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Chapter · March 2015

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Mobile Learning in Higher Education: Current Status and Future Possibilities

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Abstract

This chapter explores current mobile learning research and practice in the higher education sector and is particularly relevant for practitioners interested in implementing solutions using the latest developments in mobile technologies. The following discussion provides background to inform and guide the decision making process. The authors consider developments in mobile technology, its role within society and current usage within the sector. The discussion moves on to examine a number of relevant research studies.

Although demographical and statistical data clearly show there is a large scale adoption of mobile technology in many parts of the world and mobile devices are an integral part of many students' daily life, the authors conclude the pedagogical value of such technologies is less clear.

Examples considered illustrate how colleagues are using mobile devices in their teaching, but further research is needed to identify sound pedagogical frameworks relating to the use of mobile technologies to engage students and improve learning.

By adopting a critical perspective and suggesting further areas for research, it is hoped that the discussion below will prompt colleagues to consider how the latest developments in mobile technologies can be embedded within curricula to effectively support and enhance student learning.

What is Mobile Learning?

Education paradigms are shifting. In many instances online and blended learning solutions are part of the learning environment. Mobile technologies are beginning to feature in this mix.

The use of personal, wireless, mobile, portable, and handheld devices has increased dramatically from small-scale, short-term trials to larger more sustained and blended deployment (Traxler, 2009). The growth in use of mobile devices is followed by widespread usage of apps, changing the way people communicate and access information.

> "Smartphones including the iPhone and Android have redefined what we mean by mobile computing, and in the past three to four years, the small, often simple, low cost software extensions to these devices — apps — have become a hotbed of development." (Johnson, Adams & Cummins, 2012, p. 10).

This use of mobile devices and applications in the learning environment has lead to the concept of mobile learning or *mLearning*.

Mobile technology allows students to become nomads, "carrying on conversations and thinking across campus spaces, as always, but now with the ability to Google a professor's term, upload a comment to a class board, and check for updates to today's third assignment—all while striding across the quad" (Alexander, 2004, p. 31). Similarly, Geddes (2004) defines mLearning as "… the acquisition of any knowledge and skill through using mobile technology, anywhere, anytime, that results in an alteration in behaviour" (p. 1).

El-Hussein and Cronje (2010) conceptualize mLearning from three different perspectives: mobility of technology, mobility of learner and mobility of learning especially in higher education landscape.

mLearning facilitates individual and collaborative learning, as well as offering opportunities for increased freedom and independence; it engenders with the concept of

learning anytime and everywhere. El-Hussein and Cronje describe mLearning as "…any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning" (ibid, p. 20).

mLearning is redefining the processes and roles in education, technology and society. From an educational context, one could question whether existing theories for learning and instructional design practice recognize and offer sufficient opportunities to utilize mLearning effectively and if pedagogical frameworks should now incorporate more collaborative and independent learning activities made possible by mobile technology.

The above discussion highlights current thinking surrounding the notion of mLearning; the next section considers developments which have lead to the important role mobile technologies play in many peoples' lives and why educationalists cannot ignore these developments.

Growth of Mobile Technologies

The past 15 years have seen a growth in the speed and sophistication of networks, an increase in the number of people accessing the Internet and the development of a wide range of different mobile devices.

In the last ten years the emergence of wireless networks, broadband access, increasing bandwidth, quicker transmission speeds and the multiple use of devices, including smartphone's, tablets and readers, has a major effect on when and how users access the Internet and how they communicate with each other.

By 2012, over a third (34.3%) of the world's population were online and in Europe, 63.5% of the population were connected to the Internet (Internet World Stats, 2012). In the United Kingdom, Switzerland and Turkey the percentage of the population online in 2011 was

85%, 84% and 40% respectively (Worldwide Independent Network of Market Research, 2012).

In the late 1990s communication technologies reached new levels of sophistication and in early 2000s broadband access started to replace many dial-up services in Europe, allowing speedier download of data and quicker communications. Wireless networks were introduced in the 1990's; initially adoption was slow, but after 2005 there was an exponential increase in the number of wireless networks and wireless data traffic as many private households, commercial organizations and public institutions in Europe started to implement wireless networks.

