study and this project to answer certain research questions, which are the following ones:
- How can we make interface for mobile learning more opened and powerful in Derycke (2002)
- How can we conceive resources adapted to the mobile learning?
- What are pedagogical paradigms that can benefit from ubiquity and mobility?
- How can we conceive distributed cognitive system by using nomads’ objects?
- What is the role of mobile devices in a learning environment?
- What is the role of mobile devices in a collaborative environment?
- Language of description for a mobile and interactive learning (Scorm, EML, etc.)
- How should wireless technologies be designed to ensure that the needs of learners are met?
- What are some learner-centered design methodologies?
Figure III.2, Scenario of interaction in UbiLearn
9. **School SAT in Ireland**

An initiative funded by the European Space Agency, focuses on improving access to the Internet and delivering education-focused Internet services with an innovative two-way “Internet via satellite” network to remote Irish schools, see Figure III.3. ATiT Ireland managed the project, with Intel Innovation Centre and others providing the architecture and technical expertise. The project provided small satellite dishes to nine post-primary schools in areas poorly served by broadband. The local authority had had difficulty facilitating Internet access requirements for the schools in this region and decided that a satellite service could play an important role in meeting these needs. ATiT Ireland implemented the satellite infrastructure and set up a multicasting service that pushed selected educational content from a number of leading sources, including Intel Innovation Centre’s school Learning Technology platform on a weekly basis. Caching the content on a server at each school provided local access for students and teachers, which enabled a rich media learning experience. For interactive tasks, such as filling out questionnaires and online research, users could access the Internet through the satellite link. Using satellite technology for this type of service offers several advantages:

- Gives schools fast access to the Internet
- Can be installed in any school regardless of location
- Can be installed quickly—on average equipment setup at each school took half a day
- Provides a secure, managed network for schools
- Gives stakeholders a system capable of pushing specific web-based content and digital resources to all schools instantly
- Can be integrated with other compatible services where such services exist

![School SAT Technology Overview](image-url)
10. Use of m-learning in Universities

Ball State University Research
99.8 percent of students have a cell phone
Nearly nine in 10 students with smartphones access the Internet
97% of students send/receive text messages; 30% e-mail; 25% IM
97% smartphone owners take and send photographs; 87% take and send video

The United Kingdom and Europe
• A 10-month trial of a mobile learning organizer with 17 Master of Science students at the University of Birmingham (Corlett, Sharples, Bull & Chan, 2005). The organizers were used to deliver course materials, messages, submissions and facilitate collaborative communication. Findings: Generally positive feedback, but only 30% were using the device everyday by the end of the trial. Some technical problems were mentioned, plus some perceived limitations.
• Uniwap II: Students in a teacher training course at University of Helsinki used mobile devices to discuss teaching methods collaboratively with teachers and other students whilst on teaching pracs (Seppala & Alamaki, 2002). They also used SMS and digital images as a part of supervision. Findings: Heavy use of the program Uniwap II indicates that students engaged with the project and it succeeded in creating flexible teaching solutions.
• Alumni of The Open University’s Masters in Online and Distance Education were surveyed to examine how far mobile devices were embedded in their personal and professional lives (Pettit & Kukulska Hulme, 2006). Findings: Use-patterns have implications for educational use and further details are needed on how WMDs are used and by which groups.
• The use of Podcasts by Universities in the UK and Europe to deliver educational content: Bath University, the Open University, Warwick University, Nottingham University and Ulster University

South Africa, Australia and Asia
M-Learning and vocational education: This project describes mobile innovations in four TAFEs within Australia. The mobile devices were used in the delivery of learning to workplaces, to deliver self-induction offsite and to deliver creative learning initiatives (Ragus, Meredith, Dacey, Richter, Paterson & Hayes, 2005). Findings: Findings from each initiative are generally positive. There is evidence that these programs have been ongoing for a period of time and have been evaluated and changed.

This project describes how English language lessons were delivered 3 times per day to university students via SMS at Kinjo Gakuin University, Japan (Thornton & Houser, 2004). Findings: Tests between the students involved in the M-Learning and traditional students showed that they performed better in language tests.
The use of SMS to create channels of communication between lecturer/tutor with first year undergraduate students at Griffith University (Horstmanshof, 2004). The project was aimed at providing support and encouragement to students in order to help them with persisting in their studies. 

Findings: SMS provided students with connection and community between themselves and their tutors and this had a positive influence on persistence.

The use of SMS in microeconomics experiments at the University of Sydney (Cheung, 2004). SMS messaging was used as a response mechanism for problem-solving experiments. Findings: SMS help to overcome logistical problems.

The potential use of Wireless Mobile Devices (WMDs) at Deakin University has been explored by Armatas, Holt and Rice (2005). Findings: Mobile technologies have the ability to push information to students and support the existing online learning platforms.

The use of SMS with students enrolled in 3 university programs at the University of Pretoria, South Africa. This project describes how the WMDs were used to provide learning opportunities to learners without access to learning or who continually moving (Brown, 2005). 

Findings: M-Learning in Africa reaches more people than online learning due to the proliferation of mobile networks.

Canada and the USA

The M-Library project at Athabasca University (Coa, Tin, McGreal, Ally & Coffey, 2006). A mobile university library website was established that was available to all students. Findings: This project acknowledges that improvements need to be made to the delivery of the learning platforms but positive feedback from users encourages further developments.

M-Learning applications that were linked to existing course websites were piloted on undergraduate and postgraduate students at the Lowell College of Management, University of Massachusetts (Motiwalla, 2005). Findings: Perceived by students as an effective tool or aid to enable flexible learning.

The ActiveCampus Project at the University of California, explored wireless context-aware computing as a means of creating a learning community (Griswold, et al, 2004). Findings: Mobile technologies support classroom activities.
The use of Podcasts by Universities in the USA and Canada to deliver educational content: Harvard, Yale, John Hopkins University, University of Wisconsin, Penn State University, Brock University and University of Western Ontario.

Appendix 4 contains case studies and projects in mobile learning in higher education in some USA colleges and universities.

