

## **MOBILE COMPUTING**

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### **Abstract**

m-Learning is made possible by the existence and application of mobile hardware and networking technology. By exploring the capabilities of these technologies, it is possible to construct a picture of how different components of m-Learning can be implemented. This paper will explore the major technologies currently in use: portable digital assistants (PDAs), Short Message Service (SMS) messaging via mobile phone, and podcasts via MP3 players.

**Keywords:** m-Learning; mobile technology; portable digital assistants; PDA; Short Message Service; SMS; podcast

Online learning and blended instruction, both utilizing technology to convey educational content, are shifting from a model working only with e-Learning to encompassing mobile learning (mLearning). This shift in learning locations and learner access to information has been driven both by demand and by advances in technology that make mobile technology access a practical option for the average person. In examining the growth of these technologies it is possible to see the growth to date, and possibly the future direction of, m-Learning.

### **Introduction**

m-Learning is broadly defined as the delivery of learning content to learners utilizing mobile computing devices (Parsons & Ryu, 2006). Kambourakis, Kontoni, and Sapounas (2004) defined it as, "The point at which mobile computing and e-Learning intersect to produce an anytime, anywhere learning experience" (p. 1). The advantages of learning anytime and anywhere have long been near the top of the benefits listed by proponents of online education, but until the advent of m-Learning technologies it was not really an anytime, anyplace environment. The demand for a learner to be physically at a computer and physically connected via some kind of cable to a network meant that learning locations were constrained. With constraints in place on the available learning locations, time constraints existed as well; someone taking classes using their computer at work might not have access to that resource at midnight or on Sunday afternoon (Petrova, 2004). Mobile learning is exactly that; mobile; m-Learning as an educational method is new and more flexible than previous e-Learning applications (Georgiev, Georgieva, & Trajkovski, 2006). Learners can have the opportunity to review course materials or correspond with instructors or colleagues while sitting in a restaurant or waiting for a bus; they are not made immobile by the restrictions of desktop computer technology.

Because m-Learning is such a new field the research is still in a stage where different categories

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of m-Learning pedagogy are being developed, identified, and researched (Frohberg, 2006). With this developmental stage in mind, the very existence of m-Learning, not to mention its growing application, is directly tied to the growth of mobile technology. This fact is why it is so important for researchers and practitioners to be familiar with mobile technology applicable to m-Learning. It simply is not possible for someone to log onto a learning management system (LMS) wirelessly from a personal digital assistant (PDA) if wireless networks don't exist or if PDAs do not support wireless connectivity.

Hardware advances are one of two key components to the emergence of m-Learning, the other being networking. To be mobile technology, hardware had to advance to a point at which people would carry and access the device on a regular basis. It is generally accepted that devices like mobile phones, PDAs, and MP3 players fit into the category of mobile devices (Mellow, 2005; Andronico, Carbonaro, Casadei, Colazzo, Molinari, & Ronchetti, 2003). Sources disagree on the status of laptop and notebook computers as mobile devices. While they are capable of working without plugging into a power source and can utilize wireless networks, they are not devices that people can carry everywhere and quickly access at any time due to their size, configuration, and the time required to boot up and shut down. For the purposes of this paper, mobile technology will be described as a device that can fit in the average shirt or jacket pocket and be carried on a daily basis.

Wireless networking is the second technological component contributing to m-Learning success. While some m-Learning resources can be utilized in a non-networked, offline environment, many depend on access to the Internet to exchange information and access up-to-date information. To serve this need, mobile devices needed a way to access network resources without plugging into a land line connection. Currently the leading candidate for this technology is the IEEE 802.11 wireless communication standard, commonly called Wi-Fi. Also gaining ground in the market are wireless phone broadband connections and, to a lesser extent, the IEEE 802.15.1 wireless communication standard, commonly called Bluetooth. While Bluetooth is more frequently used as a device-to-device data transfer technology, its use as a network system is possible. Regardless of which standard is in use, wireless networking provides learners with the opportunity to connect with colleagues and instructors via online resources from a much broader variety of places than are accessible via traditional wired connections. An in-depth review of the technology will be explored in a later section, but it is important to recognize just how important this technology is in facilitating m-Learning environments.

