

**A SYNTHESIS OF MOBILE LEARNING LITERATURE IN EDUCATION,  
BUSINESS, AND MEDICINE**

by

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## Abstract

M-learning, or using a mobile device as a tool for learning, is a relatively new phenomenon. This project examined m-learning within Education, Business, and Medicine. Specifically, three types of mobile devices were examined within the three sub-categories of m-learning: the mobile phone or smartphone, the iPod, and the PDA. A mixed-method design was used to review 40 m-learning articles and to synthesize the literature to explore m-learning projects around the world. The literature revealed that m-learning was used in many parts of the world, and mostly in North America, within all three fields. There were also numerous projects in Europe, Asia, the United Kingdom, and in Oceania. Mobile phones, smartphones, iPods, and PDAs were used in all three fields.

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## GLOSSARY OF TERMS

**Bluetooth:** a radio technology enabling devices such as mobile phones, laptop computers, and printers to communicate with each other.

**E-learning:** electronic learning online, especially via the internet or email

**Facebook:** a social networking website.

**G3 (or 3G):** high speed mobile communications network which allows for mobile video.

**GPRS:** general packet radio service, a high speed form of wireless communication.

**GPS:** Global Positioning System, based on satellite systems to provide positioning and navigation information.

**Internet Explorer Mobile:** Microsoft's version of Internet Explorer for cell phones and PDAs.

**iPhone:** a popular smartphone with a built-in iPod and thousands of available add-on applications, including educational modules such as dictionaries and language tutors.

**iPod :** a small and portable media player, capable of playing digital audio, and with some versions, digital video.

**iTunes:** a digital media player application used for playing and organizing digital music and video files.

**Macromedia Flash Player:** a software for viewing animations and video on a web browser. It can be used with numerous mobile operating systems.

**m-learning:** the use of mobile devices such as cell phones, PDAs, and iPods as educational tools. Also known as mLearning, mobile learning, or handheld learning.

**MMS:** multimedia messaging service used to exchange multimedia content such as photographs and videos between mobile devices.

**MP3:** a compressed digital music format for the transfer and playback of music on small digital music players such as iPods.

**PDA:** personal digital assistant, such as Palm Treo or Pocket PC.

**Podcast:** a series of audio or video digital media files downloaded from the internet.

**RSS:** Real Simple Syndication, which is a web feed format to publish frequently updated works such as blogs and podcasts.

**Smartphone:** a cell phone with extended capabilities conducive to m-learning, such as high speed Wi-Fi for internet browsing and email.

**SMS:** Short Message Service. Also known as texting.

**WAP:** Wireless Application Protocol, the wireless communication environment used for mobile web accessed from a mobile phone or PDA.

**Wi-Fi:** wireless technology used for cell phones and PDAs.

**Windows Mobile:** a compact operating system designed for use with mobile devices such as smartphones and PDAs. Included with Windows Mobile can be Office Mobile, which is a suite of mobile versions of Word, Excel, PowerPoint, and Outlook.

**WML:** Wireless Markup Language, a set of standards used to tag and format text displayed on handheld wireless devices.

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To my husband, Ian, thanks for your support and for taking care of the household so I could focus on my project. And to my son, Ryley, you now have free access to Mom's laptop when you want it. I know in the not-too-distant future, a laptop or a netbook will seem passé to you, and m-learning will be your norm.

Completing my degree while working full time proved to be an endurance test, but I finally passed. Getting a masters degree has been on my to-do list for years, and now I can finally say "I did it!"

## CHAPTER ONE: INTRODUCTION

Imagine you are a university student studying a second language. While sitting in a coffee shop over a leisurely cup of coffee, you decide you have some time to study, so you pull out your cell phone. Using your high speed Internet Explorer Mobile software, you download a grammar lesson, review it, and then proceed to test your knowledge with a self-assessment, also downloaded to your cell phone.

Or you are a family physician with a very busy practice. While examining a patient you decide to prescribe a new drug. You are not sure of possible drug interactions with the patient's existing medication, so you use your Personal Digital Assistant to browse a bookmarked pharmaceutical website and check for drug contraindications. You do not need to excuse yourself to consult a large, cumbersome volume of drug listings, and can be on to your next patient that much sooner.

Or you could be a business person waiting in the airport for your flight home. You have an hour before you leave, so you take out your iPod and your earphones. You listen to the latest podcast from your company's president, with the details of the last quarter's performance.

The picture being painted here is one of m-learning, otherwise known as mobile learning or handheld learning.

Laouris and Eteokleous (2005) ran a Google search for mobile learning in January 2005 and received 1,240 items. In June 2005 they ran the same search. It resulted in 22,700 items, demonstrating that the interest in mobile learning was growing rapidly and exponentially. In June 2005, a Google Scholar search resulted in only 231 items. The researchers concluded that mobile learning means different concepts to different people,

depending on context. They collated numerous definitions of mobile learning, and found that researchers such as Pinkwart, Hoppe, Milrad, and Perez (2003) and Traxler (2005) generally agreed that the basic premise of mobile learning involved e-learning that used mobile devices and wireless transmission.

My own search on the words “mobile learning” in January 2010 resulted in 99,600,000 items on Google and 1,250,000 items on Google Scholar. These searches indicate an enormous increase in the interest in mobile learning over the last five years.

Quinn (2000) theorized that m-learning was the intersection of mobile learning and e-learning. It was learning independent of location in time or space. Quinn (2000) predicted that one day mobile devices would have wireless networking, would always be “on” (as opposed to dial-up), would have high-resolution colour screens, and would act as tiny, yet powerful, computers. Of course, these devices now exist, not many years later, as a testament to the fact that the technology enabling m-learning to exist is growing exponentially.

A mere two years after asserting that mobile learning was basically a more transportable version of e-learning, Traxler (2007) opined that mobile learning was difficult to define, and his opinion had altered:

Some advocates of mobile learning attempt to define and conceptualise it in terms of devices and technologies; other advocates define and conceptualise it in terms of the mobility of learners and the mobility of learning, and in terms of the learners' experience of learning with mobile devices. (p. 1)

He went on to argue that mobile devices create not only new forms of knowledge and new ways of accessing it, but also new forms of art and performance, commerce and economic

activity. He theorized that mobile learning is not really about “mobile” or “learning”, but is part of a new mobile conception of society.

For the purposes of this research project, I defined mobile learning as the use of a wireless handheld device; a cell phone, personal digital assistant (PDA), or iPod to engage in acquiring knowledge. This knowledge could be a component of formal education in a school, or it could be information gained from a mobile device in a business or medical setting. It could also be knowledge accessed in an everyday activity, such as when checking a bank account balance or looking up the current outdoor temperature.

## The Problem

### *Rationale and Statement of the Problem*

The mobile phones, PDAs, and music players of today are no longer just for making phone calls or listening to music. As mobile devices acquire more power and more features, researchers are studying their potential uses in Education, Business, and Medicine, in various parts of the world.

#### *Cell Phones and PDAs*

Prensky (2005) reported that 1.5 billion people worldwide used cell phones in 2005, and that the high-end phones of the day were like powerful computers in the purse or pocket. The UN Millennium Goals Report (2008) estimated that 2.2 billion mobile phones were in use by the end of 2006. While m-learning and its related technologies in North America lag behind that of Asia and Europe, it is a growing field. As more and more of the technologies are put into place, Canada and the U.S. are poised to take advantage of improved cellular wireless service and new models of cell phones and PDAs.

Tapscott (2009) surmised that Canada and the United States can expect to follow the mobile phone usage trends seen outside North America. In many countries access to the internet is cheaper by mobile phone than it is by desktop or laptop computer. In every country in Africa, mobile phones outnumber landlines. Just over half of consumers in the United States subscribe to wireless data plans; that ratio rises to 90 percent in many Asian countries. Asians employ their mobile phones for many purposes other than for phone calls and text messaging. They use their phones as train passes and for buying food at vending machines. Their mobile phones are an integral part of their daily lives (Tapscott, 2009).

Tapscott called today's phones "sleek digital Swiss Army Knives that do a lot more than make a phone call" (p. 48). They are small, powerful computers that combine voice communication, music player, web browser, texting device, digital camera, and video camera into one portable device. The newest mobile devices, called smartphones, are capable of browsing the internet at high speeds, sending and receiving email, as well as playing video and text messaging. They feature full QWERTY keyboards to enable quick email and texting. Every new generation of the cell phone and the PDA has increased screen resolution for improved graphics and video (Prensky, 2005).

To accompany the latest mobile hardware, computer technology companies are researching and developing ever-increasing mobile communications software adapted for the small screen. Microsoft offers mobile versions of its ubiquitous Word, PowerPoint, and Excel, and has its own Windows Mobile operating system. Apple, Blackberry, and Google have all created their own mobile operating systems and are developing long lists of software applications as the use of smartphones becomes more widespread. Tapscott (2009) theorized that the popular Apple iPhone "hints at the versatility of tomorrow's devices" (p. 48).

Thousands of software applications are available for the iPhone, making it simple for the user to customize the device to their specific needs.

### *iPods*

According to the official Apple website (2007), 100 million iPods had been sold worldwide as of April 2007. iPods are used with increasing frequency to download and play recorded lectures via podcasts, making lectures accessible to those who have difficulty attending face-to face-classes (Doolittle, Lusk, Byrd, & Mariano, 2009). A visit to the iTunes web store lists dozens of universities offering free lecture downloads to iPod. Included are prestigious institutions such as MIT, Cambridge, and Harvard universities.

The stage is set for using cell phones, PDAs, and iPods as mobile classrooms. Metcalf and De Marco (2006) noted that mobile devices are beneficial in making small amounts of knowledge available when we are not otherwise occupied. The ability to have a mobile device capable of reactivating knowledge as often as needed provides new support for effective learning.

### *E-learning to M-learning Terminology*

M-learning can be considered to be a subset, or a natural evolution of e-learning, with a new set of terminology to go with it. Common e-learning terms are **multimedia**, **interactive**, and **media rich**. M-learning is described with such terms as *spontaneous*, *connected*, and *informal* (Laouris & Eteokleous, 2005). Table 1 below shows how the language pertaining to learning is changing with the evolution of m-learning. These m-learning descriptions are reflective of today's mobile, "always on", informal society.

Table 1

*Terminology Comparisons between E-Learning and M-Learning*

e-learning	m-learning
Computer	Mobile
Bandwidth	GPRS, G3, Bluetooth
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Collaborative	Networked
Media-rich	Lightweight
Distance learning	Situated learning
More formal	Informal
Simulated situation	Realistic situation
Hyperlearning	Constructivism, situationism, collaborative

I studied and analyzed the extant literature on the use of m-learning in three areas: Education, Business, and Medicine. Although there is a variety of mobile devices used in m-learning, I focused on the cell phone, the PDA, and the iPod, some of the most commonly used mobile devices worldwide.

*Net Geners and Digital Natives*

Tapscott (2009) labelled American children born between 1977 and 1997 the *Net Generation* (Net Geners). This demographic is comprised of 81.1 million children and young adults, or 27 percent of the U.S. population. Net Geners have been immersed in computer

technology all of their lives and assimilate it, rather than having to accommodate technology, as older generations are forced to do. Due to “always on” technology, Net Geners actually think differently than do older generations. They expect information to be readily at their fingertips.

The Net Generation is not limited to America. Although the percentage of each country’s population represented by Net Geners varies from country to country, there are many similarities among them. Tapscott (2009) presented eight norms, or distinctive attitudinal and behavioural characteristics that differentiate Net Geners around the world from their “baby boomer” parents. The eight norms are freedom, customization, scrutiny, integrity, collaboration, entertainment, speed, and innovation. Tapscott theorized that Net Geners are changing our world thanks to digital and mobile technology, and that we must change to accommodate their needs. In particular, education systems must change to engage and stimulate the Net Generation, and companies will have to reconfigure themselves to attract and retain this generation entering the workforce.

Similarly, Prensky (2001) gave the term *digital natives* to students from kindergarten to college who had spent their entire lives surrounded by and using technology in the form of computers, videogames, cell phones, and many other digital tools and toys. They are accustomed to receiving information quickly, to multi-tasking, and networking. Prensky (2001) theorized that these digital natives think and process information in a fundamentally different way from their predecessors. He encouraged educators to invent digital native methodologies to properly teach their students or the students would have to wait until they grew up to educate themselves.

It is clear that m-learning has a promising future; however, while educational institutions and corporations are called upon to meet the technological needs of the digital natives, issues can arise which may hamper the implementation of m-learning. The conversion of educational materials to be suitable for mobile devices requires careful planning and consideration of human-computer interaction. For example, information should be displayed in limited chunks of text to accommodate small display screens. Websites must be formatted in a such a way as to enable viewing and navigation in a miniaturized fashion. As well, the diverse mobile hardware, software, and internet connection speeds of the distributed users must be recognized when planning content delivery (Amin et al., 2006; Kroeker, 2005).

#### *M-learning Entities*

After reviewing the literature for this project, I noted that there are a number of large conferences taking place annually, devoted entirely to m-learning. The International Association for Development of the Information Society's international conference on Mobile Learning, the Asia Pacific Regional Mobile Learning Conference on Wireless and Mobile Technologies In Education and Edutainment, and the International Association for Mobile Learning conference are a few. As well, the *International Journal of Mobile and Blended Learning* and the *International Journal of Mobile Learning and Organisation* are new journals created for academics and researchers to share m-learning information. The existence of these entities helps to verify m-learning's importance on a global level. Many of the articles reviewed for this study are from conference proceedings and from the m-learning academic journals.