11. Use of m-learning in Enterprises

Tomi Ahonen Almanac 2010
4.6 billion subscriptions - 68% of planet
3.4 billion unique users - half the planet
1.2 billion PCs (including notebooks)
3x as many camera phones in use today than any kind of stand-alone camera, digital or film based ever manufactured
1.13 billion handsets sold last year compared to 270 million new PCs
More internet users on mobile than on personal Computers

Use Case #1: Mine Lab (Taiwan)
PocketSCORM
SCORM reader on mobile devices + LMS Server + SCORM repository
Part of larger Hard SCORM project
Can dynamically adjust the content to adapt
First released in June 2004 for Windows Mobile

Use Case #1: Mine Lab (Taiwan)
PAD SCORM
Stand-alone Native App for SCORM content that supports iPhone, iPod Touch, and iPad
Released in 2010
Submitted to iTunes App store

Notable Findings: MINE Lab (Taiwan)
Both Pocket SCORM & PAD SCORM Apps provide offline/disconnected capability in case connectivity is lost
Both Support SCORM 1.2 and SCORM 2004
Native Mobile Apps provide more local storage capability, and better support for multimedia and human interaction than Mobile Web Apps.
 Biggest challenges were not technical, but related to: Promoting their products
Finding and keeping SMEs & instructors onboard to create the materials High cost of development

Use Case #2: Bank of America
GoLearn – First started development/pilot in 2006
Largest use case
Repurposed existing SCORM content to fit on smaller screen (BlackBerry)
Can differentiate between mobile & computer based learners
Tracking activations, completions, and demographics
Conduct surveys to collect Level 1 data (Kirkpatrick Model)
SCORM needed in order to provide standard way of tracking completions & bookmarking
Using Intuition Player to handle SCORM

Notable Findings: Bank of America
12% higher completion rate during initial 45-day pilot
Averaged 45% less time to complete content on mobile device (no loss of comprehension)
Completion Locations:
32% business travel, 24%
work commuting, 26% at home, %18 office

Use Case #3: Accenture
First began Pilot in 2007; internal success now part of their offering to customers
Conducted surveys during prototype phase
Goal was 100% mastery of compliance training
92% of those surveyed would jump at the opportunity to use their mobile devices for this compliance training
Repurposed existing SCORM content in-house to fit on smaller screen
SCORM needed for standard tracking of completions (Intuition Player)
Internet connection needed only during initial download and when completed

Notable Findings: Accenture
More than 1,000 completions (2009)
Overall learner satisfaction ratings averaged 4.4 on a 5.0 scale
Compared to 4.0 for traditional e-learning courses

Use Case #4: Upside Learning
First released in February 2010
Developed both web-based (mobile browser) App and Native App
Web-based (mobile browser) App implemented using JavaScript
Provides front-end LMS functionality
Accommodate multiple devices using device detection script and checking the following headers:
user-agent (most widely used)
x-operamini-phone-ua (opera mobile browser)
x-wap-profile (older wap devices)
x-skyfire-phone (skyfire mobile browser)
Developed solution that doesn’t use pop ups or framesets
Requires continuous internet connection

**Use Case #5: Litmos**
Currently in beta stage with a handful of customers
Web-based (mobile browser) App provides front-end LMS functionality
Focused on HTML5, CSS, and JavaScript for development
Currently targeting iPhone and Android with plans to support BlackBerry
Provide tracking of audio, video, and SCORM packages
Back-end LMS automatically creates multiple optimized video formats Certified for SCORM 1.2
Working on offline storage of CMI data using SQLite DB (supported by webkit browsers)

**Notable Findings: Litmos**
Developing Mobile Web Apps enforces the KISS principle.
Agile approach to Mobile App development allows for more immediate updates

**Use Case #6: OnPoint Digital**
Release date upcoming (currently in beta); CellCast Mobile SCORM Player
Targeting: Windows Mobile, BlackBerry, iPhone, iPad, Android, and Symbian (Nokia)
Native App approach using SDK & build CellCast widgets for each platform for development
Also offer Web-based (mobile browser) App that doesn’t use pop up windows or framesets
Can support Flash-based SCORM content on:
- Windows Mobile 6.0 & 6.5
- Android 2.2
- No problems with supporting SCORM 1.2 & 2004
- JavaScript support is consistent across mobile devices
- Lightweight mobile API for SCORM with less complexity & offline support?
- Current screen size challenges for developers trying to repurpose existing content will improve
- Nexus One Android now supports 800x480 Apple's new iPhone 4.0 now supports 960x640 display

**Use Case #7: Rustici Software**
Early stage of offering a mobile solution, but completed the following:
- Integrated SCORM Cloud (web-service SCORM engine) with Moodle
- Developed SCORM content prototype using JQTouch framework for iPhone
Upcoming integrations of SCORM Cloud with:
Google Apps
Google Cloud Course
Worpress
Facebook

Use Case #8: VCOM3D
Prototype effort started in March 2010
Developed exclusively for JKDDC (JKO and ROCCE)
Developed other Apps for language & cultural training for Military
Consists of two Apps:
  Login, Enrollment
  Course Content

Initially targeted for iPod Touch, but was expanded to support:
  iPhone & iPad
  HTC Evo
  Droid Incredible
  Nexus One
  SCORM 2004 2nd and 3rd Edition
  API communication from Mobile App to JKO uses JavaScript
  Student’s progress is tracked within the App and only looks for active connection when course is completed
  Making specific use of cmi.learner_id, cmi.learner_name, cmi.exit,
  cmi.completion_status

ESF Mobile Learning Project

The ESF Mobile Learning Project aimed to develop methods of using mobile technologies to engage learners (employees) in Skills for Life learning in industries where learners find it difficult to access learning because of difficult shift patterns or dispersed patterns of working, primarily in the cleaning and transport industries. Its objectives were to engage learners and support their progress towards Skills for Life qualifications, embedded in vocational competence, using a blend of learning approaches. These approaches included the use of mobile devices such as mobile phones and PPCs. The project used the Move On approach, which involves careful screening, assessment and targeting of learners to help them make progress quickly and efficiently, ideally going on to take the National Qualifications in Adult Literacy and Numeracy.