### **Defining m-Learning**

There is much debate as to whether m-Learning is the next progressive step from e-Learning or simply an advanced tool that integrates with e-Learning. In either case, m-Learning is a new and unique component of distance learning. Georgiev and colleagues (2006, p. 1) defines it as, "... a new stage of the development of e-learning ... " To understand the distinctions, it is necessary to look at what e-Learning really is, followed by the emerging definitions of m-Learning:

Laouris and Eteokleous (2005), cite Pinkwert, et. al. (2003) as defining e-Learning as, “learning supported by digital ‘electronic’ tools and media.” Ramshirish and Singh (2006) open by defining e-Learning as “. . . essentially education via electronic network in which content is transferred via the Internet, intranet, extranet, audio/ video tapes, satellite television, and CD-ROMs” (p. 2). It is important to recognize that definitions of e-Learning almost always specify that there is indeed learning taking place in an environment, and that environment happens to utilize electronic means of communication to convey the learning experience. While it may be difficult to precisely define what is e-Learning and what is not, dependent on the amount of electronic integration into the course, it is probably fair to say that any educational environment which utilizes any electronic media tools as a part of the instruction is utilizing e-Learning, even if it is not a 100 percent e-Learning environment. As an example, a face to face class viewing information on an archeological dig on DVD would be utilizing e-Learning as a component of their experience, while an asynchronous online course where all activities take place in the confines of a CMS would be a dedicated e-Learning class.

Given that e-Learning is learning incorporating electronic media, what defines m-Learning? This paper will define m-Learning as any e-Learning application delivered on-demand via mobile digital device. As a relatively new term, however, there are many other definitions in use. Kambourakis, Kontoni, and Sapounas (2004) define m-Learning as being, “The point at which mobile computing and e-Learning intersect to produce an anytime, anywhere learning experience” (p. 1). Colazzo, Ronchetti, Trifonova, and Molinari (2003) state that, “A mobile learning educational process can be considered as any learning and teaching activity that is possible through mobile tools or in settings where mobile equipment is available.” Laouris and Eteokleous (2005, p. 2) cite multiple sources for definitions of m-Learning, including :

- Pinkwert et. al. (2003), who defines m-learning as “. . . e-learning that uses mobile devices and wireless transmission.”
- Polsani (2003), who defines m-learning as “. . . a form of education whose site of production, circulation, and consumption is the network.”
- Traxler (2005), who defines m-learning as “. . . any educational provision where the sole or dominant technologies are handheld or palmtop devices.”
- and Sharples (2005), who defines m-learning “. . . as a process of coming to know, by which learners in cooperation with their peers and teachers, construct transiently stable interpretations of their world.”

The common thread of all these above definitions as cited by Laouris and Eteokleous (2005, p. 2) is that they incorporate the use of mobile technology to facilitate the transfer and acquisition of knowledge, the learning process. Again, like e-Learning, m-Learning can be utilized on different scales. One environment may utilize m-Learning as a single component of a single topic, while another environment may be dedicated to using m-Learning as the only means for learning. In either case the technology applied will be mobile.

With both e-Learning and m-Learning defined, it is possible to see many similarities between the two processes. Most obviously, learning is a key component of both; the goal of the application, regardless of the technology utilized, is to engender the acquisition of knowledge by a learner. Also obvious is that electronic technology is used in both systems. Granted, there are differences in the types of devices and the types of media used, but e-Learning and m-Learning are really studies in technology integration into educational environments. Clearly, the theories behind these two different forms of instruction are the same; the integration of technology can improve the learning experience. With such common goals and methods, then, why is it necessary to delineate m-Learning from e-Learning? The answer to that is in the very real differences between the two.

Given that m-Learning is a discipline unto itself, there are certain advantages provided in a mLearning environment that are not present in other kinds of e-Learning. The primary advantage of m-Learning is to provide truly anytime, anyplace learning (Kambourakis, et. al., 2004; Ramshirish & Singh, 2006). What this means to the learner is that they are no longer constrained by static resources. A desktop computer, no matter how powerful or user-friendly, will always be limited by size, weight, and the need for power and network connections via cables plugged into sockets and ports that are not mobile.

The advantages of m-Learning can be summarized as being advantages of access. Whether it is a question of time, place, or simply convenience, ease of access streamlines the learning process for the learner. From an efficiency perspective, the less time spent managing resource access, the more time is available to capitalize on the value of those resources. These advantages do come at a price, however. There are unique demands for designing and administering m-Learning environments.