Europe has experienced the highest growth in mobile data traffic. The overall growth rate between 2010 and 2015 is predicted to be 193% (Portio, 2012, p. 16). Mobile phones have become increasingly sophisticated in recent years. 3G phones, incorporating services over a wider area and better data transfer rates, became increasingly popular after 2005. Data transmission speeds increased further and the stability of services improved with the introduction of 4G networks, although at the time of writing these have yet to become available in some areas of Europe.

Corresponding developments have taken place regarding the availability of mobile devices. Mobile subscriptions increased globally from 4.5 billion in 2009 to 6 billion at the start of 2012. This growth is likely to continue with numbers predicted to reach 8 billion by the end of 2016 (Portio, 2012, p. 7). At the beginning of 2012, 86.1% of the world's population had a mobile subscription; in Europe the percentage stood at 131.4% with many individuals have more than one subscription (Portio, 2012).

The ownership of tablets is relatively low in comparison to that of traditional mobile phones and smartphones, but tablet ownership is starting to grow. Companies are now launching a wider range of tablets and readers, offering users more choice. This expansion

has resulted in increased traffic and data downloads via mobile devices. Research suggests that ownership of traditional mobile phones, computers and laptops is decreasing whereas that of smartphones and tablets is increasing (WIN, 2012).

The growth in smartphone usage, data traffic and applications (apps) downloads is underpinned by an increase in bandwidth. Worldwide broadband uptake grew exponentially between 2006 and 2011. Adoption was particularly noticeable in Europe where bandwidth per Internet user was the highest in the world in 2011 (ITU, 2012).

The cost of data transmission has fallen, making it cheaper for users to download data and communicate with others via smartphone or tablet. Abraham and Schuster (2011, p. 13) noted that the cost per MB worldwide fell by 86% between 2008 and 2011.

It is clear from this discussion that users are able to download more data, using more devices, quicker and easier today than they could do previously. But what type of data are they downloading and what are they using their mobile devices for?

Individuals have traditionally used mobile phones for communication. This is still the most popular activity, although text messaging has overtaken voice calls in the top spot. The advent of smartphones with computer-like operating systems, and the growth in associated data services has seen a rapid growth in users accessing emails and downloading mobile media (ComScore, 2012). After text messaging, the four most popular activities are: taking photos; accessing news and information; accessing the web using the browser; accessing the web via apps (ComScore, 2012). The third and fourth of these activities are not mutually exclusive. Many users use both and tailor their activity according to their location. There has been a noticeable escalation in app downloads, which increased by a factor of 9 between 2009 and 2011 (Portio, 2012). In 2011, the percentage of the total mobile audience who used apps to access the web was similar to the percentage that used a browser access the Internet (ComScore, 2012).

What are the implications of these changes for practitioners in the higher education sector? Has the growth in Internet technologies and mobile devices had an impact on how students want to learn and the learning environment? These questions are explored next.

Mobile Device Platforms and Technologies

The significant rise and spread of mobile operating systems started in the 1990s with the Palm and later Windows CE and Symbian systems closely followed by Bada, Blackberry OS and iOS.

Gartner (2012) reports that at the end of Q3 in 2012 the share in the world-wide sales of mobile devices, analyzed by deliverer, showed Samsung (22.9% of global sales to end users or nearly 98 million devices) and Nokia (19.2% or more than 82 million devices) are the top sellers. This is followed by Apple (5.5%), ZTE (3.9%) and LG Electronics (with 3.3%). These figures indicate a noticeable gap.

At the same time (Q3), Gartner (ibid) showed that the Android was the top mobile operating system worldwide. According to the analyst, more than 122 million Android based devices had been sold in 2012, representing a market share of 72.4%. iOS made to 23.5 million devices or 13.9% of market share.

With numbers of devices rising, users demanded additional functionality. Developers tried to deliver a consistent user experience on different platforms and operating systems by employing HTML5, CSS3 and JavaScript (Hartmann, Stead & DeGani, 2011, p. 2).