There was also a capacity-building aspect to the project to focus on developing capability at Levels 2, 3 and 4 for staff who were working to recruit, support or teach the learners. Tribal had capacity to work with partners to contribute to the delivery of this part of the project. It
was envisaged that the project would work with the United Road Transport Union and other unions to identify some of the learners in this cohort.

Partners include: Tribal, Middlesborough College, Newham College, People’s College
12. Theoretical Perspectives of m-learning projects

While there are many practical reasons to adopt m-learning strategies and technologies in higher education (cf., Gayeski, 2007), theoretical justification is arguably even more important. O’Malley et al., (2005) pointed out that when there is scant empirical evidence of effective learning with mobile technologies, guidelines for use should be theory-informed. Fishman, Soloway, Krajcik, Marx and Blumenfeld (2001) contended that a lack of theoretically grounded guidelines represent ‘a major impediment to the successful use of new technologies’ (p. 7).

Examples of m-learning projects within their theoretical perspectives

<table>
<thead>
<tr>
<th>Theory*</th>
<th>Example project/research study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviourist theory</td>
<td>Activities that promote learning as a change in observable actions</td>
</tr>
<tr>
<td>Mobile phones and PDAs for language learning (Thornton &amp; Houser, 2004)</td>
<td>Classroom response systems for providing feedback on multiple choice questions (Wood, 2004)</td>
</tr>
<tr>
<td>Constructivist</td>
<td>Activities in which learners actively construct new ideas or concepts based on previous and current knowledge</td>
</tr>
<tr>
<td>The virus game (use of PDAs to simulate the spread of a virus) (Colella, 2000)</td>
<td>Environmental detectives (students investigate an environmental problem using GPS in pocket PC) (Klopfer &amp; Squire, in press)</td>
</tr>
<tr>
<td>Issues related to educational media explored through videos, documentaries, animations of educational concepts and news bulletins with mobile phones (Chesterman, nd)</td>
<td></td>
</tr>
<tr>
<td>Situated learning</td>
<td>Activities that promote learning within an authentic context and culture</td>
</tr>
<tr>
<td>Ambient wood (use of PDAs to explore environmental habitat) (Rogers et al. 2002)</td>
<td>Multimedia tools at the Tate Modern (use of pocket PCs to view videos and listen to expert commentary) (Procdr &amp; Burton, 2003)</td>
</tr>
<tr>
<td>Role playing to investigate social interactions among family and friends (mobile phone) (Owen, 2005)</td>
<td></td>
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<tr>
<td>Collaborative learning</td>
<td>Activities that promote learning through social interaction</td>
</tr>
<tr>
<td>Mobile computer-supported collaborative learning (dissemination of activities, collaboration, and analysis of results using handheld computers) (Cortez et al., 2004)</td>
<td>Teacher trainers use PDAs to learn questions for a virtual treasure hunt with groups of teachers (Palms Inc., 2005)</td>
</tr>
<tr>
<td>Informal &amp; lifelong learning</td>
<td>Activities that promote learning outside a dedicated learning environment and formal curriculum</td>
</tr>
<tr>
<td>Disadvantaged youth (using mobile phones to deliver interactive stories or quizzes) (Attewell &amp; Savill-Smith, 2003)</td>
<td>Breast cancer care (delivery of text images and audio-visual materials to patients’ PDAs during their course of treatment) (Wood, Keen, Bassu, &amp; Roberts, 2003)</td>
</tr>
<tr>
<td>Learning and teaching support</td>
<td>Activities that assist in the coordination of learners and resources for learning activities</td>
</tr>
<tr>
<td>Managing teachers’ workloads (PDAs to record attendance, marks and organize lesson plans) (Perry, 2003)</td>
<td>Supporting computing students at risk (sent SMS messages on appointments, feedback, room changes and study tips) (Riordan &amp; Traxler, 2010)</td>
</tr>
<tr>
<td>Teachers used ‘phone exams’ where users’ voice print identifies them as the test taker (NMC &amp; Educause, 2005)</td>
<td>Duke University used iPods with beginning undergraduate students and staff (Ballenger, 2003)</td>
</tr>
<tr>
<td>Retrieval of information such as e-books, courseware, and timetables with PDAs (Kim, Mims, &amp; Holmes, 2006)</td>
<td></td>
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</tbody>
</table>
Research Gaps & Directions

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

Five suggested action research directions are all significant issues in m-learning and all need to be
- better investigated;
- mobile supported fieldwork,
- fostering interactivity on-campus using mobile devices,
- ubiquitous learning supported by mobile devices,
- m-learning for each discipline
- strategies for low-cost m-learning use.

Strategies for low-cost m-learning use: Reducing m-learning implementation and use costs

The investigation of low-cost practices for using mobile technology for learning clearly has great strategic importance. Cost is a major barrier to introducing mlearning into learning and teaching practice. There are two main issues here; 1. the price of the mobile devices and 2. the usage charges billed by telecommunications providers. To overcome these barriers to m-learning this research direction could aim to achieve these outcomes; Assessment of the factors which affect students’ willingness and motivation to use their own mobile devices in a variety of learning activities.

Development of strategies on learning activities suitable for use with student owned mobile devices, particularly mobile phones and digital cameras. Investigation of technical protocols for downloading from mobile devices to university PCs via USB cable or over university wireless networks, and so bypassing telecommunication providers’ networks.

Policy-makers, teachers, trainers and instructional designers alike need sound research and evaluation to help them in:
- Policy-making, planning, leading and managing.
- Resource management and costing.
• Change management, staff development, evaluation, quality assurance and accreditation.
• Learner assessment and learner support.
• Cultural factors in learning.
• International collaboration.
• Lifelong learning and non-formal adult and community education.

As technology changes pedagogy also need to change or to adapt, research on pedagogy and educational scenarios to enhance the learner’s experience requires further exploration. On the other hand any advancement in mobile technology or electrical energy will be beneficial in overcoming technological barriers and constraints to mLearning.