A number of books and journal articles also indicate a growing interest in the scholarship of teaching and learning in m-learning. As cited by such researchers as Tapscott (2009), Prensky (2001), and Cochrane and Bateman (2009), teaching methods must change to complement the learning methods of today's students, and m-learning is perfectly suited to meeting these needs.

### *Research Questions*

The purpose of this study was to answer the following questions through an extensive literature review: How is m-learning defined and how is it used in the fields of Education, Business, and Medicine? Additionally, I examined the supporting questions of what are the types of software and hardware used in each field? Who are the preeminent researchers in m-learning? And, in what parts of the world is m-learning most used?

### *Delimitations and Limitations*

Because m-learning is in its infancy, there was not an exhaustive body of scholarly literature to review. While a Google search of m-learning now results in a large number of "hits", many of the references are not to scholarly literature, but to information about conferences, to m-learning special interest groups, and to images and videos on the subject, as well as to general information that describes m-learning. A Google Scholar search resulted in numerous versions of the same articles, and often referred to technical m-learning articles beyond the scope of this research project.

Since m-learning is a new field, my university's library has a very limited collection of books and journals on this subject. Consequently, I was not able to locate many books or journals on m-learning. For the most part, I had to depend on the internet to find scholarly articles on m-learning. Some articles were available to download for free, and others by

paying a fee. I was able to obtain several articles through interlibrary loans. M-learning articles from online trade journals and industry websites were relatively easy to obtain.

### Summary

The meteoric rise of the personal mobile device worldwide has been astonishing. As the use of cell phones, PDAs and iPods has increased dramatically, so too has the number of mobile applications to make m-learning possible. Mobile devices are perceived as a necessity by today's youth, and in fact, some research indicates that due to constant immersion in technology, the brains of today's youth are wired differently than those of the older generations. They expect to have "always on" access to whatever information they require, whenever they require it.

As m-learning becomes more widely used for diverse applications, its definition is also evolving. Where once it was defined as simply a more mobile form of e-learning, researchers now credit m-learning with creating new forms of knowledge and new ways of accessing it. M-learning is dramatically changing the way we use our time and the way we interact with society. As is evidenced by the existence of books, academic journals, and conferences devoted to the subject, it is important to study m-learning in order to keep up with and guide the younger generations into the technological future. This project provided a summary of how m-learning is used in Education, Business, and Medicine in various parts of the world.

## CHAPTER TWO: RESEARCH DESIGN

### Synthesis of M-learning

As outlined in Chapter 1, this study investigated the definitions and uses of m-learning in the fields of Education, Business, and Medicine. It also looked at who the most prominent researchers are in m-learning, where m-learning is taking place, and what types of hardware and software are most popular. This chapter will outline the research design. I begin with an explanation of how I selected the articles for my research. Next, I explain my methodology for sorting the selected articles into the three main groups. Finally, I lay out my methodology for summarizing the articles in two synthesis matrices.

This substantive literature review and analysis will provide a basis for future m-learning researchers to collate previous research conducted in the field. As well, since m-learning is in its infancy, by my collating much of the information to date and describing how it can be used, some readers who were not aware of its potential may be inspired to employ it in their own fields or practices. A literature review is essential to advance knowledge and to facilitate theory development (Webster & Watson, 2002). I intend to influence both theory and practice with my work by providing an informative, useful summary of m-learning definitions and uses.

### Research Procedures

#### *Research Methodology*

The purpose of this research project was to synthesize the literature on m-learning. My goal was to analyze and summarize a cross-section of m-learning literature to investigate what m-learning was, how it was being used, and where m-learning research was being conducted. I used an exploratory research methodology to analyze qualitative data which,

according to Mauch and Park (2003), is used for “investigations into new or relatively unknown territory” (p. 129). I collected and analyzed qualitative data (the m-learning articles I reviewed), categorized the data quantitatively, and identified themes. I then created two synthesis matrices to help summarize the fields, to locate the geographical areas where m-learning is researched most, and to determine the hardware and software used.

To guide me in the research process I followed Cooper’s (1982) five-stage model for conducting integrative literature reviews. Cooper’s stages include problem formulation, data collection, data evaluation, analysis and interpretation, and public presentation. Cooper theorized that integrative reviewing contains many decision points, as are presented below. The processes I followed are set forth in the following paragraphs.

#### *Problem Formulation*

As indicated in Chapter 1, although the field of m-learning is growing exponentially, a large body of scholarly research on the subject has not yet been produced. In order to engage students, business people, and healthcare workers, and to keep up with the digital generation, it is important to further study m-learning. My research purpose was to analyze and summarize a variety of literature on the field of m-learning. I chose to group the literature into the three fields of Education, Business, and Medicine. The reasons for this choice will be explained in the *Analysis and Interpretation* section of the project.

#### *Data collection*

I began searching for m-learning articles in March 2008 and collected them up until April 2010. Prior to starting the literature search, I had decided to concentrate on the use of m-learning in Education, Business, and Medicine, as I was familiar with the concept in these areas, and I believed they would be most relevant to my audience. I had also decided to

search only for articles that discussed cell phones or smartphones, iPods, or PDAs. I wanted to explore the m-learning possibilities with these most ubiquitous mobile devices. I searched the keywords m-learning, mobile learning, and handheld learning, and used these three terms combined with “in education”, “in business”, and “in medicine”. In addition, I combined each of these key terms with “mobile phones”, “iPods”, and “PDAs”. I searched Google and Google Scholar. I also searched online educational and technology journals, indexes, and databases at the two university libraries where I have membership, which resulted in the location of further relevant articles. I selected scholarly articles wherever possible, but when it seemed data were lacking, I relied on m-learning articles from such sources as m-learning industry websites and computer software websites for a well-rounded view of m-learning. For example, I found only a small number of scholarly articles on m-learning in Business, so I reviewed a report from a mobile learning company promoting their m-learning software in India (Deltecs InfoTech, 2009).

Another valuable source of m-learning articles was my project supervisor, my graduate committee members, and a former professor who was conducting his own research on educational technology. They forwarded m-learning articles to me whenever they happened across them. At the conclusion of my literature search I had 153 m-learning articles and book chapters on hand.

According to Suri (2002), “methodological inclusivity is perceived as an important step to enhance the compatibility between the contemporary methods of primary research and research synthesis” (p. 4). I searched predominantly primary research articles; however, in conducting a preliminary literature review I noted that some of the valuable scholarly literature on m-learning consisted of secondary research. For example, Pozzi (2007) provided

an in-depth review of m-learning in school contexts, citing some of the researchers whose work I reviewed for this project (e.g., Hoppe, 2003; Naismith, 2009). As Pozzi was discussing valuable research from well-known m-learning researchers, I considered her work to be relevant to my m-learning explorations. Thus, I supplemented the primary research with a small amount of secondary research and with articles and reviews from industry in order to analyze a substantial cross section of the literature. I believe a sizable analysis of articles from a variety of sources allowed for well-informed conclusions about the use of m-learning today.

#### *Data Evaluation*

The criteria I used for inclusion or exclusion of articles for the final review were: that the research seemed to be of good, scholarly quality, or in the case of a technical report, that it was from a reputable company; that the report discussed m-learning in one or more of the fields of Education, Business, or Medicine; and that the article discussed mobile phones, smartphones, iPods, or PDAs, devices that are carried most of the time by most people. Some articles reported research on m-learning via laptop computers; however, I did not consider a laptop to be a true m-learning device. Most people do not carry laptops with them habitually, and therefore they cannot gain knowledge anywhere and anytime (Traxler, 2007).

I discarded articles that were of a very technical nature and beyond the scope of this project. The purpose for my literature sampling was to provide a good cross-section of the scholarly literature from around the world, from a number of researchers, and from a variety of sources: books, journals, conferences, and university reports. This type of purposeful sampling is described by Cresswell (2005) as “a qualitative sampling procedure in which researchers intentionally select individuals and sites to learn or understand the central

phenomenon” (p. 596). The “individuals” to whom Cresswell alluded in relation to my project are the m-learning articles I chose to review. Purposeful selection was also an important qualitative research method to Suri (2002), who called for “diversity, complexity, and richness of purposes as central to educational research” (p. 5).

I discovered that the scholarly literature from the field of Education was much more substantial than in the other two fields, and therefore I purposefully selected articles on a range of m-learning themes within Education to portray the variety of research projects in this area. A discussion of the themes is in Chapter 4.

At the conclusion of the Data Evaluation stage I had read 68 articles. I chose 40 articles to review for inclusion in my research project. I felt they were the best articles to represent a cross-section of m-learning scholarly literature. They portrayed a variety of m-learning themes, were from a variety of regions, and were written by a range of researchers.

#### *Analysis and Interpretation*

In this stage I allocated the 40 articles to the three main groups; a total of 25 articles in Education, nine in Business, and six in Medicine.

*Literature categorization.* I sorted the literature, both scholarly and industry, into three main categories: Education, Business, and Medicine. I chose these categories after discussing m-learning with my graduate supervisor, and before beginning my literature search. Certainly, knowledge of m-learning in these categories could be useful to faculty and researchers at the University of Northern British Columbia (UNBC), as we have a School of Education, a School of Business, a joint Medical Program, and a Centre for Teaching, Learning, and Technology. I knew that I would be able to find enough scholarly literature within these groups to justify a relevant and interesting research project for potential m-

learning stakeholders. I also knew that the interest in this project would include national and international venues, as the impact of this literature review is greater than meeting the needs of my own institution.

I defined m-learning in Education as acquisition of knowledge with a mobile device in an educational setting. The location could be an elementary school, a high school, or a college or university. It could also be a museum, historical park, or other cultural setting where knowledge is traditionally accessed. As well, my definition included the support of acquisition of knowledge such as organizing educational information with a mobile device's calendar, word processor, or spreadsheet software.

My definition of m-learning in Business took an unexpected twist. I had originally intended it to encompass strictly m-learning in the workplace. However, as I analyzed the literature, I discovered several researchers whose definitions of m-learning included acquiring formal knowledge, as well as other types of information. Traxler (2007) posited that:

Mobile devices are creating new forms of commerce and economic activity as well.

So mobile learning is not about 'mobile' as previously understood, or about 'learning' as previously understood, but part of a new mobile conception of society (p. 5).

Vavoula and Sharples (2002) believed that learning is mobile between areas of life, and that it may relate to work, to self-improvement, or to leisure. It can happen on work days or on weekends. To this end I included m-commerce in the field of m-learning in Business. Acquiring information such as bank account balances, checking stock activity, flight information, or the location of the nearest restaurant are all business-related learning activities that can be performed with a mobile device.

My m-learning in Business definition also included using mobile devices to acquire knowledge as a form of workplace training, or as a form of knowledge gained while in the field. It also incorporated the management of knowledge gained with a mobile device. I defined m-learning in Medicine as the use of a mobile device in a health care setting such as a doctor's office or a hospital to gain medical knowledge, to provide point-of-care service, or to assist with the management of healthcare information.

After the literature reviews were completed, I used the highlighter feature in MS Word to colour-code the commonalities among and between the three main m-learning categories. Coding is a common method to analyze text for themes (Creswell, 2005; Hramiak, 2005). These themes will be discussed in Chapter 4.

#### *Public Presentation*

Upon completing the article reviews, I created a synthesis matrix, Numerical Listing of M-Learning Articles, found in the appendix to this research project, to help summarize the data and clarify its complexity (Hatch, 2002; Miles & Huberman, 1994; Webster & Watson, 2002). Each article was assigned a number from 1 to 40, in no particular order, and its author, title, m-learning discipline, country in which the research was performed, and hardware and software described were entered into a table in numerical order. Except for the title, these criteria made up the answers to my research questions. With a brief scan of the Numerical Listing of M-Learning Articles, the reader can get a sense of who the major m-learning researchers are, where and in which field they performed research, and the types of hardware and software discussed. Data from the appendix was then transferred to Table 2.

Table 2 represents the cross tabulation results of the literature review categorization. The numbers 1 to 40 corresponding to the m-learning articles appear in the table as many

Table 2

*Cross Tabulation of M-Learning Articles*

	Education	Business	Medicine
<b>Geographical area of research</b>			
North America	4, 6, 7, 28, 32, 33, 34, 36, 40	8, 10, 13, 27	2, 9, 14, 15, 16, 29
Europe	1, 6, 7, 19, 20, 38	11, 12, 37	17
Asia	3, 5, 6, 7, 18	10, 35, 37	
United Kingdom	6, 23, 24, 25		
Africa	18		
Oceania	21, 22, 30, 31, 39	26	
<b>Hardware</b>			
Mobile phone	1, 3, 4, 6, 7, 18, 19, 28, 30, 31, 38, 39, 23	10, 11, 27, 37	9, 17
Smartphone	5, 21, 22	8, 12, 13, 26, 27, 35	2, 14, 29
PDA	3, 4, 5, 6, 20, 24, 32, 38, 39, 40	8, 26, 27	2, 14, 15, 29
iPod	21, 25, 33, 34, 36	13	16
<b>Software</b>			
Palm OS	3, 4, 5, 6, 7	8, 10, 11, 13	14, 15, 29
Windows Mobile	6, 7	10	9, 14, 15, 29
Web	6, 24, 28, 36, 38	27, 37	15, 16, 17, 29
SMS	7, 18, 30, 31, 39	27	17
MMS		12	14
GPS	3, 4, 39		
Specialized software	3, 4, 5, 19, 23, 25, 32, 33, 38	8, 10, 26, 37	14, 15, 29, 36

Email	1, 18, 20, 24	8, 27	17
Video	21, 22, 23, 24, 39, 40	35	
Game			
iTunes			16
Facebook	33, 34	12	
Adobe Reader			15, 29
PowerPoint			16
RSS Feeds			16
Camera	33, 40		
Calculator	21, 24, 39	28	
Clock	28		
MS Office	36		

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Note. Windows Mobile-enabled PDAs were formerly known as Pocket PCs.

times as appropriate. For example, in the appendix, Trifonova's (2003) article was assigned the number 6, and it discussed Educational m-learning research in the United Kingdom, Finland, the United States, and Taiwan, using the mobile phone and the PDA, and the software SMS, MMS, and the Web. The number 6 appears in the table 10 times, to represent all the areas of the world the m-learning occurred, in which field it was used, and which hardware and software types were used.