The same authors (Hartmann, Stead & DeGani, ibid, p. 3) suggest that similar results producing native apps with high performance and integrated technical features. can be achieved by cross-compiling, based on developing frameworks that provide application programming interfaces (API) independent of operating systems used (for example, JavaScript, Ruby or Java. However, this functionality is complex to build and needs to be

usable over a number of different platforms. An alternative method is to deploy a virtual machine around the mobile app that simulates the target operating system and thus makes the app work in a number of different environments and delivers high portability and flexibility. A further method is to create a web app that runs in the user's mobile browser using HTML5 and CSS3 with rendering engines like WebKit. In this case, the app runs either in a standalone browser or in another app that integrates a browser view called "hybrid web" (Hartmann, Stead & DeGani, ibid, p. 4). In the hybrid case, a native app bridges the desired functions that run in the browser instance to the hardware of the mobile device. Both interfaces, native app and browser instance, communicate via JavaScript or dedicated APIs. This solution is quite popular because it combines flexibility of the app with the performance of the native device hardware.

Another method that can be used to deploy software on mobile devices is the widget approach. A widget is a small and specialized tool delivering one specific function to the user. Many mobile operating platforms and browsers offer such widgets. However, standardization has not been achieved in the widget approach and may result in developers having to create a range of different apps or widgets to suit different devices. JavaScript , together with a wrapper API , can be used as a general mediating language between most widgets and the respective platforms (Hartmann, Stead & DeGani, ibid, p. 5).

Several development frameworks exist. Hartmann, Stead and DeGani (ibid, p. 5) classify them into four types, namely library, framework, platform and product/service. Typical and wide spread Open Source platforms are Rhodes, Phonegap, Appcelerator, MoSync, JQueryMobile, QT and others.

Based on their technological approach to software development and deployment, Hartmann et al. (ibid: 14f) categorize nine different types of mLearning:

1. mVLE-based: mobile extension to a common LMS;

2. content delivery: traditional linear relationship;
3. record of achievement: m-devices record achievements in a portfolio;
4. just-in-time-training;
5. social learning: the m-devices supports peer interaction;
6. enhanced reality: augmented reality functions enhance the learning process;
7. learning support: the m-device facilitates learning from other sources (e.g. dictionaries for reading/speaking);
8. experience-based learning: the m-device enhances the user's experience e.g. offering orientation functions, a camera, etc.
9. game based learning.

These categories represent theoretical constructs and do not necessarily exist as such. They are not mutually exclusive and some of them may not relate to mLearning and refer to specific situations of use that can intermingle. For example, a concrete learning situation may show aspects of these different types. However, the typology is useful to differentiate between various aspects of usage scenarios, as well as approaches that can be used to develop and deploy the software on mobile devices.

Adding this understanding to the development of mobile technology assists in framing a perspective for the existing and potential research in mLearning. The next section of this discussion provides an overview of research and the evolution of mLearning to date.

mLearning Research

For many students in higher education mobile phones, smartphones and tablets are an integral part of their daily lives. Anecdotal information suggests they use these devices mainly for social interaction and entertainment. Educators and researchers are conscious that students engagement with mobile devices offers learning and teaching opportunities; Ng'ambi

and Lombe (2012, p. 181), state "… converge social and entertainment uses of mobile devices to scaffold student learning and foster deep engagement with content".

In a move to better understand the role that mobile technologies has on students' learning, and could have in the future, a number of researchers are focusing on this area.

Alzaza and Yaakub (2011) explore students' awareness and expectations of mLearning services by investigating higher education students' experiences in Malaysia. They suggest that students in higher education today have adequate technical skills, awareness and self motivation to use mobile technologies to support their learning. In addition, they conclude that many higher institutions have the necessary technological infrastructure to implement mLearning activities within the curriculum. Alzaza and Yaakub's study identifies that students used mobile devices to access (in order of popularity): assessment results; course registrations; their calendar and schedule services. The study also highlighted a number of barriers. They found that the cost of transaction, slow data exchange due to inefficient networks and concerns over confidentiality of personal information could present obstacles and prevent the widespread implementation of mLearning activities within institutions (ibid).

Uzunboylu, Cavus and Ercag (2009) investigate the increased use of mobile technologies, data services, and multimedia messaging systems and students' increasing awareness of the potential use of mobile technology in the learning environment. Their findings indicate that students used mobile phones to capture images of specified environmental issues and then forwarded the images via phone and exchanged relevant information via SMS messages with other students in their group. The study reveals that many students are aware that mobile technologies can be used to support their academic development and learning and in many cases are already using them unofficially. Furthermore, the study suggests that the use of mobile technologies could improve engagement and help develop positive attitudes towards learning.