Example of a research questions:

How to couple mobile terminals with radio transmitters?
Can mobile technologies lead to improved students performance in foundation courses?
How to make mLearning suitable for practical disciplines?
What is the roadmap towards the development of standards for mobile learning?
Can mobile learning answer to cross border accreditation and recognition?
How far mLearning can be efficient to disabled learners?

**Best Practices**

Since learning through mobile devices is still limited both technically (speed of data access, memory capabilities and media support) and economically (cost of devices, cost of wireless data access), while developing standards and best practices we must give consideration to addressing these barriers.

Here are a few best practices to consider:

**Minimize Data Entry:** Avoid making learners use their phone keyboards too much as these can interrupt learning, and become tedious and time consuming. At most, keep answers to optional choices or short fill-in-the-blanks to check understanding.

**Use Text Support:** Structure learning material to be used for general reference, like definitions and how-to guides. This may not allow for complete learning material, but can provide learning support through notes, which can be easily read and accessed quickly.

**Avoid Costs to Learner:** If the student is incurring costs to learn via their mobile devices, that’s a big problem. So while implementing mobile learning keep in mind downloading costs if any, as well as data access costs.
**Test Design Approaches:** To figure what content works best you need to try different options. Do you provide a text summary and then ask questions? Do you detail a process and then provide visual support? Do you link to online videos? Try multiple options and see what works best for your students.

**Provide Offline Options:** Downloading information and content is not yet commonplace and can still be a hindrance to many. Content does not necessarily have to be delivered via wireless connection or the internet. You could also offer PC access through memory cards which can then be “sideloaded” to a mobile device.

**General Best Practices**
Gather Requirements: “If You Fail to Plan, Then You’re Planning to Fail”
Define goals and requirements for your project
Prototype, prototype, prototype (start small, think big)
Make distinction between “learning” and “performance support”
Identify target device(s) and potential OS version(s)
Native App or Web App? Or Both?

Who will provide support? Help Desk?

**General Best Practices**
Design with Usability and Accessibility in Mind
Determine smallest screen area to support (4x6 cards)
When repurposing content, provide a comparable learning experience:
Replicate assessment interactions whenever possible (true/false; drag/drop)
Use bullets to make contextual information more concise
Increase use of color, bold, and font types to boost effectiveness/prevent loss of emphasis
Reduce or replace audio and video with static graphics and transcripts
Follow W3C guidelines for creating Accessible content:
With BlackBerry there is significant differences between browsers
Explicitly setting the width and height of an image in the HTML can

resolve issues with text wrapping around images
**General Best Practices**

Plan for the Disconnected Mobile User

Provide an offline or disconnected version of your content?

Poor connectivity issues can result in bad user experience

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**STAGE 1**

The need and potential for mobile technologies

- Identify where information and communication play a role in your existing and planned work and the processes you wish to support
- Establish the directions, and precedents for, the information flows you wish to facilitate

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**STAGE 2**

The socio-technical context for using mobiles

- Identify social issues which may have an impact on communication effectiveness
- Analyse some of the barriers and opportunities for control, use and impact of mobile technologies in the context

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**STAGE 3**

Choosing the technology and content

- Based on the prior analysis, identify the technical components which fit your aims, context and budget;
- Ensure relevant content and capacity exists to create the desired impact
Recommendations

The list of recommendations will serve as guidelines for successful m-learning strategies and deployment. The lessons learnt from past case studies and projects form the basis for these recommendations.

1. M-learning must not be confined to learning on a mobile phone
2. Any m-learning project should be blended with other learning modes and viewed in a holistic manner. The percentage of activities to be converted into mobile may be defined using the triangular framework.
4. Pedagogy needs to be adapted to the technology chosen.
5. Learning should continue offline, example though offline players, given that battery life time and access to electricity are major constraints in some countries.
6. There is a need to have many more pilot projects in Africa to gauge the impact of m-learning on the continent.
7. Some technological challenges if solved or with appropriate alternatives, for instance coupling mobile terminals for radio broadcasts in rural areas may have substantial impact on the objectives on a very large scale.
8. Exploit the potential of emerging technologies such as the Cloud and 4G and LTE Broadband.
9. Empower institutions to integrate m-learning pedagogy and tools in the curriculum development
10. Build capacity in the development of mobile content and applications for the m-learning market in Africa.
11. Exploit the potential of multimedia & advanced graphics design to capture interest of low achievers.
12. Satellite communications and other forms of production of energy will boost mobile internet access in rural areas.
13. A mobile community is beneficial for a mobile learner to evolve comfortably.
14. Enhancing user educational experience demands innovations in m-learning scenarios and systems.
15. To accommodate m-learning strategies through projects in national ICT strategic planning.
16. Contextualizing mobile learning may support cultural and language identities.
17. Disabled persons can take maximum of m-learning if properly designed.
18. The mobile technology can be efficiently used for institutional and students administration. For example, simple applications like notification of deadlines for submission of projects with SMS.

19. A cost model for infrastructure, applications, devices and services should be worked out in any feasibility study of an m-learning project.

20. The m-learning activities as well as the applications and devices provided to students should be managed by the institution; appropriate procedures must be designed and adhered to.

21. The stakeholders in an m-learning system must be trained accordingly.

22. Team building and collaborative can be encouraged by m-learning.

23. Apart from learning content the mobile technology offers a variety of complementary functionalities and opportunities that can be loaded on a handheld device.

24. With the advent of more powerful handheld devices with rich media content at lower costs, much of the learning will happen outside classroom in informal settings, subsequently institutions will have to adapt to new scenarios.

25. M-learning has no single formula for all subjects areas and context, each scenario and topic is a unique case. Some subjects may seem easier on the m-learning mode than others.

26. The advantage of the mobile phone is that it was initially designed for voice and audio communications which are the most significant ones in teaching. Learning content with voice and audio could be very effective in m-learning mode.

27. M-learning can be implemented on small scale rather than starting directly with large scale megaprojects equivalent to virtual campuses in e-learning.