### Summary

In order to contribute to the literature on m-learning, 153 articles on m-learning in Education, Business, and Medicine were collected, scanned for relevant qualitative data, and subsequently condensed to 68 candidates for reading and possible review. The 68 articles were evaluated for research quality and content. A total of 40 articles were analyzed and reviewed. They had been purposefully selected to portray a wide scope of m-learning uses.

Next, two synthesis matrices were created. The first was a text matrix listing the reviewed articles, with their authors, main field, country where research was performed, types of hardware and the types of software discussed. A shorter, tabular matrix was then created to summarize the data in a more succinct manner. The matrices were created for easy reference and comparison of the m-learning data. The reader does not need to read the entire literature review to get an overview of the literature findings.

## CHAPTER THREE: REVIEW OF THE LITERATURE

In this chapter I present 40 reviews of m-learning articles in the fields of Education, Business, and Medicine. Because m-learning is a relatively new field, there is not a large amount of scholarly literature to review. I found many more research articles on m-learning in Education than in Business or Medicine; however, m-learning is burgeoning in the latter two fields and we are beginning to see more literature written on the subject.

### M-Learning in Education

#### *M-Learning Theory*

Sharma and Kitchens (2004) posited that after d-learning (distance learning) and e-learning (electronic learning), m-learning is a natural progression for education. The advent of new technologies such as Bluetooth and Wi-Fi has enabled students to connect to training anytime and anywhere. Because we are now in a knowledge-based society, Sharma and Kitchens argued that college degrees are a necessity, and that the numbers of students over 40 years of age has risen dramatically over the past decade. Older students with families, jobs, and otherwise busy lives require self-paced, on-demand educational methods, which fit well with the m-learning paradigm. Mobile learning enables students to access course material and instructions anytime and anywhere, increasing daily attention to learning material and boosting motivation.

To obtain their opinions on this type of learning, Sharma and Kitchens (2004) conducted a survey of students and teachers who had used m-learning. The students felt that their experiences with m-learning were more communication-rich and more effective than traditional face-to-face learning. The teachers, however, felt that teaching online was more time-demanding than teaching face-to-face, and without the direct interaction, they had to

spend more time monitoring the students' engagement and progress. The researchers agreed that mobile learning would involve a power shift, with less emphasis on the teacher, and more on the students taking responsibility for their own learning. Learning communities, where teachers would serve more as guides than "sage on the stage" tutors, would become the norm for m-learning.

Sharma and Kitchens (2004) believed that m-learning, with its flexibility, provided a unique opportunity for teachers and students in various learning environment settings. They cautioned that teachers would have to spend more time for course delivery and would have to keep up with changing mobile hardware and software environments. The authors added that the use of web services for browsing and the use of email and downloads of software and multimedia from the World Wide Web would assist teachers in creating rich learning environments for mobile education.

Pozzi (2007) asserted that mobile learning was a very flexible approach to addressing individual learning needs and objectives. She summarized previous research that emphasized five characteristics of mobile devices that allowed the devices to produce unique educational opportunities: portability, social interactivity, context sensitivity, connectivity, and individuality. She added that students could easily adapt to mobile learning, as constant exposure to digital technologies made them native digital literates and was a natural fit for them.

Mobile devices, according to Pozzi (2007), could promote inclusion, and could respond to the diversity of needs of all learners, including those with intellectual or physical disabilities, those with learning impairments, and those who cannot attend school. M-learning

allowed students with cognitive difficulties to learn at their own pace, and provided them with specific activities or supplemental materials.

Pozzi (2007) cautioned that because mobile learning would enhance a more autonomous learner's role, the teacher would become a mentor and facilitator more than a "knowledge repository" who "pours" the contents into the students' minds (p. 753). As such, teachers would have to change the way they teach, and the overall school system would need to change to provide equipment, continuous technical support, and revision of curriculum and evaluation. In concluding, Pozzi asserted that more research was needed in the field of m-learning. She expressed her hope that schools would adopt mobile learning en masse, to promote inclusion for everyone.

The field of human-computer interaction in an m-learning context was examined by Debevc, Varlic, Kosec, and Stjepanovic (2007). In particular, they outlined how m-learning could be optimized for use by persons with special needs. They argued that as mobile learning was rapidly growing, it was essential for developers to consider the diversity of potential users.

The researchers designed a rudimentary test system to explore what types of problems might be encountered when persons with special needs used mobile devices for learning, and if m-learning would be feasible for them. The test results indicated that m-learning for special needs was indeed feasible, but would require modifications. Some limitations of mobile devices on which improvements were required were small display areas, limited working memory, and restricted use of multimedia contents.

Suggestions given for m-learning content developers included larger images and font sizes for those with sight impairment, audio descriptions of images and video and audio

navigation for the blind, sign language video and subtitles for the deaf, and logical navigation and larger number of images for those with impaired cognition. Debevc et al. urged m-learning developers to consider system limitations and to plan carefully. They postulated that by creating well-designed, accessible m-learning systems, all people would be well served; not just the disabled.

### *Mobile Phones and Smartphones*

According to Prensky (2005), even the simplest voice-only cell phones are more complex and more powerful than the computer that landed a spaceship on the moon in 1969. He added that we need to think of our cell phones as computers, just as our desktop computers and laptops are. As well, he noted that the United States and Canada were the only places in the world where personal computers outnumber cell phones. Some countries have up to 10 times the number of cell phones than they have personal computers.

He asserted that in education, cell phones complement the short-burst, casual, multitasking style of today's digital native learners. He noted that while SMS has been in use in North America for a short period of time, Europeans and Asians have enjoyed this technology for several years. SMS can be used in learning environments to give pop quizzes, spelling, or math tests, or to poll students' opinions. Students can use SMS messages in real time to analyze and diagnose a problem. Prensky noted that this strategy would be particularly useful to medical students.

The bright, high resolution screens of most cell phones are appropriate for meaningful amounts of text to be displayed, with users able to adjust the display of text to their own reading speed. Entire novels written on and read on cell phones are popular in Japan. Now that cell phones have memories or memory card slots, educational programs may be

downloaded to the phones. Prensky (2005) noted that this would be useful for studying for specialized exams such as the MCAT medical school entrance exam or the GRE for entrance to graduate school.

Prensky (2005) highlighted the value of GPS built into some cell phones. He believed GPS would have clear applications in geography, math, orienteering, archaeology, and architecture. He noted that some colleges use cell phone GPS for their orientation programs, allowing students to find their way around campus. Prensky concluded that educators must develop ways for students to use the cell phones already in their pockets as exciting, innovative tools. Rather than punish cell phone use in school, they must encourage students' creativity and ingenuity.

Thornton and Houser (2005) conducted a three-part study on mobile phone use by university students studying English as a second language in Japan. They theorized that learning a foreign language involves memorization and practice of a large number of vocabulary words and that much exposure to the vocabulary is necessary. Since face-to-face class time is very limited in Japanese universities, the researchers wanted to know if mobile phones could aid in teaching English to the students.

In the first part of the study, 333 Japanese university students were polled regarding their use of mobile devices. One hundred percent of the students owned mobile phones capable of viewing standard web pages and sending and receiving email. Email was the most utilized mobile phone feature, with an average of almost 200 email messages exchanged each week. The students were asked to rate the desirability of several types of mobile phone-enabled educational functions. The functions students most used were receiving notifications

for class cancellations and room changes, receiving and submitting assignments, and receiving quiz and exam grades.

For the second part of the research, three times per day Thornton and Houser emailed mini vocabulary lessons to 13 students studying English as a second language, and posted the identical lessons on a mobile-compatible website that another 13 students were to study. The lessons consisted of word definitions, using each word in multiple contexts, and they also reviewed previously introduced vocabulary. After two weeks, the groups switched media for another two weeks of studying vocabulary. Vocabulary tests were administered before and after the study, and the researchers found a marked increase in the test scores after the mobile learning took place. The most gains were in the group who received the emailed lessons at regular intervals, as they were prompted to study more often than the students who were encouraged to view a website once a week.

In part three of the study, the researchers wanted to investigate the usability of multimedia mobile devices to study English idioms. Students used mobile phones and PDAs to study web pages and 15-second videos explaining idiomatic meanings. They then answered questions evaluating various aspects of the hardware, web pages, videos, and educational effectiveness. The students' evaluations were positive, citing such aspects as hardware and software ease of use, and that they were good for studying and remembering English idioms.

Thornton and Houser (2005) concluded that when educational materials were designed for mobile phones, students evaluated them positively, and test results proved that they were able to learn via mobile devices. They found that rich multimedia captured the

students' interest, and that "pushing" study opportunities by mobile email resulted in students learning English vocabulary more effectively.

Another study on learning a foreign language through m-learning, inspired by Houser's work, was conducted by Levy and Kennedy (2005). They theorized that vocabulary learning activities that could be presented through short, discrete definitions on a small screen size could be performed effectively by SMS. They wanted to prove that repetition of vocabulary learning at timed intervals, afforded by SMS, would result in better retention of new words than continuous repetition during a single period.

The researchers conducted a project over a seven-week period. Eighteen third year university students enrolled in an Italian literature and society course were sent vocabulary items at timed intervals. New words, definitions, and example context sentences, as well as messages related to grammar, literature, and general information were delivered to their mobile phones using "once only" or "recurring delivery" options. The vocabulary items were from the novel the students were studying in the course. A special SMS service, called the Telstra Mobile Online SMS Business Services, was used, allowing text messages to be prepared in advance, and sent either instantly or at pre-scheduled times. It was found to be intuitive and easy to use, and all messages were sent out on time.

The results of the study were positive, and students responded favourably to learning Italian vocabulary through SMS. The types of content they appreciated most were messages on vocabulary, news, literature, administration, and surprisingly, grammar, even though it was not a main focus of the trial. The students clearly enjoyed receiving mini-lessons two or three times a day, and reported that vocabulary recall prompts were particularly effective in helping them learn and retain new words.

Levy and Kennedy (2005) planned to continue SMS in Italian, and hoped to expand the program to incorporate other languages. They reported that their study sparked interest across multiple university faculties, and that reaction from colleagues and university management had been very positive.

Moura and Carvalho (2008) asserted that in the current knowledgeable and internet-devoted society, mobility and ubiquitous learning become more relevant. They called new ways of learning a pedagogical paradigm, which required changes in the design of educational materials, and the way they were made available. They developed the Mobile Generation project to study the use of mobile phones and iPods by 15 secondary students, all of whom owned a mobile phone or MP3 player. The objective of the study was to give the students the opportunity to learn at their own pace, time, and location, and to provide feedback by answering two questionnaires.

In the first component of the study, the researchers created diversified educational activities to be conducted with cell phones. These activities were designed to measure collaborative work, student motivation, quick access to course material, and the ability to access information at any time and anywhere. The students were allowed to work at their own pace. Positive feedback was provided in all sections of the first questionnaire.

The students downloaded MP3 podcasts of Portuguese language lectures for the experiment's second component. Again, they reported positive outcomes and said the podcasts were a complement to the classroom lectures because they aided in preparation for tests, in memorization of course details, and in stimulation to learn. Most of the students enjoyed listening to podcasts of course materials, rather than reading them.

Moura and Carvalho (2008) concluded that mobile devices were important educational tools, extending the boundaries of the classroom and providing students with more learning options. They predicted that mobile devices and wireless technologies would become routine, both inside and outside the classroom, and they planned to develop further educational content for mobile phones.

Lu, Lin, Lin, and Su (2007) theorized that mobile learning would change the traditional one-way learning model where teachers teach and students learn passively. Based on Realistic Mathematics Education, a theoretical perspective that argues math must be connected to reality and be relevant to society, the researchers designed an experiment to test whether K-12 students could learn math more easily by going outside with mobile phones or PDAs, and applying mathematic principles to the real world, rather than staying stuck in a classroom.

The students downloaded software from the internet to play a competitive arcade-style game on their mobile devices, which involved moving around the school grounds to collect data about real-world items such as trees and buildings. They were encouraged to work collaboratively to solve the math problems. As well, exploration of the school grounds was necessary to solve the problems, resulting in “real time” learning, rather than learning from a textbook.

Lu et al. concluded that the interactive and collaborative activity with the mobile devices supported learning and integrated constructive learning. They asserted that by using mobile devices and situation-based mathematic problem-solving activities, the students were better able to grasp mathematical concepts. They suggested that learning with the internet is

attractive to students and engages them, and mobile devices help learning outside of the traditional classroom.