A number of studies have focused on the impact of mLearning on student outcomes or performance. McConatha, Praul and Lynch (2008) conducted a research study in the US to investigate the impact of introducing mobile access to help students access and review study materials. Findings show that implementing this flexible type of approach had a positive effect on performance.

In a similar study, Wong, Chin, Tan and Liu (2010) investigate the role of mLearning in a language learning context. They examine how mobile devices could be used to create artifacts to support Mobile Assisted Language Learning (MALL), a methodology which emphasizes learner-created content and contextualized meaning. In this study students used smartphones to capture photographs of the real-life contexts that related to the language areas being studied. They subsequently used these images as the basis for written or spoken work. Wong et al concluded that using mobile technologies in a blended learning environment leads to authentic learning experiences for many students.

Jeng et. al. (2010) propose a mLearning design framework which focuses on mobile users, learning strategies, situated environments and they stress the importance of underpinning mLearning activities with sound pedagogical strategies. They argue that mobile technology supports the development of "situated classrooms", by allowing students to communicate with each other in class, access relevant data or use built-in functionality such as a camera or gsp receiver on their mobile device to create an augmented knowledge context environment. In contrast, Boyinbode, Bagula and Ngambi (2011) maintain that non-situated, flexible access to learning materials (for example, podcasts, videos, etc.) via mobile devices can support student learning from any location.

Mobile collaborative learning (MCL) environments build on the social, student–to-student or student-to-lecturer communications within the education environment. Lee (2011) introduces the theoretical and technical foundations for designing and developing a MCL

application to support student learning. Lee developed and tested a prototype app, based on students' pedagogical requirements, which could be used to facilitate collaborative working and sharing of learning materials. Lee concludes that mobile technologies could provide a useful tool to facilitate interactions which lead to shared understanding.

Järvelä, Näykki, Laru and Luokkanen (2007) explore the use of wireless networks and mobile tools to scaffold collaborative learning. They conducted three design experiments based on the notion of collaborative learning as an activity with socially shared origins of cognition and self-regulated learning. All experiments investigated innovative ways to structure and regulate individual and collaborative learning using smartphones. The first study explores the facilitating students' self-regulated learning processes, the second study encouraged scaffolded collaboration and the third focused on how blended collaborative learning can be used to facilitate socially shared collaboration and community building. Järvelä, Näykki, Laru and Luokkanen conclude that mobile devices can contribute to student learning by providing students with additional opportunities that may not otherwise be available and that they help students engage in meaningful interactions to support shared understanding.

Gupta and Manjrekar (2012) investigate the potential of mobile technologies to bridge the gap between students' expectations and experiences of higher education. Improvements in the quality of higher education were found in collaboration between other institutions, research facilities, bridging the gap between classroom teaching and real-life implementations, teaching strategies and employability of graduates. Mobile technologies have the potential to help bridge the gaps experienced between expectations and experiences and between university learning and the world of work consequently bringing about improvements in the quality of some aspects of higher education.

Osang et al. (2013) deliver empirical data on the implementation of m-learning in the context of Nigerian Open University. Given the high percentage of the availability of mobile devices (with 63.9%) they regard mlearning as a means to face the "…endemic crisis in Sub Saharan Africa´s teaching and learning development systems." (Osang et al. 2013, p. 3). They discuss the challenges of implementation and conclude that m-learning might be a new trend to revolutionize education in Africa (p. 13), the success of which depends on the insight of users into efficiency and necessity of the respective services and features.

The discussion in this section focuses on the current practice in higher education and theories relating to mLearning in higher education. What conclusions can be drawn? And how can these ideas can be taken forward to support students' learning in the near future?

Conclusion

As sections 2 and 3 highlight, mobile technologies are now part of everyday life for many people, including students at university. Section 4 suggests that students are using mobile devices for learning and that institutions are starting to provide services to support mLearning and highlights some of the current research in the area.

It is clear that there are some noticeable gaps in practice and in the literature. Firstly, there is a limited amount of available information about sustainable institution-wide mLearning developments and few recommendations about how to embed mLearning into the curricula. Secondly, there appears to be a lack of understanding about the pedagogical value of mLearning.