28. To develop content respecting the AICC or SCORM standards in case of interoperability with e-learning LMSs if an institution is willing to track and conduct assessment.
A Framework for Mobile Learning and Training

We have presented the various frameworks applied in the literature and on real life projects in Part I of this document. The framework proposed in this research study has been inspired from existing frameworks with the aim to provide a pragmatic simple tool for any institution to plan and implement for any mobile learning project. Emphasis is laid upon here on the project management approach. A mobile learning project is before everything a project that requires proper project management and leadership to be successful.

The first step of applying the framework would be to setup an m-learning project committee to lead and drive the project. This committee should comprise the different stakeholders namely a chairman, a technologist, a pedagogue, network operator, subject specialist and a student in case of higher education.

The 10 components to be considered within the framework are grouped into 2 blocks, the conceptual phase and the running phase. In a timeline the running phase comes after the conceptual phase but the components in one block are not necessarily consecutive. Each component comprises a set of queries, questions and computations that need to be addressed in the decision making process.

Currently, each m-learning project is a unique project, the standardization and commercialization of the mobile projects have not yet enabled reuse or replication of those projects in other situations and contexts. Presently, there are few off the shelves products for m-learning contrary to e-learning or traditional distance education replication or transposition from one country to another was quite feasible, smooth and effective.

Subsequently, all mobile learning scenarios need to be looked upon on a case to case basis with the appropriate questions and checklists listed below must be answered first.
The Conceptual Phase

- Cost Model (sub levels: technology, infrastructure, services)

  Mobile device deployment strategy, 1:1
  Internet connectivity
  Licensing scheme
  Off the shelves products
  ROI & ROTI
  Maintenance & Support Costs
  Course content
  Tutors & mentors fees
  Economies of scale
  Who will fund the project?
  Cost is pretty affordable as comparatively less recurring cost and one-time investment

- Requirements (sub levels: pedagogical issues, design, formal/informal settings)

  The institution should understand at the outset whether an m-learning system or component is required and will be helpful to the learners and the institution itself, i.e. what are the needs for mobile learning?

  Different methodologies exist to determine the need to go for m-learning; it could be a training needs analysis or a case to case scenarios for example space can be a constraint to accommodate more students.

  Suitability of the programme or course to m-learning
  Why a mobile learning project?
  Assess the technology with pros & cons the most appropriate for the project.
  Match with curriculum needs.
  What is the percentage of blended learning & integration with existing or other VLEs?
  How much of learning & how much teaching?
  Design of the course content
  Pedagogical issues
  The project should correspond to the learning theory identified and vice versa, the table in section 12 in Part II draws examples of the different learning theories and corresponding past projects.
- **Stakeholders (sub levels: learners profile, institution, service providers)**

  Who are the learners?
  Profile of the learners
  Academic support staff
  Network operator
  Service provider
  All stakeholders in the mobile echo system
  Ensure the system will be usable and acceptable for all stakeholders

- **Targets (sub levels: population type, geographical reach, set objectives)**

  We need to define the type of mLearning to be adopted. Is it a performance centric approach, a learner centric approach, an institution centric approach, an instructor centric approach, a peer to peer approach?
  What are the objectives set?
  What are the learning outcomes?
  Curriculum adapted?
  What’s complementary to in-class?
  How to cater for practical sessions?
  Tutorials
  Module map
- **Uniqueness (sub levels: degree of innovation, level of customization, integration into curriculum)**

  Innovative scenarios  
  Enhance learner’s experience  
  Level of customization on existing solutions  
  Scope of the project  
  What is the ratio of time allocated to mobile and to traditional learning?  
  What value does mobile technology add to the learner?  
  What percentage of the content should go mobile?  
  We should not re-invent the wheel in view of any pilot project

**The Running Phase**

- **Sustainability (sub levels: train the trainers, viability, recurrent)**

  Teachers should be trained to assist the learners and other teachers  
  Keep the momentum of the programme  
  Agile techniques to accommodate changes and adapt the system  
  Enhance current and new instructional activities  
  Lessons learnt  
  Ensure security and privacy of the learners and the institution

- **Collaboration (sub levels: interactive tools, motivation, activities design)**

  Enhance collaboration & sharing  
  Multimedia and tools for collaboration  
  Youngsters like graphics & multimedia and interaction  
  Team building & problems solving

- **Effectiveness (sub levels: quality assurance, assessment, examinations)**

  Quality control and assurance  
  Assessment ..  
  Examinable or not..  
  Condition system..  
  Feedback from learners  
  Examinable or not  
  Credit system  
  Professional certification
- **Academic support (sub levels: supervision, tutorials, practical sessions, additional resources)**

  Academic supervision, how is it conducted?
  Exams and support
  Additional resources

- **Administration (sub levels: administrative, financial)**

  Teaching support
  Guidelines for usage of the device
  Deadlines
  Assistance, request for interruption
  Alerts
  Financial notifications
  Books on loan
  Develop strategies and procedures for management of devices
CONCLUSION

As a matter of fact, mobile cell phone has been the fastest adopted technology for the past decade in the world. This is very true for the African continent where the growth in subscriptions of mobile phones is the highest. Concurrently, many institutions and organizations have been exploiting the mobile technology to achieve pre-defined goals in formal and informal educational settings. There are pre-conceived opinions about what mobile learning is and how to go for it.

The findings of this research study briefly explained in the 3 major parts I,II,III have helped in enumerating the research gaps and directions, some best practices, listing the recommendations and as per the goal of the TOR, to come up with a framework for the implementation of mobile learning and training.

The first objective set for Part I was “explaining what mobile learning is”. We have seen that there are trivial definitions of mobile learning and that technology, pedagogy and knowledge are the key elements in any mobile learning system. We have highlighted the specificity of mobile learning such as context awareness and its virtue when combined with the Internet and other VLEs and also found that mLearning is not merely an extension of e-learning but a paradigm shift in integrating technology into education.