Scornavacca, Huff, and Marshall (2009) presented their research project on interactive SMS for large classes. They postulated that classroom interactivity provided significant benefits to students, such as promotion of an active learning environment, provision of greater feedback for lecturers, and increased student motivation. However, interactive activities for large classes of over 100 students were difficult and inefficient. The researchers noted that classroom feedback systems had been used since the 1960s, but they were not always efficient or cost effective.

Scornavacca et al. introduced their TXT-2-LRN System, using the basic mobile phones that virtually every student at the university test campus brought to school each day. The system was based on SMS text messaging, and was comprised of a mobile phone connected to the instructor's laptop computer, and an SMS management tool, which supported SMS-based voting, chat, information, and quizzes.

During a trial over five one-hour lectures on information technology, four groups of 300 commerce students were introduced to the TXT-2-LRN system. They were actively encouraged to use SMS in class to engage their instructor with comments and questions, without disrupting the class. The instructor could view the messages on the laptop screen, group similar messages together, and decide when would be the best time to respond. The students were also invited to participate in m-quizzes, where they could respond to multiple choice questions with SMS. The instructor reported that instantaneous feedback on concept tests and using results to stimulate class discussion were notable benefits of SMS interaction.

Scornavacca et al. concluded that students and instructors could benefit from SMS-based classroom interaction systems. The lecturer in their study perceived a gain of quality and quantity of feedback from the students. Students reported that the system made classes more interesting. They preferred using the SMS to interact with their instructor rather than raising their hands to ask questions. Further studies to investigate the system in different socio-demographic contexts and disciplines were planned.

Ardito, Buono, Costabile, Lanzilotti, and Pederson (2007) were interested in the role that gameplay could take in education, and how cell phones could assist in the delivery of games. According to Ardito et al., since gameplay was fun, it made students more likely to learn and remember educational material. It also encouraged collaboration and fostered conflict management skills. When facilitated with cell phones, gameplay in education could stimulate the imaginations and curiosity of children and make them excited about learning.

The researchers conducted a study of elementary age students visiting an archaeological park in Italy. Equipped with cell phones, several groups of four or five students were given maps and instructions to play an excursion game in the park. An electronic game developed by the researchers had been downloaded onto the phones, and the students interacted with the game to explore the site, gather data, identify locations, and note them on their maps during a type of treasure hunt. Whenever the students identified a correct target point they would type a code into the phone or use the phone to take a picture of the target. If at any time the students had difficulties finding the next location, they could obtain clues from the "Oracle" on a cell phone menu. After completing the treasure hunt, the students could view a 3D image of the target points, comparing it with how it looked in modern times.

Ardito et al. concluded that gameplay using a cell phone stimulates student engagement. They believed that in this case the students had an enhanced learning experience because the mobile gameplay excited them to learn about history. They planned to modify the game architecture to enable mobile gameplay at a wider set of historical sites.

Naismith and Smith (2009) presented their study in which they developed two Flash-based multimedia tours for a geology museum in the United Kingdom. They theorized that museum visitors often do not take full advantage of learning opportunities offered by museums due to a lack of supporting materials that can adapt to a range of learner interests. Mobile technology, they surmised, could offer visitors location-based information and guidance based on the learners' interests and needs.

Two multimedia tours were developed to target different types of learners: a general audience and a younger, school-age audience. The researchers wanted to promote adaptable, non-linear exploration of the museum, even though its physical layout was strictly linear. Eight mobile phones equipped with Pocket PC were used in a trial involving 25 participants. A specialized mobile guide system and Macromedia Flash were pre-installed on each device. The guide software used infrared technology to identify tags on the museum display cases and exhibit the appropriate multimedia content. The participants were free to wander the museum and use the mobile devices as they wished. Depending on which type of tour they were on, their device contained a combination of audio, video, text, and images.

After administering questionnaires and interviews, the researchers determined that both groups of participants proclaimed the mobile tours to be fun and engaging. They found the system to be easy to use, and they enjoyed the variety of media available as a learning tool. They recommended that headphones be included with the mobile devices, as the sound

quality was poor, but overall reported that the experiment was a positive mobile learning experience. Naismith and Smith concluded that mobile learner-centered technology was feasible and desirable in a museum setting.

Lefoe, Olney, Wright, and Herrington (2009) argued that while mobile learning was an important new pedagogy, educators needed to move beyond training to using the mobile technologies. They identified a need for teachers to spend time planning for mobile integration in learning activities, as often pedagogical aspects of m-learning were forgotten due to funding and workload structures. They provided an overview of a staff development project at an Australian university's Faculty of Education.

Faculty members were tasked with personal use of mobile technology for a period of six months before implementing the technology in their teaching. With an action learning approach, they used smartphones and iPods to immerse themselves in the technologies adopted by their millennial learner students. The goal of the program was not only to learn how to use the mobile technologies themselves, but also how to employ the technologies as part of their everyday teaching, to engage and keep up with their digital-minded students.

After the six-month technology familiarization period was over, the faculty implemented m-learning projects for their students for a further twelve months. During this time they met regularly to share ideas and to collaboratively explore m-learning possibilities. They used the digital technologies to support their learning and reflective activities, and to provide photographic and audio reflections for later analysis by the researchers.

In summarizing this research project, Lefoe et al. asserted that comprehensive staff development and support were critical in implementing mobile learning activities. It was imperative that teachers use and understand digital technologies before implementing them in

their curriculums. They also believed it was important to use these technologies in creative ways to engage their students.

An experiment by Herrington (2009) was aimed at proving that smartphones had the potential to be used as effective teaching tools in higher education. Research was carried out with 14 teachers of higher education courses to evaluate smartphones as data collection tools to capture video, pictures, and audio. This digital data was gathered to create digital narratives, whereby learners collaboratively created and edited a story, and used movie editing software to post a video on a social networking website such as YouTube. Herrington thought that this method of mobile learning would provide a social constructivist alternative to more common methods of knowledge construction.

Before beginning the study, the students had the opportunity to attend smartphone workshops to learn how to use common features. Their task was to create a two to three minute digital narrative by writing a storyboard demonstrating a skill they used to teach, to capture pictures and videos using a smartphone, to download the multimedia into movie editing software on a personal computer, to add narration and music, and to upload the completed video to a social networking website. The researchers were interested in determining: how adult educators were able to use a smartphone in creating a teaching episode, what activities became possible with a smartphone that would have been difficult or impossible without it, and what pedagogical strategies were required to assist the students' use of the smartphones as data collection tools.

The results of the study indicated that students initially felt overwhelmed upon learning of their task, but they were surprised at how easy the smartphones and the software were to use. All of the students were successful in carrying out the smartphone assignment.

They cited portability and ease of use as important factors in adopting smartphones for mobile learning. They also liked that smartphones allowed for spontaneity in taking pictures and videos for educational purposes. As well, they appreciated the chance to learn how to use the smartphones before beginning their projects. For future m-learning projects, Herrington (2009) planned to consider the affordances of mobility, rather than those of spontaneity with the m-learning devices.

Motlik (2008) compared the diffusion of mobile phone technology in developing countries to the lag in mobile phone technology in North America. Asia is the world's top consumer of mobile phones, and developing countries such as Malaysia, Thailand, and the Philippines have high rates of mobile phone use, due to the fact that Asia was the world leader in the production of mobile handsets in the 1990s. As well, Asia enjoys a sophisticated 3G wireless network which is standardized across the continent and enables fast data transfers.

Mobile phone diffusion in Africa, while not as high as in Asia, is growing rapidly as well. Almost all African countries have access to mobile communications, which means that some countries have at least doubled the percentage of residents with access to a telephone. In comparison, North America's rate of mobile phone adoption is low, due to lack of a standardized high speed network, and to the fact that internet use remains high. The developing countries of Asia and Africa are not well served by the internet, as the cost of connecting these areas is prohibitive.

Motlik (2008) posited that Asia is at a crossroads where the countries must decide whether to increase investment in e-learning methods, as is done in the West, or to explore new delivery methods afforded by m-learning. Motlik argued that problems exist with e-

learning, such as poor instructor training, poor instructional design, lack of internet accessibility, and high costs. M-learning, on the other hand, is more affordable and more accessible. In concluding, he added that it would be a serious mistake if instructors of Asian and African distance education were to focus on web-based learning rather than mobile learning, as m-learning would be the more accessible of the two.

After learning that Prensky (2008) recommended using cell phones for exams, an American college adopted this practice for their own pedagogical procedures. The ensuing media frenzy prompted Prensky to write an article on the subject. Prensky criticized today's adults for wanting their children's education to be the same as when they were educated, before digital technology. He feared that our children are being prepared for the past, and not the future. He proposed that testing them without the tools they have at their disposal would be similar to asking somebody what time it was, but not letting them consult their watch.

According to Prensky, memorizing the multiplication tables and the names of places on the map belong in the "olden days", when information was more difficult and slower to find. Many of today's kids carry mobile phones capable of mathematical calculations, of storing maps, and of telling the time. Prensky theorized that understanding of key concepts is important today, and memorization of facts is not. Children should free their minds of "trivia", easily accessed on their phones, and be evaluated on their ability, rather than their memorization skills. Prensky argued that we must prepare our children for their digital futures. To anyone who questioned what students would do if their cell phones broke down, he answered that they would do the same as if their watch battery ran down. They would simply ask someone else for the time.

Schachter (2009) stated that as cell phones with ever-expanding capabilities multiply among teenagers and preteens, so too have the concerns of teachers and administrators about the distractions the phones can cause. Some schools in the United States have banned cell phone use to the extent that if students are caught using one, the phone is confiscated and the parents are fined. However, other American schools are realizing the educational potential these cell phones and other mobile devices can offer, and are harnessing the “anytime, anywhere learning movement that leaves laptops and even smaller netbooks behind” (p. 1).

Schachter described a project at a Texas intermediate school where 55 fifth-graders spent most of their days using smartphones to learn. The phones, the wireless connectivity, and a special mobile educational platform were donated to the school by the respective vendors for this project. The students could draw the solar system on their devices, and then animate them to show planetary orbits. They used animations to change number values by moving around decimal points. They took pictures, explored websites, and used spreadsheets and Word documents for research projects. The coordinating teacher called the project one of the most exciting things he had ever done. He added that he did not have to change the curriculum from what he had done before to fit the technology.

At another school in Ohio, students in grades three to six used donated smartphones for math problems, for typing papers, and for creating animations. Assignments were downloaded, completed, uploaded, graded, and returned, all with the smartphones. Their teachers reported that the students were more engaged and that there were less behavioural issues. Parents reported that they would buy their children a smartphone before they would purchase a dedicated gaming device.

In concluding his article, Schachter agreed with learning advocates who complained that the cost of connectivity for smartphones needed to come down considerably for universal educational use. Smartphones could be acquired for little or no extra cost with a subscription, but the monthly subscription cost at least \$30 per month per phone, making them unaffordable for many school districts.

A paper by Dyson, Raban, Litchfield, and Lawrence (2009) addressed the high cost of mobile learning in higher education. Despite growing interest in m-learning as a means of engaging technologically savvy students, this phenomenon has not often extended beyond the project stage in most institutions. Dyson et al. blamed this on the high costs of purchasing and using the technology. However, they presented some possible solutions to the problem.

The main challenges to the widespread adoption of m-learning in education were listed as usage charges billed by telecommunications providers for both students and institutions, the price of mobile hardware for students and institutions, the price of m-learning software for institutions, and the cost of establishing and maintaining institutional wireless networks for institutions. Another challenge was that although most universities have established their own wireless networks built for laptop computers, often the networks are not compatible with some mobile devices.

One way to overcome m-learning costs, as argued by the researchers, is to base learning activities around the students' own mobile devices, whether they be mobile phones, iPods, game consoles, or PDAs. At the researchers' home institution, 97% of the students owned a mobile phone. The newest models were capable of browsing the internet, downloading files, taking a photo, emailing, and accessing location-based data from GPS satellites, making them suitable for many learning activities.

Another way to overcome usage costs is to use packet technologies such as Wireless Application Protocol (WAP) and Wireless Markup Language (WML). These entail very small transmission costs, at around 1.5¢ per 1 kB (at time of publication).

Dyson et al. described two low-cost mobile learning experiments they implemented involving classroom and fieldwork activities. With the mInteract and m-Fieldwork programs, students used their own devices, mainly mobile phones, for in-class interaction activities and for data collection during field work. In both cases students did not have to pay for usage fees, and the researchers deemed both trials a success.

Dyson et al. asserted that only by achieving sustainability could m-learning become a normal, integral part of educational practice. They opined that further research was needed to ultimately overcome the cost barriers to this important, contemporary method of learning.

#### *iPods*

A study by Evans (2008) investigated the effectiveness of m-learning in the form of podcasting for teaching students in higher education. The particular goal of the study was to investigate the use of podcasts as a revision tool by learners after a traditional lecture, but before an examination.

One hundred ninety-six first-year Business and Management students at a London university were given access to 3 five-minute podcasts of lecture reviews per week. They were able to use either an iPod or a personal computer to access the podcasts. All of the podcasts were available to them up until the day of the exam, meaning that the students could review the lectures as many times as they wanted.

The results of the study were positive, as the students reported the podcasts to be efficient, effective, and engaging learning tools. They also valued the flexibility offered by

podcasts, especially in terms of the ability to study where and when they wanted. One quarter of the students listened to the podcasts while commuting. Evans (2008) theorized that since London public transport was cramped and crowded, it would not normally be possible to review course materials in the traditional way with textbooks and notes. An iPod offered a convenient method of learning while in a small, possibly noisy space. He suggested that podcasting filled an important needs gap by enabling learners to learn when it might not normally be possible.