Wishart and Green (2011) point to several possible reasons for the lack of institute-wide developments. These include, the lack of skills to facilitate development, the need of appropriate advice and support usage; limited procurement and accounting policies around computer usage; legal issues surrounding data ownership; and concerns about privacy. In addition, the current pressures on staff time lead to lack of resources or enthusiasm to reformat the curricula to accommodate mobile technology.

The focus of many research activities to date is on implementation and student feedback, perhaps indicative of early stage technical developments. Mobile technology has moved beyond the early adopter stage and there are high levels of saturation in many societies. Mobile device ownership is growing rapidly and an increasing number of students use smartphones and tablets, officially or unofficially, as part of their learning. Although technology facilitates learning, it cannot do so without sound underpinning pedagogy.

The current lack of understanding about pedagogical integrity of mLearning is illustrated by a comment made by Koszalka and Ntloedibe-Kuswani "The potential benefits of mLearning are not yet understood from the perspective of either safe or disruptive uses" (2010, p. 153). This viewpoint suggests that further research about mLearning is required to provide a greater understanding about the following key areas:

- how mobile technologies can be used to enhance effectiveness of teaching;
- the role of mobile technologies in supporting individual differences of students both in terms of preferred learning approaches and subject disciplines;
- using mobile technologies to enhance collaboration and sharing either for student-to-student or student-to-teacher activities.

Koszalka and Ntloedibe-Kuswani (ibid) argue that research is needed to ensure mobile technology is used to support good curricula design and positive learning experiences. Similarly, Jeng *et al*. (2010) conclude that "To create new innovative learning opportunities, one needs to take into account the usability and the rationality" (p. 8) of mLearning as an embedded element within the curriculum.

Further studies are required to identify sound pedagogical frameworks to guide colleagues about how best to integrate mLearning into the curricula, create activities which support student learning, and offer engaging and satisfying learning experiences. More medium term or large scale studies need to be conducted to provide a sound evidence-base.

Koszalka and Ntloedibe-Kuswani (op cit) suggest that studies to establish the pedagogic integrity of mobile technology would benefit from using the following:

- experimental or quasi-experimental design;
- follow-up studies for looking at remediation;
- random and clustered sampling (mostly convenience samples);
- really reliable and valid measurement instruments;
- control mechanisms for possible threats to validity and biases;
- mention or address technology problems;
- grounded theory and;
- instructional design strategies.

An additional concern for practitioners in higher education, and elsewhere, is the longevity of any strategies or activities that they implement. Technology has changed rapidly over the last few years and is likely to continue to do so. Future technical developments will inevitably have an impact on individuals' lives and are likely to present new teaching and learning opportunities. The 2012 Horizon report identifies a number of technologies likely to impact teaching and learning over the next few years. They suggest that developments over the next two to three years could include game-based learning and learning analytics resulting in data gathering tools to provide better understanding about student engagement and learning. Over the next four or five years relevant developments will include gesture-based computing and the Internet of Things connecting the physical and digital worlds in order to provide real-time information (Johnson, Adams and Cummins, 2012).

Other areas of development are augmented reality (AR), pervasive learning (learning anywhere, anytime, any data and from any device), Open Educational Resources (OER) and Massive Open Online Courses (MOOCs).

There is clearly an exciting future ahead for practitioners and students in higher education. The latest developments in technology including mobile technologies have the potential to become an important element in the learning and teaching environment. However, there is also much work still to do in understanding that potential and how it relates to better learning experiences for students, and teaching experiences for staff in higher education.

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Glossary of Terms

Android

API

Augmented Reality

Bandwidth

Blended Learning

Broadband Access

Communication Channels

CSS3

Handheld Devices

HTML5

Hybrid web

Javascript

Learning effectiveness

Massive Open Online courses

Mobile development platform

Mobile development framework

Mobile Learning

Mobile operating system

Nomadic Learning

Open Educational Resources

Online Learning

Open Source Platform

Pedagogical model

Pervasive Learning

Smartphones

Transmission Speeds

Typology of mLearning

Ubiquity

List of terms suggested to be used in the Index

The same list can be used for the Index part also.