The second objective for Part I was “presenting current status of mobile learning as well as latest research”. Here we have seen the current mobile learning situation in formal and informal settings as well as in the enterprise. Mobile learning is in its 2nd generation coinciding with the 4G of mobile technology and there are numerous short term pilot projects and initiatives across the globe. The latest research has been summarised in the research gaps and directions section.

The third objective of Part I was “outlining the challenges faced by when designing and implementing mobile learning”. The primary barrier is here the lack of strategy and vision. Other challenges are equally important namely the pedagogical match with the technology. It has also been noted that apart from restrictions imposed by the hand held device such as small screen size, mLearning remains in the informal domain due to lack of standards and the didactic instructor centric approach that instructors tend to revert back. It’s true mLearning by it’s nature tends to render training informal, thus either learners are highly motivated or collaboration and multimedia retain the their interests.

Part II corresponds to the objective “compiling advances, initiatives and applications in mobile learning”. We have seen here the economic potential for growth of mobile learning and the emerging technologies that will revolutionise mLearning as from 2010. These are the 4G rollout and the advent of a cocktail of technologies like IPv6, Web 2.0, IMS, augmented learning and in memory analytics. Products and suppliers have been listed in Appendix 3.
The first objective set for Part III was “documenting case studies of how mobile learning is being used to teach and train in different places worldwide. The case studies and projects compiled and reported in Part III are very meaningful and reveal the complexity of mLearning projects. Since 2001, there have been a series of initiatives and projects at institutional, enterprise and few at governmental levels. The majority of them for a short duration of 4 to 8 months and most of the time training is informal. We have noticed a regression of mLearning projects in higher education and a focus on content development. Technology is no more a barrier in the developing world as well as in the developed one. Case studies from China and Bangladesh have shown that teachers continuous training in rural areas are very much possible with mLearning. What really differs from one project to another is the educational scenario, and sometimes with unknown or unmentioned theoretical perspective. Some projects can be emulated to other parts of the world. More case studies and projects are compiled in Appendix 4.

The second objective set for Part III was “discuss the future of use of mobile learning in education, training and informal settings”. Several future scenarios have been reported. Attention was drawn on how large carriers together with other stakeholders are proposing mLearning on a subscription basis and new products such IT certification content is already on the market. One could be future project relevant the African context was identified, it’s about the use of mLearning to leverage the pass rate for students in foundation courses with insufficient entry requirements for mainstream tertiary undergraduate programmes. Another one could be the improvement in Maths for secondary students through mLearning.

The new framework proposed is a generic one that can be applied on a case to case basis as each mobile learning project seems to be unique by itself. The framework presents 2 blocks of critical factors, one conceptual and the other at runtime. The 2 new projects identified above can be conceived with the help of this framework.

Mobile learning and training implementations require de facto project management skills before any consideration. With advent of new technologies new opportunities, challenges and paradigms will appear, by how much these technologies will drive the educational goals need to be further investigated. There has been interesting mobile projects in Africa principally relevant to its development, very few indeed in the educational sector, most significant one happening in South Africa. There are interesting success stories across world that can be adapted, emulated and translated to the African context, but also indigenous specificities that must be addressed.
Appendix 2

Conferences & Workshops
Mlearn
The International Conference on Open and Online Learning (ICOOL)
IADIS is the International Association for Development of the Information Society (http://www.iadis.org/).
The Mobile Learning Conference 2011 MobiLearn
MoLeNET Mobile Learning Conference:
www.molenet.org.uk/moleconf/learningconference2010/

Organisations
WLE Centre: Mobile Learning Symposia and the London Mobile Learning Group (LMLG)
Futurelab (http://www.futurelab.org.uk/)
G1:1 (http://www.g1on1.org/)
PLAN
Becta
Kineo, www.kineo.com
Kaleidoscope, www.noe-kaleidoscope.org/
Mobilelearningsig, http://www.mobilelearningsig.com/content/case-studies
The London Mobile Learning Group: http://www.londonmobilelearning.net/

mLearning international journals
The International Journal of Mobile and Blended Learning (http://www.itiglobal.com/ijmbl/)
Elsevier Special Issue of the Journal of Systems and Software on “Mobile Applications: Status and Trends”.
The International Journal of Mobile Learning and Organisation (IJMLO);
www.inderscience.com
International Journal of Interactive Mobile Technologies (IJIM)
International association of mobile learning
Journal of Mobile Information Systems
Asian Journal of Distance Education
Asia Pacific Journal of Education
Asia Pacific Education Review
Indian Journal of Open Learning
Malaysian Journal of Distance Education
Open University Hong Kong’s
Turkish Online Journal of Distance Education
Distance Education in China
Korea’s Journal of Lifelong Learning Society
Appendix 3
Tools for Applications & Content Development

Key mobile learning authoring tools include:

- Captivate, Creative Suite & Dreamweaver—Adobe Systems, Inc. (USA)
- Presenter & Engage—Articulate Global Inc. (USA)
- Camtasia Studio—TechSmith Corporation (USA)
- Desire2Learn 2Go—Desire2Learn (Canada)
- DominKnow Mobile—DominKnow, Inc. (Canada)
- Drona—Deltecs Infotech (India)
- Float Learning—Float Learning (USA)
- Lectora Publisher—Travantis (USA)
- iQpakk—MentorMate (USA)
- MyLearning Authoring Tool—Tribal/CTAD (UK)
- Push Mobile Media—Push Mobile Media (USA)
- Toolbook—SumTotal (USA)
- UpsideLMS Mobile—Upside Learning (India)
- Vcommunicator Authoring Suite—Vcom3D (USA)
- vMobiLearn—Vistacast LLC (USA)
- WebBuilder—ReadyGo (USA)

Xyleme, Inc, www.xyleme.com

AvantGo is a producer of mBusiness products for palmtops and pocket pcs.

IBrite has developed an authoring product for putting content together for the Palm PC. http://www.ibrite.com/download_software.htm.

Transition is an award-winning provider of Lectora and IBM Lotus e-learning products and services.