Georgia College and State University (2006) reported on their iPod Story. Shortly after Apple introduced the iPod in 2001, the university's vice chancellor for information and instructional technology began using an iPod during his commute time. He turned the commute into productive work time by catching up on paperwork his assistant had turned into audio files. He began to realize the tremendous positive effect the iPod had on his workload management, and from there an idea was born to employ iPods to add value to academics at his liberal arts institution. After issuing a call for proposals for interdisciplinary courses that would be iPod-enhanced, two initial projects were chosen, and 50 iPods were distributed for students' use.

In a course titled "War, Politics and Shakespeare", the instructors included audio recordings about Shakespeare, as well as songs about war and peace. There were also historic speeches on war and student recitations from the works of Shakespeare. The course was deemed "an astonishing success" (p. 1).

A Gothic Imagination course introduced music, which had been the missing link, to the students. They listened for parallels in theme, tone, the politics, and social climate of the

Gothic movement. The instructor appreciated that the iPods freed up class time for discussion, as the students could listen to the audio recordings away from class.

As of the 2005-2006 year, over 40 i-Pod-related initiatives were running at the university. The faculty appreciated that by having their students perform the less demanding work with their iPods, higher order thinking was maximized in class. The iPod initiative was extended beyond the classroom. Several Study Abroad programs utilized the iPod, as did a student virtual learning community and a group of innovative and creative faculty and staff who worked on plans for future iPod activities. This university iPod initiative was very successful in joining technology with the liberal arts, inspiring innovative ways to teach and learn.

Brittain, Glowacki, Van Ittersum, and Johnson (2006) described a project in which University of Michigan dentistry students used podcasts to listen to lectures as many times as desired. The students were expected to learn vast quantities of information, and they doubted their ability to accurately summarize the information in their notes. They approached the school and asked to have each lecture videotaped for later review.

School administrators wanted to provide the students with a worthwhile, yet cost-effective method of providing lecture recordings. After evaluating various types of educational technology, the administrators chose podcasting of audio lecture recordings, rather than the video recordings that were originally requested. They considered several factors when choosing the recording technology. Students said they appreciated the mobility of podcasts. They could take the lecture recordings anywhere and listen to them anytime, which would not be the case with video recordings. Costs for technical staff to set up and run equipment in the two scenarios were compared, and podcasting won over video.

The students were made responsible for obtaining instructor permission to record the lectures, for providing their own iPods or alternative devices, and for helping to set up lecture recording scenarios. It was a collaborative effort between the administration and the students.

Brittain et al. concluded by reinforcing two lessons that can be applied to most learning technology projects: involving the client in the implementation of the technology, and the importance of using proven instructional design. Although the podcasting delivery was not what the students had originally requested, their involvement in the evaluation of possible solutions to their needs was a key factor in the positive end result. The podcasting continued on to assist dental students in their wake.

According to Maag (2006), at the same time that increased numbers of students were enrolling in nursing colleges, the number of nursing educators was decreasing. Maag presented her research on m-learning with iPods to highlight its benefits and to encourage educators to adopt this alternative learning technology.

Maag stated that the students of the day, called the Net Generation, had been raised in a media-rich environment and an information-centric world. They expected educators to provide innovative technological tools that complemented their inherent skills and characteristics. Maag opined that innovative technology was altering students' and healthcare providers' expectations of learning. Additionally, effective learning models and knowledge of the Net Generations' characteristics were necessary to provide effective, reflective learning.

Maag provided an overview of how podcasting works. Two forms of podcasting are possible. Simple podcasts are a digital audio event, or MP3 format such as a conversation, lecture, or interview delivered to content management software, such as iTunes. Enhanced

podcasts add multimedia so that PowerPoint slides, video clips, and images can be added to the iPod. To publish a podcast, the digital file is posted to a website in an RSS feed. The subscriber downloads an RSS reader to subscribe to that website and subsequently receives automatic downloads of updated materials.

Maag (2006) conducted a research project to discover nursing students' opinions of using iPods as educational tools. During two academic semesters she recorded and uploaded traditional face-to-face nursing lectures to a website and RSS feed. Students were able to download the lectures to their iPods to listen to as many times as desired. She also provided constructive feedback to her students via a five-minute MP3 audio file. Upon being surveyed about their experiences with the iPod m-learning, students indicated that the podcasts assisted them in retaining information, that they had opportunities to learn while performing other activities, and that they were useful for reviewing material before exams. Overall, the results were positive. Maag also noted that the availability of lecture podcasts had no significant effect on class attendance, which was contrary to the expectation of critics.

In conclusion, Maag (2006) summarized her belief that open-source broadcast technologies supported the busy lifestyles of learners and allowed for the reinforcement of learning materials. She called for ongoing evaluation of lecture podcasts to guide plans for the development of distance education nursing programs.

#### *PDA's*

Trifonova (2003) reviewed the research on mobile learning in order to classify mobile learning themes. She identified five main areas of m-learning research: mobile learning pedagogy, courses for mobile devices, tourist and museum guides, lifelong learning, and use by K-12 classes.

Trifonova (2003) reported on research performed on the cognitive and pedagogical aspects of mobile device use in education. She highlighted the application of activity theory to mobile phone use. Activity theory emphasizes that human activity is mediated by tools and that tools are created and transformed during the development of the activity itself (Kaptelinin & Nardi, 1997). Tool use influences the nature of behavior and the mental functioning of individuals. As such, some m-learning researchers were giving application designers advice on how mobile devices could be most useful, according to their research on children's learning. Trifonova noted that mobile technology gave students and teachers alike opportunities to develop ingenuity.

Projects in the United Kingdom and the United States in the area of course development were producing m-learning materials for people with literacy and numeracy problems, developing mobile language programs with word practice and quizzes, and creating special programs such as organizers and timetables to assist learning with PDAs. Trifonova (2003) found that new mobile technologies had great impact on student engagement because they were fun to use.

Mobile instant messaging (SMS) experiments were conducted in the United Kingdom, Finland, and Norway. In the United Kingdom, students were split into groups, and each group was sent information about course and exam schedules and grades, either by email, by SMS, or by web. The responses were most positive from the students who received the text messages, as they felt this type of announcement was more personal than email or web. Researchers in Finland experimented with MMS, or multimedia message service. Photo sharing with mobile phones was incorporated into coursework, and this was also found to be a valuable learning activity.

A study in the United Kingdom called the Ultralab Project was aimed at the tourism industry. Mobile phones equipped with GPRS delivered media-rich, context-aware information to tourists. The generation of 3D landscapes based on the position of the phone made it possible for a user to stand on a specific location and have the system generate a view of their position in the ice age, or another place in time. As well, a museum in San Francisco took advantage of a project where mobile web content was created to allow for interaction with the museum's exhibits. Teachers involved in the study thought the technology would be useful for learning activities before and after museum visits.

Trifonova (2003) pointed out that one of the biggest initiatives she explored in the m-learning domain was the HandLeR project in the United Kingdom. The project explored lifelong learning; in particular, knowledge sharing, wearable and mobile learning devices, and conversation between mobile learners. Another study, the KNOWMOBILE Project, was conducted in Norway, where researchers planned to explore problem-based learning amongst medical students using PDAs. The way in which the students ultimately used the devices made the researchers realize it was more of a study on lifelong learning. The students used the PDAs as problem-solving tools, but also used them to communicate with each other to organize social activities. They were eager to test the devices to discover for themselves how the PDAs could be used for their studies and in their daily lives. The researchers concluded that the PDAs should be regarded as gateways to technical and social networks.

Trifonova (2003) also reported on experiments in U.S. and Taiwanese K-12 classes, where students were assigned networked PDAs for math problems. They worked in groups and the results were posted for everyone to see. Incorrect answers were worked on further by the entire class, and only the teacher knew who made the mistakes and why, and thus could

evaluate the knowledge of each student. The students reported that this type of anonymous learning made them feel comfortable and free to take risks. Typically shy students enjoyed learning without being put on the spot and they also appreciated the group work, where they participated and collaborated more than with regular face-to-face instruction.

After concluding her research, Trifonova (2003) asserted that m-learning was applied best to certain scenarios; where discussions in distributed groups were necessary, where data was collected in the field, and where knowledge needed to be accessed at the spur of the moment. She recommended that m-learning be kept to short, five-to-10 minute modules and that it be simple and fun to use.

Wishart (2009) conducted a project in a U.K. secondary school science department during one academic year. Her goal was to build capacity in the school through m-learning practice; in particular she wanted to encourage reflective practice amongst the teachers and the teacher trainees with the use of web logs (blogs). She cited the importance of developing evidence- informed professional judgment, and believed that the anywhere and anytime capabilities of PDAs would enable the reflections. The trainees' reflections were to be shared with their teacher mentors on a regular basis.

All 13 teachers in the department and six teacher trainees were given PDAs and were shown how to use them for such activities as discussion groups and email, accessing course documentation, acquiring knowledge from the Web, photographing experiments, organizing lesson plans, and for maintaining a reflective web log. None of the participants had ever used a PDA previously.

The teaching staff and teacher trainees participated in focus groups throughout the year, and both groups identified the same three software applications as central to the

potential of the PDA for learning and teacher support: the calendar for keeping organized, the spreadsheet for noting attendance and grades, and the word processor to make notes immediately after an event or thought had occurred. The teacher trainees appreciated being able to use their own device whenever necessary, rather than having to impose on their mentors to use a desktop computer.

In her conclusion, Wishart noted that her goal of encouraging reflective practice with the PDAs did not succeed with the teacher trainees. They were uncomfortable with sharing their thoughts and opinions with their teacher mentors. However, the just-in-time nature of mobile learning and having instant access to the Web, to calendars, and to class lists and grades was perceived as valuable. Wishart added that the teachers continued to use the PDAs after the study had concluded; for internet access, taking photos, class administration, and diary scheduling.

An interesting project by Polishook (2005) charged 12 university music composition majors with composing music on PDAs. Polishook wanted to determine if the students would approach the composition process differently than they would without the PDAs. Would the technological interface so different from manual writing tools and score paper influence artistic process and technique?

The students received portable handheld workstations consisting of a Palm PDA, a folding keyboard, a portable music synthesizer, and music software programs for music notation, playing drumbeats, and controlling sound effects. Over a year the students were asked to write music directly with and for their handheld devices and to consider how they could use the devices for artistic expression that could not be performed with traditional tools. The PDAs were used to create graphical scores, and for just-in-time composing, where

they would stop whatever they were doing and suddenly start composing music as a group activity. One student even wore her PDA around her neck, to use it at a moment's notice whenever she felt inspired to compose.

Polishook (2005) emphasized the creativity that the PDAs fostered in the students. Instead of giving in to restrictions, they developed ways to work within the limitations of the handhelds. They were forced to think creatively to overcome constraints, and Polishook deemed this an important outcome of his project. He theorized that although PDAs will never take the place of the desktop computer or the piano for music composition, the ability to hold them in our hands makes them an extension of who we are. He concluded that his Handheld Composing project helped his students think critically and reflectively about artistic practice.

McCaughy and Dillon (2008) reported on their examination of the use of PDAs in physical education. Their goal was to examine shifts in preservice teachers' perceptions about using PDAs to enhance instruction in physical education. They tried to identify factors that led to the shifts in thinking.

During a six-month project, seven preservice teachers enrolled in a physical education teacher certification program attended several PDA training sessions. They had many opportunities to practice the skills they learned. They then participated in three PDA field experience activities in local elementary schools, where they instructed students on movement. The PDAs were used to organize and play music, to take pictures and video clips of the students performing motor skills, and then provide feedback, and to create rubrics for evaluating physical education.

At the beginning of the project, the participants expressed skepticism that PDAs could be helpful in the instruction of movement content. They worried that using PDAs

would reduce student learning time, that the PDAs would function unreliably, and that they were not skilled enough in operating the mobile devices. However, none of their concerns were realized. At the project's end, the preservice teachers reported that PDAs were practical in enhancing teaching of physical education. They were especially appreciative of the ability to easily control and acquire new music in their teaching. They also found value in taking pictures of their visually oriented students for providing feedback. They all reported that they planned to use PDAs in their first teaching jobs.

McCaughy and Dillon (2008) theorized that this shift in attitude toward PDA use in teaching was due to four key factors: the preservice teachers had time to learn and play with the technology before and during the project implementation; they had a knowledgeable and available instructor (for the PDA technology); they were able to use the PDAs in real-world field activities; and they had created an informal peer learning community.

The researchers recommended that teacher educator programs provide ample opportunities for preservice teachers to explore and use instructional technologies, but at the same time be prepared for the issue of funding and access to PDAs and other technologies. They also suggested that formal establishment of peer learning communities may not always be necessary to support learning of educational technology, as they will often emerge on their own.

### Summary

This section presented the extant literature on m-learning in the field of Education. I discussed m-learning theory on older learners and on students with special needs. I then presented some of the ways in which cellphones, smartphones, iPods, and PDAs have been used in various parts of the world to educate students in a variety of educational settings.

## M-Learning in Business

### *M-Learning in the Workforce*

Tapscott (2009) cautioned that the tech-savvy Net Geners entering the workforce will not be satisfied with the hierarchical model of most businesses. Companies who want to be successful will have to implement the networked structures and peer collaboration valued by younger generations. He added that the Net Generation was already transforming the workforce and that their new approaches must be welcomed by businesses and governments around the world.