### **m-Learning Technology**

With these design requirements in mind, the available m-Learning technologies can be explored. The broad categories include PDAs, mobile phones, and MP3 players. The start of this discussion involves defining what m-Learning devices are. The Hardware section will explore details of each device, but what categorization defines these devices? Generally, mobile devices can be defined as electronic devices that are small enough to fit in a shirt or jacket pocket. Mellow (2005), states that, "This would include such devices as mobile phones, portable digital assistants (PDAs) and iPods. It would not include laptops, as while they are portable, they are not mobile . . . Mobile devices should fit in your pocket" (p. 1). In relation to the widespread availability of these devices, Petrova (2004) says that, ". . . in the near future mobile communication devices will exceed the number of personal computers" (p. 1). Finally, Trifonova and Ronchetti (2003) define mobile devices as, ". . . by mobile device we mean PDAs and digital cell phone, but more generally we might think of any device that is small, autonomous, and unobtrusive enough to accompany us in every moment of our every-day life, and that can be used for some form of learning"

It is interesting to note that these definitions, by default, eliminate notebook computers from

classification as mobile devices. As Mellow (2005) stated, there is a distinct difference between portable and mobile. The prime characteristic of mobile devices is that they are carried on a regular, if not constant basis. The old routine of picking up car keys and wallet every morning has for most people expanded to include at least a cell phone, if not a PDA and MP3 player as well. It is this constant access to the devices that drives m-Learning as a viable delivery system.

Working hand-in-hand with the physical mobility of the devices is the virtual mobility of networking. No device, no matter how powerful or portable, can deliver educational material if it does not have access to that material. Thus, mobile networking is a key component of the mLearning environment. The connectivity allowed by mobile networking gives learners not only access to static instructional materials, but to dynamic discussion environments and updated information from an instructor. Taken to the farthest extreme, anytime, anyplace learning becomes all the time, everywhere learning. With these parameters of mobility defined, it is time to examine the mobile devices themselves in detail.

### **Mobile Hardware**

Probably the first device that comes to mind when mobile hardware is discussed is the PDA. These devices offer many of the features of a full-size laptop computer but in a package that fits in a pocket. As discussed, mobility is a primary component of m-Learning hardware, and few devices offer the combination of mobility and features that the PDA does.

From the start, the PDA experience lends itself to being ideal for the m-Learning environment. Whether a Palm or PocketPC operating system, a PDA will start up almost instantly, as opposed to the boot process that is required for a larger computer. This advantage by itself is a significant one; if a learner wants to check e-mail or reply to a message board while in between appointments, the time spent booting up and shutting down a traditional computer platform is a very real deterrent, the PDA interface eliminates that wasted time.

### **Mobile Networking**

For mobile hardware to engage in the mobile learning environment it is necessary for these devices to have access to m-Learning content, often located on a network resource. If the mobile device was limited to working at a location where a network cable could be plugged in then its use would no longer be mobile, regardless of how small the device itself is. The second half of technology mobility has been the rise in mobile networks. The combination of mobile hardware with mobile technology is what allows this phenomenon to progress.

Perhaps the most prevalent and most widely recognized mobile networking technology is the IEEE 802.11 specification, commonly called Wi-Fi. Wi-Fi works by using a series of access points, which are transmitter/ receiver stations that wireless devices can connect to via their own Wi-Fi networking card. Initially seen as external cards that were used in a Personal Computer Memory Card International Association (PCMCIA) slot on laptops, Wi-Fi networking devices are now being

integrated into standard-size PDAs and even smaller platforms such as mobile gaming devices. If a mobile device does not have a built-in Wi-Fi card there are a wide variety of add-on cards available, some small enough to fit into the SD slots on handheld devices. Thus, many devices not originally configured to access wireless networks can be converted to do so.

The hotspot phenomenon has rapidly expanded to provide coverage to many public places (Balachandran, Voelker, & Bahl, 2003). This gives m-Learning students and instructors the freedom to not only work at a wide variety of locations, but also to deliberately choose comfortable locations, such as a favorite coffee shop, from which to work. Thus, m-Learning participants can not only work on the move, but they can also work from a good environment that may not be available to someone tied to a desktop or landline networked laptop.

The other side of the Wi-Fi connectivity issue is the possibility for groups to meet and connect to each other via what is referred to as an ad-hoc wireless network. This does not require an access point as it does not necessarily connect users to the Internet, it just allows users to connect to each other via Wi-Fi. In the event that participants in a m-Learning course meet in a physical location to work on a group project or just to discuss the course content they can avoid the need to print notes on paper or e-mail documents ahead of the meeting even if they are at a location that does not have an accessible hotspot. Once together, they can create an ad-hoc network and exchange electronic documents wirelessly even without a service provider.

### **Conclusions**

Mobile technology, both hardware and networking applications, is a necessary component for the existence of m-Learning. As instructors and designers, practitioners of m-Learning need to be fluent in the use of these technologies and cognizant of what technologies their learner population has access to. Application of specific pedagogical theories is directly connected to the technologies in use in a m-Learning system and as such, design of m-Learning environments demands a systems approach, where development accounts for all aspects of the environment. As technology continues to improve and innovate the options open to m-Learning will expand; the key is to focus on the fact that the goal of m-Learning is to facilitate learning, no matter what form the delivery may take.

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