Isopia provides this definition of mLearning: 'With the power and functionality of Sun LearnTone LMS extended to mobile devices, Sun enables enterprises to offer a seamless, blended learning experience extending from classrooms and desktops, to PDAs, two-way pagers, mobile phones and hybrid devices'.

Experient.com have published a white paper titled Mobile eLearning Systems which promotes its Calypso product. Calypso enhances current technologies, it is said, that do not adequately exploit the potential of the internet for learning. Calypso allows learning any time, any place, any where without constant access to, or persistent use of, the internet.
INSEAD, NOKIA, and ICUS formed an Asia-Pacific consortium to pilot m-learning. The initial result of their endeavor was the development and deployment of an e-course delivered via WAP-enabled NOKIA phones. The course, eBusiness on the Move, was developed to make use of both WAP (wireless) and Web (wired) technologies, allowing participants to access content via phone and computer.

List of Learning Management System (LMS), most of them with m-learning options.

- WebCT
- BlackBoard
- Learning Space
- IntraLearn
- Top Class eCollege
- Click2learn
- Authorware
- First Class
- Docent
- LearnLinc
- Virtual-U SiteScape
- Web Course in a Box
- UniLearn
- Generation 21
- Phoenix Pathlore
- Saba Learning Enterprise
- Pathware
- Knowledgesoft
- VCampus
- EduSystem
- Serf
- LUVIT
- Mentorware
- The Learning Manager
- QuestionMark
- Eloquent rainersoft
- WebBoard
- Convene.com
- Quest
- PlaceWare
- Embanet
- OLI
- Ucompass
- IVLE
- Integrity eLearning
- InterWise Millennium
- Theorix
- Inspire
- Jones e-education
- Prometheus
- Anlon
- Class Act!
- Colloquia
- Southrock
- U4all.com
Safari

Safari is the iPad's web browser. It allows you to view complete web pages as they would appear on a standard computer. You can zoom into text or images easily for a closer look. You can have multiple pages and/or sites open at once using “tabbed” browsing. Text and images can be copied for use in other apps.

Mail

Mail is an email app that allows you to access and manage all of your email. It will allow you to manage multiple email accounts e.g. you can sync your EduMail account to it, and also attach a Gmail or Yahoo account. Mail works closely with the Contacts and Calendar apps to make sure you are always organised.

Photos

The Photos app organises all of the images on your iPad. You can create impressive looking slideshows from directly within the app. When an image is selected you can email it to someone, set it as wallpaper for your iPad, or 'copy' it for use in another app.

iPod

The iPad is also a fully featured digital media player. The iPod app allows you to play your music, download and listen to podcasts and audiobooks.

Maps

Maps draws on Google Maps to provide digital maps and satellite images of almost anywhere. Great for Humanities projects, or just taking a look at what your home looks like from space!

Notes

Simple word processing and note-taking can be done using the Notes app and the onscreen keyboard. Notes can be synced via iTunes to your computer, or emailed to yourself for further polishing in a word processor such as MS Word, or Apple Pages (Pages is also available as an iPad app allowing a fully featured word processor on
the iPad).

**Calendar**

The Calendar app has the look and feel of a traditional desktop calendar, with the added bonus of being able to view day, week or month to a page. Entries made on the calendar can be set to automatically sync to an email account (such as your EduMail account).

**YouTube**

The YouTube app brings to the iPad all of the rich learning resources that have been shared on YouTube. Need to learn how to use Photoshop - YouTube it! Want to bake the perfect souffle - check out a step-by-step video on YouTube!
Appendix 4


Mobile Learning in Higher Education

I recently attended a NERCOMP event on Mobile Learning in Higher Education. NERCOMP - the NorthEast Regional Computing Program -- is an EDUCAUSE affiliate. The "day of discovery" was hosted by Kristin Lofblad Sullivan, Manager of Instructional Technology at Harvard University's Graduate School of Education.

Session: mLearning 101

The first session was presented by Jason Gorman, Instructional Designer, Harvard Graduate School of Education (HGSE), Gino Beniamino, Instructional Technologist, HGSE, and Susan Eppling, Instructional Media Developer, HGSE.

Mobile devices were defined as anything you can take outside the classroom and connect to the internet or a network via a broadband connection. Clearly there is a proliferation of diverse software platforms and devices that meet this criteria and that was noted as a challenge. But the opportunities for education are staggering given the statistics:

- Out of a total U.S. population of 308MM, there are 285MM cell phones.
- More people in India have access to cell phone than toilet.
- 41% of the global population of 6.3 BB carry mobile phones.
- For real-time updates see the PhoneCount website.
- "Nomophobia" is the fear of being out of mobile contact.

Challenges to deployment include the need for skilled developers/vendors, faculty fluency and interest, funding, platform decisions, the lack of common devices, student opinions of tools, the 'digital divide' and access to tools, unrealistic expectations of students/faculty/administrators, technology support, changing opinions of assignment design, and the overall ‘technology happens’ issues concerning technical problems when using devices and platforms of this nature. These were organized into three broad categories: technical, teaching and learning, and institutional.

Next we reviewed some sample projects, each showcasing a different type of device and approach to mobile learning.

ABILENE CHRISTIAN UNIVERSITY

ACU has embarked on a number of mobile initiatives, with some noteworthy projects involving the iPhone and iPad. Students, faculty and staff created a movie called
Connections to "visualize a new kind of learning environment". Many of the challenges outlined above were felt. But they achieved some interesting outcomes, including:

- Creation of a Mobile-Learning Fellows program. Gave half-dozen faculty grants to innovate in different ways (also had corporate sponsorships/partnerships). Published, discussed with community, disseminated ideas, etc.
- Closed some computer labs to offset costs
- 89% of students and 87% of faculty rated it a success
- But student performance NOT measurably increased

DUKE UNIVERSITY

Duke created the Duke Digital Initiative in order to incorporate the use of emerging technologies in the classroom. One initiative project centered on the use of "flip-phones" to foster critical reflection through video. For more on the actual project, see the eLearn Magazine article: How Tiny Camcorders are Changing Education and the blog post on 6 Recommendations for Teaching with the Flip Video Camera. Outcomes included:

- Better quality essays
- Some fear of technology was noted
- Unforeseen tech problems were noted
- Use of video promoted in-class discussions
- Students felt that video was more evocative than text
- Classroom may become a public space – pro and con

SIMMONS COLLEGE

The Biology Mobile Classroom project was reviewed (see overview PDF). This initiative involves taking laptops out into the field to allow students to crunch numbers and perform on-site analysis and experimentation. Dozens of laptops were issued (via grants).