Corporate training departments are embracing m-learning. Because most of their employees carry cell phones or PDAs on a daily basis, it can be cost effective to send training materials to the workers' phones, and is a new and exciting way to learn. A press release by Deltecs InfoTech (2009), an m-learning solutions company in India, boasted of their new mobile-based training solutions for corporations and training institutes. Deltecs geared their training products towards organizations with large workforces who were spread out in the field, and who otherwise would not have access to on-demand training, and to middle and senior managers too busy to attend workshops and presentations. Much of what they needed to know could be learned via their mobile phones whenever they had the time.

The Deltecs training platforms transformed smartphones into mobile classrooms, offering information via text, graphics, video, and audio. A mobile authoring tool could convert many types of training material into a format for mobile devices. Assessments, corporate presentations, and audio and video sessions for sales and product training could all be delivered in a mobile format to workers on the road or in the field, and to time-pressed managers. As businesses become more geographically distributed and their workforces

become more technologically sophisticated, Deltecs Info Tech was poised to help ensure attention and retention to business training needs.

Metcalf and De Marco (2006) theorized that with the growing trends of mobility in our society, it was important to gain back some of the time we spend commuting, in airports, and waiting in line. M-learning with mobile phones and PDAs allows you to have connective, online access even while you are on the go in a mobile setting, which is important for a large portion of professionals. The researchers asserted that the goal of m-learning was to develop learning content that integrates with mobile applications and provides learning and performance in a just-in-time, just-in-place dynamic. They decided to explore the ways that just-in-time learning could be enhanced by the use of new technologies such as audio and multimedia, accessing enterprise systems while on the go, reference materials, and small courses for business professionals.

Metcalf and De Marco (2006) reported on corporations using m-learning that enabled their salespeople and technicians to stay up to date on client information, training, and technical data no matter where they were. Using mobile email, the sales team leader could keep track of employee sales. The technician out on a service call could use his smartphone web browser to look up how to do a complicated repair. It was easy to keep information not only easily accessible, but constantly updated, rather than referring to an outdated manual in hard copy.

The researchers concluded that m-learning was here to stay and that the next generation would include augmented reality, mobile collaboration, and decision support tools. They predicted that mobile gaming would become important for getting people interested in using mobile performance support and handheld collaboration. They asserted

that users would need to spread awareness of the time savings, efficiency, and greater results and profits offered by m-learning technology.

Dzartevska (2009) proposed a conceptual framework for developing a mobile learning system in a professional environment. Believing that the workforce would soon be comprised largely by the technology-savvy Millennial generation, Dzartevska asserted that businesses would be wise to employ mobile training as a means to deliver flexible, always-available training. She posited that PDAs and smartphones were becoming “absolutely necessary for employees to manage their busy schedules and their workloads in a highly dynamic, competitive, and time critical business environment” (p. 274).

Collaborating with a company in the supply chain industry, Dzartevska (2009) concentrated on the logistics management component of the business activities. A mobile learning prototype was developed for warehouse operation and dangerous goods training, based on multiple studies of m-learning design requirements, and on the organization’s specific training needs. While making it clear that different organizations require different types of design approaches and techniques, Dzartevska noted that in this case the goal was to ensure that users could locate critical, just-in-time information, dangerous good qualification, and handling procedures. Users were also to have easy access to definitions of industry-specific terms or processes, and to important product information. As well, they were to have immediate sharing of information, questions, and feedback with other employees or with trainers.

Dzartevska (2009) concluded that although the prototype was never put into actual use, valuable information was gained on how to create an m-learning framework for a variety of business learning environments. She asserted that the success and acceptance of a mobile

learning environment depended greatly on the creativity and design of the learning objects delivered. The learning content creators needed to understand the business thoroughly, but they also had to transform that information into learning material with sound pedagogy. Dzardevska expected to continue collaborating with the supply chain company and to test the m-learning system in a real life environment.

Von Koschembahr (2005) expounded on the virtues of m-learning in the sales workforce. He argued that although salespersons had enjoyed instant communications with mobile devices for years, these devices were evolving rapidly and could allow access to important information in the form of mobile learning, the convergence of enterprise applications and wireless devices.

The same learning content that was on a company's website and intranet could be made available on already-familiar wireless tools, making learning more convenient and flexible. He called SMS the lowest common denominator of m-learning, but added that wireless learning functions such as reading company policies were a natural extension of the mobile device. He gave the example of a train conductor who used a handheld device to collect fares and check in passengers. By adding wireless capability to that device, the conductor could go online to read a recently changed company policy.

Von Koschembahr (2005) theorized that by providing point-of-decision access to information and by providing ad hoc learning opportunities during downtime, m-learning could address industry challenges such as cost savings, enhanced customer service, and better selling opportunities. He also discussed a blended learning model in which traditional classroom training could be enhanced with m-learning. By creating training materials only once for the classroom and adding capability for anytime and anywhere access on mobile

devices, significant cost savings could be gained. He postulated that after regularly accessing small “learning nuggets” whenever and wherever necessary, before long, an employee would not be able to differentiate learning from other everyday job functions.

Von Koschembahr concluded that m-learning provided companies with a competitive edge and produced a workforce with high job satisfaction, ultimately reducing employee turnover. He predicted that the potential of the wireless industry was without limit, and foresaw learners in the future downloading interactive courses and learning modules from the backseat of a cab or waiting in an airport terminal.

According to Wagner and Wilson (2005), mobile devices were becoming more and more affordable for everyone, and no matter age, gender, national identity, or socio-economic status, broad mobile device adoption knew no bounds. New mobile technologies were quickly being adapted to as well, and no sooner did a new technology come along than it was immediately embraced. Wagner and Wilson stressed that the growing adoption of mobile devices made mobile learning logical and that m-learning was for people who need access to information and performance support when out in the field or on the job.

Wagner and Wilson asserted that mobile learning allowed workers to take advantage of place-independent flexibility because they had the ability to connect with the right content on the right device at the right time. They stated that mobile learning was not e-learning on a cell phone, as bandwidth and processing power were limited. However, the mobile phone was appropriate for conversations and information exchange, performance support, and real-time collaboration.

Rather than the traditional behavioral, hierarchical, lecture-recitation models of training, Wagner and Wilson surmised that effective training for current and future mobile

professionals needed to be based on communications and social learning. This could be realized through instant messaging and blogs to create new knowledge. They argued that learning professionals would have to help shape the mobile learning movement to avoid substandard mobile applications.

The researchers noted that workers could enjoy ubiquitous connectivity and special services for the mobile worker, especially useful for anyone who had to spend more than 20 percent of their workday away from the office, and services for the mobile learner, where the professional could remain connected and informed. In closing, Wagner and Wilson reminded the reader that the current models for training were based on a model of “command and control” (p. 43), with an instructor in charge, goals to be met, and criteria to be mastered. They stressed that with the rise of mobile device adoption, a foundation of connectedness, communication, collaboration, and competitiveness would come for the mobile professional.

#### *M-Learning as M-Commerce*

M-learning is used in Business not only as a method of training and in-the-field learning. Mobile commerce (m-commerce) has been in use in Asia and Europe for a decade, and is a recent phenomenon in North America (Adhikari, 2009). Mobile applications to access information such as banking and paying for goods and services with our phones are just in the initial stages in Canada and the United States (Tapscott, 2009).

Siau, Lim, and Shen (2001) presented an overview of mobile commerce (m-commerce) development. They observed that m-commerce promised many more market opportunities than did traditional e-commerce because of its inherent characteristics such as ubiquity, personalization, flexibility, and dissemination.

The researchers listed value-added services as an important feature of m-commerce. They included easy, timely access to information, such as availability of flights, immediate purchase opportunity, beaming money for bank withdrawals and deposits, and buddy finding, where a user could be alerted when a colleague is nearby, or when the nearest restaurant is close.

In terms of the technology required to enable m-commerce, Siau et al. recommended Wireless Application Protocol, Bluetooth, a high speed 3G network, and Wireless Markup Language (WML). They also touted location identification technology as an important aspect of m-commerce. Physical location of users could be tracked with GPS, adding value to mobile commerce applications whose content is varied depending on location. Asia and Europe were enjoying early success in m-commerce, as they were equipped with the proper technology. However, mobile technology lagged behind in North America, where they were just beginning to see basic services like wireless access to news, weather, and sports.

Siau et al. warned organizations that they would have to be cautious in implementing m-commerce. They would need to reorganize themselves, develop new business models, and change organizational behaviour. They would have to ensure that their mobile services were reliable, and that customers' transactions were secure. Siau et al. advised that there was still work to be done in these areas, but that mobile commerce held great promise in providing important data in real time, to revolutionize numerous facets of everyday life.

Although mobile phones were once considered a luxury, Kumar and Zahn (2003) noted that they were quickly taking the place of conventional phones, and that wireless networks were freeing people from their desks, allowing them to live and work in more flexible ways. They thought that analysis of mobile communications was important, since

they were profoundly effecting business operations. As noted by other researchers, Kumar and Zahn added that the United States had more personal computers per 100 habitants than any other country, but that they lagged far behind Europe and Asia in cell phone use. The United States seemed ready to catch up, as the researchers reported that they wanted to emulate the I-Mode, a type of mobile phone in widespread use in Japan. Users of the I-Mode could send emails, transfer funds between bank accounts, book plane tickets, play interactive games, and download music.

Kumar and Zahn described how Britannica wanted to push their encyclopedia products to the mobile phone and PDA market. They faced some obstacles in that the phone screens were small, and they did not want users to become frustrated with having to punch too many of the phone's buttons. The problem was solved by breaking Britannica's content down into paragraphs that could fit the mobile screens. Britannica introduced its first cell phone application in September 2000.

Kumar and Zahn also reported on mobile business uses in Japan and Finland. Japanese consumers could purchase goods with a cell phone and be billed on their monthly cell phone bill. Cell phone users in Finland could pay for mobile purchases by sending a text message to a telephone company, receiving a code number, and providing the number to the merchant. The merchant would then contact the phone company for payment from the customer's account.

The researchers concluded with predictions that we would soon see such mobile phone functions as bar code scanning, optical character recognition, and digital cameras. They encouraged businesses to pay attention to mobile commerce to enhance operational efficiency by distributing information to employees remotely, and by offering new ways to

interact with their clients. They surmised that mobile communications could lead to improved business operations, and happy employees, customers, and suppliers all over the world.

Kleijnen, Wetzels, and de Ruyter (2004) explored the factors contributing to the adoption of mobile services in the context of wireless finance. They wished to study perceived cost, system quality, and social influence. Believing that marketers should understand consumers' motivations that will lead to the adoption of wireless technology, they wanted to provide a deeper insight into what was needed for consumers to accept the new technology.

The proven TAM (Technology Acceptance Model) was their basis for studying whether consumers believed mobile services could be integrated into their daily activities. A questionnaire was designed to ask consumers about their views on mobile services usefulness, ease of use, costs, system quality, attitude, intention to use, computer skills, mobile technology readiness, and social influence. Each of the 105 research subjects owned a mobile phone with WAP technology and actually used the technology.

The researchers found that perceived cost of mobile services played a less important role than was expected. They attributed this to the consumers' expectation of high quality content, making up for cost. The effects of computer skills and mobile technology readiness were critical, as were situational contexts rather than functional aspects of mobile services. They found social influence to be an important factor, as positive word of mouth played a key role in persuading consumers to use mobile financial services.

This or That (ToT) was a research project on a social shopping application for iPhones created by Boardman, Casalegno, McMurray, and Pomeroy (2008). ToT was a way

to explore the potential of mobile social shopping. They theorized that shopping is a rich-user experience that has evolved from a needs-based activity to an emotional and rich social experience for the shopper and his or her community. They speculated that for social shoppers, the actual purchase was secondary to the tactical goals and the social interaction with others while shopping.

The ToT application integrated Facebook with the Apple iPhone to allow the lone shopper to connect with their social network for collaboration and informed decision-making on products and services to purchase. This could happen anywhere and at any time. The shopper could take pictures of the product, add a short description, create a survey to gain their friends' opinions, set a survey expiration date, and send a notification to the group whose feedback was considered relevant. Multiple groups could be set up ahead of time or at the spur of the moment.

Once the "experts" received the notification, they could log onto the application to view the photographs, complete the survey, and leave comments. The shopper would receive notice when the survey expiration time had been reached. The ToT application integrated with Facebook completely, using the shopper's already-existing friends lists, profiles, and pictures.

Boardman et al. conducted a study of 12 subjects in Barcelona and Madrid to test the ToT prototype. The testers had to own an iPhone with data plan and have an active Facebook account. In addition to the 12 initial testers, another 39 users participated in the study after being invited through the Facebook application.

After the two-week study was completed, the researchers found the ToT application to be promising for wide-scale distribution. They planned to enhance the application by

adding SMS capability to reduce the feedback time lapse and by enabling it for mobile platforms other than the Apple iPhone.

### Summary

This section introduced the scholarly literature on m-learning in Business. PDAs and smartphones are used to provide just-in-time information to workers, whether they are busy professionals in need of on-demand training, or are workers in the field requiring access to technical data. M-commerce, a sub-category of m-learning in Business, was also discussed. M-commerce provides mobile business-related processes and information such as banking and paying for goods and services to the mass consumer.

### M-Learning in Medicine

In 2008 over half of U.S. physicians owned a PDA or smartphone (Manhattan Research, 2008). Mobile devices are quickly becoming mainstream in the medical field, and of the physicians who do use PDAs, over half consider them essential to their professional practice. PDAs are used routinely as decision support tools for drug reference databases, drug dosage calculators, for clinical references, and for continuing medical education programs. As well, more medical schools are requiring PDAs or smartphones in the classroom.

Manhattan Research (2008) reported that physicians use their PDAs and smartphones to supplement medical expertise at the point-of-care. They believed that mobile devices were essential to practitioners in the on-the-go medical field. As mobile devices become increasingly advanced, offering more types of content and features, the researchers expected physicians to continue to adopt the devices and their value-added applications.

Osborne ((2008) discussed a pilot text messaging project at Children's Hospital Medical Center in Cincinnati, Ohio. Clinicians at the hospital had noticed that teenagers with

serious asthma were often forgetting to take their regular medicine and were subsequently suffering with ill health. They also noticed that while these teens were undergoing examinations, they would frequently send and receive text messages on their cell phones.

A program was started in which a staff member sent text messages to a group of about 20 patients between ages 12 and 21, reminding them to take their medication. The messages were sent to each patient once or twice per day, depending on how often the individuals needed their controller medication. The teenagers reported that the quick text messages were very useful in helping them to develop good self-care habits. They felt much better and appreciated not being “nagged at” to take their medication regularly.

Initially, a staff member sent the text messages manually on her own cell phone at pre-determined times; however, Osborne (2008) reported that the hospital administrators were testing a commercial system for automated text messaging. The project was deemed a success, and the hospital prepared to launch a larger study aimed at people of all ages with chronic disease.

Scherr, Zweiker, Kollmann, Kastner, Schreier, and Fruhwald (2006) conducted a study on the mobile monitoring of cardiac patients at home. Two categories of patients, those with chronic heart failure and those with arterial hypertension, were at increased risk for hospitalization or even death. The researchers wanted to determine if self-monitoring of patients' health and transmission of the data to their physicians could reduce the risk factors. A telemonitoring system was developed, and for a total of 1,735 days the critical variables of heart rate, blood pressure, and body weight were measured at home by 14 cardiac patients and six hypertension patients.

The monitoring system consisted of a mobile phone with WAP technology at the patient's home, a personal computer at the doctor's office, and a computer server. Each participant was equipped with an automatic blood pressure device and a digital weight scale. The patients were asked to monitor their blood pressure, heart rate, and weight every day at the same time. After doing this they connected to the internet with the mobile phone, entered the data, and sent it to the doctor's computer for processing. The entire process took less than five minutes. If a patient's values exceeded a predefined limit, the doctor was automatically notified by a text or email message. The system also allowed the doctor to set automatic SMS reminders to have the patients take their medication, weigh themselves, and measure their blood pressure and heart rate.

The patients were asked to fill out a questionnaire at the end of the monitoring period to provide feedback on system usability, acceptability, reliability, and effectiveness. The feedback was positive. Patients felt that the self-monitoring system helped them comply with their treatment program and made them more aware of their blood pressure and body weight. Scherr et al. reported that other studies have shown that telemonitoring of weight and blood pressure have significantly reduced mortality compared with standard care. They proposed that telemonitoring has clinical utility for patients with heart failure or hypertension.

Adatia and Bedard (2003) produced a very informative document to outline handheld software for physicians. They opined that more than a quarter of Canadian physicians used a PDA, and that number was expected to increase to more than half within two years. The ever-growing library of mobile medical software was becoming difficult to sort through, and the researchers aimed to categorize and provide an updated and extensive summary of the most widely used programs. The article focused on software available for Palm PDAs, but it

was noted that many of the programs could be operated on other operating systems such as Microsoft Pocket PC.

As a preamble to the categorization of programs, Adatia and Bedard (2003) clarified that most medical programs for the Palm operating system could be downloaded from the internet; some for free and some for purchase. Many free trial versions were also available. They warned that some popular titles may be abridged versions with important content omitted, reducing the usefulness of the product. They also cautioned that some programs could be too large for the PDA's memory storage capacity, and that it might be helpful to purchase hardware with memory expansion capability. As well, they suggested it was important to evaluate the manner in which information was presented, since having to scroll through large volumes of text would be cumbersome.

Adatia and Bedard (2003) summarized seven main categories of medical software for PDAs: General medical reference programs, downloadable journal content, pharmacopoeias, medical calculators, patient-tracking programs, billing and coding software, and handheld word processing and office programs. Seemingly the most important category was pharmacopoeias, which allow physicians to easily look up indications, side effects, and dosages of medications. A check could also be run to look for drug interactions. Of physicians surveyed by Harvard University to study a specific brand of software, 50 percent indicated that the pharmacopoeia program helped them avoid at least one adverse drug event per week.

Adatia and Bedard (2003) predicted that in addition to the wide range of mobile medical software available, the streamlining of pager, cell phone, Dictaphone and email messaging functions into a single device would come to the world of handheld technology.

They announced that the upcoming Palm operating system upgrade would allow improved support for audio recording and playback, meaning that physicians would be able to dictate clinical notes, letters and email messages directly into their handheld devices.

Luo (2004) contributed a similar article regarding PDA use in medicine, however his focus was on portable computing in psychiatry. He provided a brief history of the PDA, noting that the modern, ultra portable PDA appeared and was widely adopted in 1996 with the Palm Pilot. Luo touted the PDA's sharp screens, powerful processors, external memories, and the built-cameras, MP3 players, cell phone service, and wireless internet capability belonging to some models. He pointed out that most PDAs were based on the Palm operating system or Windows Mobile. Like Adatia and Bedard (2003), Luo also cautioned that processor speed and memory size and type must be considered when choosing a PDA, depending on the software to be used.

Luo (2004) separated PDA use for psychiatry into six categories: general use of common features such as the calendar and reminder alarms, document editing, databases and spreadsheets, presentations, email, and medical uses. The medical uses section was further categorized into seven sections, providing a comprehensive overview.

Patient tracking, medical texts, drug reference guides, medical education, prescription writing, research, psychiatry-specific applications, and security were discussed, with drug reference guides being singled out as the most popular medical use of the PDA. An advantage of the PDA-based guide was that regular updates could be obtained from the internet. Luo (2004) noted that medical schools and residency training programs were increasingly requiring students to purchase PDAs. The specialized software allowed for rich

learning experiences and even for highlighting gaps in curriculum as students tracked all of their activities.

In the psychiatry-specific category Luo (2004) described applications for screening dementia, for diagnosing psychiatric illness, for special reference texts, and for psychotropic medication calculators. He concluded by asserting that PDAs were increasingly able to support physicians managing complex information, and that implementation of the devices was increasing every year. He predicted that the PDA would become an essential tool in medicine.

Conkin Dale and LeFlore (2007) wrote an article on the use of PDAs and smartphones in clinical practice for pediatric nurse practitioners and others in the field of pediatric health care. They summarized the types of PDAs and smartphones available, the types of operating systems, and provided the prices of some model examples. They also presented a list of websites offering product information to assist practitioners in choosing an appropriate mobile device.

They advised that mobile devices were purchased with internal memory, or RAM, but that extra memory, or ROM, could be purchased to increase storage capacity. ROM in the form of a memory expansion card was necessary to store large files such as pictures, videos, and music. In some cases an external expansion card was required to run memory-intensive software such as databases and e-readers. In other cases, the internal memory was most important, particularly for software that required updates from the internet.

Conkin Dale and Le Flore (2007) discussed the value of using PDAs and smartphones as point-of-care resources. They observed that quick access to point-of-care information and guidelines and evidence and decision-making tools could improve learning in evidence-based

practice. The researchers stated that wireless access to medical information technology had emerged as one of the most important technologies used in health care. They predicted that wirelessly accessing information otherwise not available would gradually diminish the need for quickly outdated static software.

### Summary

This section discussed the literature on PDAs and smartphones used in medicine. Medical professionals have come to rely on m-learning for important point-of-decision reference tools and patient monitoring devices. The devices are used for screening, diagnosing, and treating patients, as well as for medical office support tools.

### Chapter Summary

The literature on Education, Business, and Medicine showed that m-learning is an exciting new use of technology gaining increasing attention. Cell phones, smartphones, iPods, and PDAs with ever-expanding capabilities are used by educational institutions, corporations, the general public, and the medical field to access information in a modern, technically sophisticated manner. Up-to-date information can be accessed anytime and anywhere, making it possible for the learner, the business person, the medical professional, or the average person to obtain critical information whenever it is needed. M-learning saves time and money, connects people, boosts motivation, and can be tailored to a variety of users. Researchers are confident that as mobile devices and wireless networks rapidly evolve, m-learning will continue to engage the public on a worldwide basis.

## CHAPTER FOUR: CONCLUSIONS AND RECOMMENDATIONS

This research project was designed to investigate mobile learning. It looked at the following questions: How is m-learning defined and how is it used in the fields of Education, Business, and Medicine? What are the types of hardware and software used in each field? Additionally, who are the prominent researchers in m-learning, and in what parts of the world is m-learning most used? In the following sections I present my conclusions.

### M-Learning Definitions

While there was general consensus that the study of and implementation of m-learning was important to meet the needs of the Net Generation (Lefoe et al., 2009; Pozzi, 2007; Prensky, 2001; Tapscott, 2009), there was some disagreement on the definition of m-learning. Some researchers (Pinkwart et al., 2003; Quinn, 2000) theorized that m-learning was simply e-learning on a smaller device. However, researchers who conducted studies later in the decade argued that mobile devices were changing the nature of knowledge and discourse in modern societies. They asserted that learning could take place at home, at work, or at places of leisure, and was mobile between different areas of life (Pozzi, 2007; Traxler, 2007). In effect, m-learning is changing societal paradigms by being more about accessing information of any type anywhere and anytime, rather than being defined as a type of formal learning.

The definitions from Pozzi (2007) and Traxler (2007) led to my inclusion of m-commerce in the definition of m-learning in Business. I had originally planned to discuss only m-learning in the workplace; however these articles from the latter half of the last decade presented changing m-learning definitions, which seemed to coincide with advancing mobile technology. Quinn (2000) had predicted that mobile devices would one day be tiny,

powerful computers with wireless connections. As mobile wireless technology advanced, allowing for anytime, anywhere access to any type of information, the definitions of m-learning advanced as well, to encompass all types of knowledge gained through a mobile device.

After synthesizing the literature, I agree with Traxler's opinion (2007) that m-learning is a concept within our increasingly mobile society. No matter where we go, access to knowledge is within our pocket. If we want to know the score of last night's hockey game, the answer is in our pocket. If we want to find a recipe to make tonight's dinner, a tiny cookbook filled with thousands of recipes is in that same pocket. And if we need to know the capital city of Peru, the answer is accessible within seconds. M-learning is about much more than "school smarts". It is about the ability to always have information at our fingertips, rather than having to store a great deal of it in our brains.

#### How M-Learning is Used

##### *M-Learning in Education*

In reviewing the Education literature, several themes emerged. One of the most prevalent themes within Education was the use of m-learning to acquire a second language (Levy & Kennedy, 2005; Moura & Carvalho, 2008; Thornton & Houser, 2005; Trifonova, 2003). Projects using mobile phones and iPods were described, and these devices were found to be very effective for reviewing vocabulary whenever needed.

Another commonly researched theme was inclusion for those with special needs. Pozzi (2007) and Debevc et al. (2007) applauded m-learning's flexibility, allowing students to learn at their own pace, at school, or away from school if they were not able to attend

classes. It was felt that mobile learning was a natural fit for special needs learners, as their exposure to assistive digital technologies made them native digital learners.

The importance of teachers having the opportunity to explore and understand m-learning theory and technology before providing it to their students was observed by multiple researchers (Herrington, 2009; Lefoe et al., 2009; McCaughtry & Dillon, 2008; Wishart, 2009). They stressed that pre-implementation training for teachers was critical in order to understand the pedagogical implications of m-learning, and also to keep up with their digital-minded students.

### *M-Learning in Business*

#### *M-Learning in the Workplace*

The most common adaptations of m-learning in the workplace were mobile training and mobile tools for reference while working in the field. Several researchers (Deltec Infotech Pvt Ltd., 2009; Dzartevska, 2009; Metcalf & De Marco, 2006; Von Koschembahr, 2005) emphasized the time savings and subsequent cost savings afforded by m-learning. Productively using time that had traditionally been wasted while on business trips was emphasized as a valuable use of m-learning.

#### *M-Learning as M-Commerce*

M-commerce was a combination of Education and Business, because while it was used for business-related functions such as banking, it was also used for accessing everyday sorts of timely information, such as flight information or the location of the nearest restaurant (Adhikari, 2009; Kumar & Zahn, 2003; Siau et al., 2001). M-commerce provided opportunities for businesses to improve operations and to have new ways to interact with their clients.

### *M-Learning in Medicine*

While I did not locate a large amount of literature on m-learning in Medicine, the articles I did find contained a wealth of information. PDAs and mobile phones were widely-used devices for a variety of functions such as medical reference materials, drug calculators, and medication reminders. The most often-discussed m-learning function was the mobile drug interaction reference, which was credited with saving lives (Adataia & Bedard, 2003; Luo, 2004; Manhattan Research, 2008). Mobile devices as on-demand decision support tools were generally an important feature of m-learning in Medicine.