Some outcomes and considerations:
- Powerful hardware/software was needed
- Participants definitely felt it took learning to a deeper level
- Participants felt a strong potential for cross-discipline use

Considerations for the future
Some general considerations for the future of mLearning were discussed:

- Teaching and learning considerations – students have more insights into this technology than many teachers do
- Institutional considerations for how to fund, train, socialize
• Technology keeps changing -- stay tuned for "Super WiFi" -- the FCC is selling off new frequencies that will augment mobile capabilities. Also compatibility standards – HTML 5, linux 2.2, Mac/PC, etc.
• E-waste – old cell phones – proper disposal and recycling (see some impactful photos of eWaste)
• Privacy

Session: "Walking Ulysses: Joyce's Dublin Today"

Walking Ulysses is a mobile learning project created by Boston College professor Joseph Nugent (and instructional designer Tim Lindgren co-presented). The goal was to afford a 21st century visitor to Dublin the ability to walk around and experience, to the greatest degree possible, the sights, sounds, smells, etc, of Joyce's 20th century city. They aimed to achieve this via the use of collaborative mapping and mobile technologies. Students are thus participants in a hybrid physical/virtual space and are also active contributors to the site and hence the shared knowledge it extends.

They initially tried using Google Maps to trace characters’ paths but were quickly overwhelmed its capabilities. Ultimately the BC instructional technology group provided a grant to Prof. Nugent for $10,000 to hire a developer to build something - but what to build? Website + iphone app? Couldn’t afford an Apple application, so went with a web application + a ‘mobile skin’. The instructional technology group had no prior experience in this domain but figured it out as they went. They organized content by chapters (chapter = path), then tagged content by ‘sense’ (sound tag, smell tag, etc). They then gave those items location tags and put them on a map. But they wanted the map to be reflective of the time period and hence needed a Google Map-type interface capable of filtering between people, buildings, events, etc.

The team used the Google Maps API but then also worked with the Drupal open-source content management system both because they found it to be a powerful web development platform but also because it offered a lot of the basic functionality they desired (especially when combined with JavaScript for interactivity). They first focused on wireframing/prototyping and started with the web interface prior to the mobile interface. Ultimately they considered the ‘user on the street’ use cases – a person lands in Dublin and wants to explore city through the lens of the novel -- what features and functionality would help them?

Session: Mobile Learning at Tufts Medical School

Speakers for this session included Susan Albright, Director of Educational Technologies, Technology for Learning in the Health Sciences (TLHS), Tufts University Sciences Knowledgebase (TUSK), and Mark Bailey, Manager of Support for TUSK.
TUSK is a "dynamic multimedia knowledge management system" that the Medical, Dental, and Veterinary Schools at Tufts and several other international schools use for knowledge management and info-sharing. This year they rolled out a mobile version for the platform in response to a number of factors, including lack of computers in partner schools, preceptors asking for support in office, students wanting to access content ‘on the go’, etc. Additionally, in the healthcare field internationally, the phone IS the computer. Globally there are 400 million computers vs. 4 billion cell phones. Nearly 100% of students at partner schools have phones – only 10% have computers. Besides ubiquity, Tufts believes in the learning potential of mobile devices (they cited research by Naismith regarding mobile technologies and learning).

The team encountered some design challenges for the mobile piece, including appropriate use of the new context for information, the screensize, load time, storage, diverse phone platforms, etc. Design considerations included understanding user patterns (done via survey), achieving objectives using fewer links per page, allowing more scrolling in favor of larger text size, simplified pages, and ultimately achieving a "one design MANY platforms" solution. Testing was done using free online phone emulators, and the Opera mini browser was determined to be the baseline minimum technical requirement. The team is keeping their eye on the "HTML5 vs. Adobe Flash" issues. Mobile content on the site includes slides, flash cards for self-assessments, patient log entry forms, etc.

Session: Mobile Learning in Executive Education at Harvard Business School

Speakers for this session included Curtis Hermann, Senior Multimedia Engineer, and Katie Martin, Director of Program Innovation, both from the Educational Technology Group at Harvard Business School.

In spring 2009, HBS Executive Education launched a pilot program using iPod Touch mobile devices. This allowed program participants real-time access to program information and content from any on-campus location. The devices were provided to over 160 participants with funding contingent upon an extensive post-use evaluation. The iTouch was chosen because it would allow for a single-platform for content development, it did not contain a phone (no plan required), and it was an attractive vehicle for A/V content. Assessment was handled via pre- and post-program surveys, flash polls, focus groups, individual interviews, and weekly journals. Key takeaways:

- The device was quickly adopted as critical to daily activities, used on average 47 minutes/day by participants. They primarily used the device to check email, and to keep appraised of the program’s schedule and announcements. There is also a program directory.
- Participants preferred the anytime/anywhere nature of the device in contrast to desktop computers provided in their living quarters.
- Audio versions of certain Harvard Business School case studies were provided on the devices. Participants found these to be a complement to, but not a
replacement for, hardcopy cases. About 1/3 listened and then read, about 1/3 read and then listened, and about 1/3 read and listened simultaneously. A small percentage preferred paper only. Most participants agreed that they were better prepared for case study discussions when they had audio/video components as part of the learning.

Moving forward the program will not provide the devices for participants but they did work to produce an iPhone app that participants can download in advance of attending. This app provides similar access to content and information via their program portal. Resourcing a program of this nature required faculty outreach, content identification and creation, device adoption, and training/support. Just loading participants’ personal devices with content takes a few days of intense support resources and is a limiting factor on their ability to scale the program.
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