#### Types of Hardware

Mobile phones and smartphones, iPods, and PDAs were all used in each of the three main fields. Many of the activities performed on mobile phones required only basic cell phone functions, and not the more sophisticated features of the more costly smartphones. SMS, cameras, video recorders and players, and the mobile internet can all be found on today's basic phones, although it is possible that some of these features were available only on more advanced smartphones at the time of the earlier research. The terms "mobile phone" and "smartphone" seemed to be used interchangeably, and it wasn't always clear which of the two was being used in the research projects.

iPods were used most frequently in Education, but they did appear in the Business and Medicine articles as well. In all three fields, iPods were seen as effective revision tools, with lectures and corporate reports available anytime and anywhere.

PDAs were sometimes used like basic cell phones for SMS; however, specialized software was often installed on them for such activities as educational museum tours,

accessing memory-intensive medical software, and for “attending” virtual meetings. PDAs were definitely the most popular m-learning hardware type in Medicine.

### Types of Software

A wide array of software was used for m-learning in the three fields. The most variety was in Medicine, where researchers provided comprehensive lists of medical software available for PDAs. The most discussed types of software for mobile phones and smartphones in all three fields were SMS, mobile web, and email. For iPods, Apple’s proprietary iTunes was the only software available. Several articles mentioned companion software for podcast-related publishing activities.

### Pre-eminent M-Learning Researchers

The most often-cited researchers in m-learning were Houser, Kukulska-Hulme, Prensky, Quinn, Sharples, and Traxler. I reviewed at least one article by each of these m-learning experts, and they all appeared frequently on the reference lists of the articles I reviewed. Traxler’s and Sharples’ names commonly appeared as committee members and presenters at international m-learning conferences. I also consider Tapscott among the list of prominent m-learning researchers. While his research did not concentrate on m-learning per se, it provided invaluable information to the m-learning world, helping others understand the Net Generation’s needs in our increasingly mobile society.

### Where is M-Learning Taking Place?

The research in the articles I reviewed for m-learning in Education took place mostly in North America. This surprised me, as the preliminary research I had read prior to beginning the literature search indicated that North America lagged behind Asia and Europe in terms of mobile learning. I had expected the majority of m-learning research to come from

across the ocean. North American research appeared a number of times in Business and Medicine as well. M-learning in Education also took place numerous times in Europe, Asia, the United Kingdom, and in Australia and New Zealand. One article discussed m-learning in Africa, where the phenomenon was catching on quickly, due to increasingly available mobile phones. M-learning in Business occurred in multiple projects in North America, Europe, and Asia, and in one occurrence in Oceania. There were no Business research projects in the United Kingdom or in Africa. The Medicine m-learning articles were almost entirely from North America. One project took place in Europe.

#### Commonalities Between the Fields

The m-learning features most often highlighted across the three fields of Education, Business, and Medicine were flexibility, collaboration, “anytime, anywhere” access to information, and m-learning being stimulating to engage in. I was surprised to learn that collaboration was seen as a key component in m-learning. I had pictured solitary individuals hunched over their mobile devices, engaged in their own little world. However, the researchers often reported that m-learning was useful for connecting with other people to interact in meaningful ways.

#### Reflections

Although I am pursuing a graduate degree in education, I do not have an extensive background in teaching. While my graduate school cohorts were choosing research topics directly related to their teaching careers, I had trouble selecting a topic relevant to my job as a university administrative support worker. A conversation with a colleague one day touched on the subject of m-learning, which I had not previously heard of, and having always been interested in technology, my curiosity was sparked and a research topic was born.

Many times while performing the research for this project, I was asked which topic I was studying. When I replied that I was studying mobile learning, most people got a quizzical look on their face and asked, "What is that?" Nearly everyone I know owns a cell phone, an iPod, or a PDA, and uses them frequently, yet they have never heard of m-learning. They have no idea that by pulling out their mobile phone to look up information, they are taking part in the global phenomenon known as m-learning.

I believe this will change soon. Within a few years these same people or their children will use a mobile device as part of a class activity. Or they will use their phone to register for classes. Perhaps they will be sitting in a medical clinic and watch while the doctor investigates possible drug interactions on his or her PDA. Advertisements for mobile banking are appearing more and more frequently on television.

The earliest m-learning article I reviewed was from the year 2000, and it was the sole article I found from that year. I reviewed nine articles from 2009. There is no doubt that the interest in m-learning is rapidly expanding.

It is exciting to know that I am researching a topic few people have heard of, but they soon will know of this fascinating and rapidly evolving phenomenon, and many will use it in their daily lives, if they are not already doing so. Now that this research project is complete, my next goal is to attend an international m-learning conference to learn more about current trends in the field and to meet with experts in the field.

All throughout this process, I had the impression that relatively, I was one of the first m-learning investigators on a scholarly level. My analysis will provide a good starting point for future m-learning researchers. Teachers and faculty interested in employing mobile technologies in their classrooms can investigate the data to determine whether m-learning

may be right for them. School and university administrators may explore the articles in the education categories to find out what is being done at similar institutions. The results of this study can assist corporate trainers to provide staff with a new way of training using the mobile devices they already have. Medical administrators may be prompted to research how to increase office efficiencies by adding mobile software to their staff's PDAs.

A more personal reason for choosing m-learning as a research topic is that I am interested in pursuing a career in educational technology or corporate training. I knew that studying the literature to explore the opportunities afforded by m-learning would be a good start to my own career. Scholars such as Tapscott (2009) and Prensky (2001, 2005, 2008) theorized that the Net Generation is transforming society in terms of mobile device use, and a basic knowledge of m-learning in the selected categories should prove to be beneficial to my career goals.

### Recommendations

After poring over dozens of m-learning articles and reviewing the research, I offer the following recommendations:

1. More professional literature on m-learning needs to be written, particularly in Business and Medicine.
2. More m-learning conferences need to be held in the Western Hemisphere. Currently, most conferences are in Europe and Asia.
3. North American journals on m-learning should be created. To the best of my knowledge, there are no m-learning journals from the Western Hemisphere at this time.

4. Costs for mobile phone data plans should be reduced. Fees for data services like accessing the Web and email are very high and are cost prohibitive for many people. Europe and Asia have much lower phone usage fees, and we must follow their lead.
5. The University of Northern British Columbia (UNBC), my place of employment, should investigate m-learning as a pedagogical tool. We currently use the online course management systems Moodle and Blackboard, and m-learning could tie in with these systems. We would need to train interested faculty how to use the mobile technology and how to convert their course materials to a mobile-friendly format. I would also like to see course timetables, room numbers, grades, and class lists become accessible by mobile phone or PDA.
6. UNBC should investigate m-learning programs for English as a Second Language students. The majority of UNBC's ESL students are Asian. A mobile language learning program would be ideal for these students whose cell phones are an integral part of their daily lives at home; for learning, for commercial activities, and for entertainment.

As we prepare for the uprising of the Net Generation, I hope this research project should prove useful to educators, businesses, health practitioners, administrators, and to anyone interested in learning anytime and anywhere. I foresee exciting possibilities as mobile technology advances. We must continue the research to meet the needs of the mobile, digital age.

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## Appendix

## Numerical Listing of M-Learning Articles

	Author	Title	Field	Country of research	Hardware	Software
1	Moura, A. & Carvalho, A.	Mobile Learning: teaching and learning with mobile phones and podcasts	Education	Portugal	Mobile phone MP3 player	MP3 software
2	Manhattan Research	Health in the Palm of Your Hand	Medicine	United States	PDA Smartphone	Epocrates MerckManual 5-Minute Clinical Consult
3	Thornton, P. & Houser, C.	Using mobile phones in English education in Japan	Education	Japan	Mobile phone PDA	Email Web Video
4	Sharma, S. & Kitchens, F.	Web services architecture for m-learning	Education	United States	Mobile phone PDA	---
5	Lu, H., Lin, J., Lin, C., & Su, K.	A study of the construction of a mobile learning oriented mathematics learning activity	Education	Taiwan	Smartphone PDA	Web Arcade game
6	Trifonova, A.	Mobile learning: review of the	Education	United Kingdom Finland United	Mobile phone PDA	SMS MMS Web

		literature		States Taiwan		
7	Prensky, M.	What can you learn from a cell phone? Almost anything!	Education	United States Japan Europe	Mobile phone	Web GPS SMS
8	Metcalf, D. & De Marco, J.	mLearning: Mobile learning and performance in the palm of your hand	Business	United States	Smartphone PDA	Game software Web Email
9	Osborne, H.	In other words... Using text messages to improve medication adherence	Medicine	United States	Mobile phone	SMS
10	Kumar, S. & Zahn, C.	Mobile communications: evolution and impact on business operations	Business	Japan, United States	Mobile phone	Email Web SMS
11	Kleijnen, M., Wetzels, M., & de Ruyter, K.	Consumer acceptance of wireless finance	Business	The Netherlands	Mobile phone	Web
12	Boardman, D., Casalegno, F., McMurray, B., & Pomeroy, S.	Rethinking the mobile social shopping experience	Business	Spain	Smartphone	Facebook ToT software
13	Wagner, E. & Wilson, P.	Why learning professionals need to care about mobile learning	Business	United States	Smartphone iPod	Web
14	Adatia, F. & Bedard, P.	Palm reading: 2. Handheld software for physicians	Medicine	Canada	PDA Smartphone Pocket PC	Web Email Various types of medical software Microsoft

						Palm OS
15	Luo, J.	Portable Computing in Psychiatry	Medicine	Canada	PDA	Web Various types of medical software Microsoft Pocket PC Palm OS Adobe PDF Reader
16	Maag, M.	iPod, uPod? An emerging mobile learning tool in nursing education and students' satisfaction	Medicine	United States	iPod	iTunes PowerPoint Web RSS feeds
17	Scherr, D., Zweiker, R., Kollmann, A., Kastner, P., Schreier, G., & Fruhwald, F. M.	Mobile phone-based surveillance of cardiac patients at home	Medicine	Austria	Mobile phone	Web Email SMS
18	Motlik, S.	Mobile learning in developing nations	Education	Asia Africa	Mobile phone	SMS Email
19	Ardito, C., Buono, P., Costabile, M. F., Lanzilotti, R., & Pederson, T.	Re-experiencing history in archaeological parks by playing a mobile augmented reality game	Education	Italy	Mobile phone	Game software
20	Pozzi, F.	The impact of m-learning in school contexts: An "inclusive" perspective	Education	Italy	PDA	Email
21	Lefoe, G., Olney, I., Wright, R., & Herrington, A.	Faculty development for new technologies: Putting mobile learning in the	Education	Australia	Smartphone iPod	Camera Video recorder Audio recorder

		hands of the teachers.				
22	Herrington, A.	Using a smartphone to create digital teaching episodes as resources in adult education	Education	Australia	Smartphone	Video recorder Audio recorder
23	Naismith, L., & Smith, M. P.	Using mobile technologies for multimedia tours in a traditional museum setting	Education	United Kingdom	Mobile phone	Macromedia Flash Player Mobile guiding software Video
24	Wishart, J.	Use of mobile technology for teacher training	Education	United Kingdom	PDA	Web processor Word processor Spreadsheet Camera Video recorder
25	Evans, C.	The effectiveness of m-learning in the form of podcast revision lectures in higher education	Education	United Kingdom	iPod	Podcasting software
26	Dzartevska, A	Developing a mobile learning platform for a professional environment.	Business	New Zealand	PDA Smartphone	Specialized software
27	Von Koschembahr, C.	Optimizing your sales workforce through mobile learning	Business	United States	Cell phone PDA Smartphone	SMS Mobile web Email
28	Prensky, M.	Using cell phones for exams	Education	United States	Cell phone	Calculator Clock Mobile Web
29	Conkin Dale, J. & LeFlore, J.	Personal digital assistants: Making the most of them in clinical practice	Medicine	United States	PDAs Smartphones	Specialized software Mobile web Adobe Acrobat

						Windows Mobile Palm OS
30	Scornavacca, E., Huff, S. & Marshall, S	Understanding the value of interactive SMS for large classes	Education	New Zealand	Mobile phone	SMS
31	Levy, M. & Kennedy, C.	Learning Italian via mobile SMS	Education	Australia	Mobile phone	SMS
32	Polishook, M.	Reconceptualizing artistic practice with PDAs	Education	United States	PDA	Specialized music software
33	Brittain, S., Glowacki, P., Van Ittersum, J., & Johnson, L	Podcasting lectures: Formative evaluation strategies helped identify a solution to a learning dilemma	Education	United States	PDA	Apple QuickTime Broadcaster iTunes RSS
34	Georgia College & State University	The GCSU iPod Story	Education	United States	iPod	iTunes
35	Deltecs Info Pvt. Tech	Mobile training or blackberry training – a new buzz word in corporate training programs	Business	India	Smartphones	
36	Schachter, R	Mobile devices in the classroom	Education	United States	Smartphones iPods	Special education software Mobile web MS Office
37	Siau, K., Lim, E., & Shen, Z.	Mobile commerce: Promises, challenges, and research agenda	Business	Asia Europe	Mobile phones	Mobile web Specialized financial software
38	Debevc, M., Verlic, M., Kosec, P., & Stjepanovic, Z.	How can HCI factors improve accessibility of m-learning for persons with special needs?	Education	Europe	Mobile phones PDAs	Mobile web Specialized software

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39	Dyson, L.E., Raban, R., Litchfield, A. & Lawrence, E.	Addressing the cost barriers to mobile learning in higher education	Education	Australia	Mobile phones PDA's	Audio recorder Video Camera GPS SMS
40	McCaughy, N., & Dillon, S.	Learning to use PDA's to enhance teaching: The perspectives of preservice physical educators	Education	United States	PDA's	Camera Video

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