Mobile Learning: A summary of research progress since Mobile Learning: A handbook for educators and trainers was published by Kukulska-Hulme and Traxler in 2005.

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Abstract

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"The vision is clear, mLearning is the intersection of mobile computing and e-learning: accessible resources whenever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment, e-learning independent of time or space. What is less clear is where we are now and how we will deliver on this vision."

- *Dr. Clark Quinn (Quinn, 2000)*

Introduction

Virtually every student on every US college campus is engaged in the use of mobile learning through the use of mobile devices. And, employers are not far behind. The American Society for Training and Development (ASTD) reports 65% of employers have either deployed mobile learning or are planning to develop mobile learning (Wentworth & Green, 2011). What is less clear is how learners are actually using mobile devices to enhance their learning. The advent of smart phones and tablets is blurring the lines between laptop computing and mobile devices. However, most researchers agree that the term "mobile" generally refers to a device that is portable and personal (Naismith, Lonsdale, Vavoula & Sharples, 2006; Traxler, 2007). Mobile learning is advancing so rapidly that companies and learning institutions can hardly keep abreast of the latest developments. Consider these important facts:

- "Mobile has set the record for the fastest growth from zero to one trillion dollars in annual revenues" (Ahonnen, 2012; Quinn, 2012).
- "The adoption rate of mobile outpaces all past technologies including radio, television, and desktop and laptop computers" (Quinn, 2012, p1).
- Last year, there were more smartphones sold than personal computers (Glodget, Gobry, and Cocotas, 2012; Quinn, 2012).
- "People are more mobile than ever and they use mobile devices to help them live, work, and learn wherever they are" (Shank, 2010, p.9).

- Mobile banking has grown by 129% in the last 12 months (Neilson, accessed 2/5/13, http://www.nielsen.com/us/en/industries/telecom.html).
- The average teen sends or receives 3,339 text messages every month (Neilson, 2013).

Although mobile adoption rates are growing and the devices have the power to do sophisticated tasks, "Americans tend to adopt mobile phone for more personal rather than work related issues" (Sung & Mayer, 2012, p. 1329). The advancement of mobile technologies is so important that Google developed a "mobile first strategy" (Quinn, 2011, p. 2). "Mobile is the focus for the future, and all enterprise software will be mobile accessible" (Quinn, 2011, p. 2).

Mobile learning was born in the early 1970s when Alan Kay and others at Xerox Corporation Research Center in Palo Alto described object-oriented programming. Kay developed the Dynabook concept, an educational platform in 1968 which led his collegue Steve Jobs to the I-Phone in 2007 and the I-Pad in 2010 (Edible Apple, 2013)

Today when people hear the term "mobile learning", many people think only about taking e-learning courses on the small screen size of a phone, which is not always the case, resulting in dismissal of potential applications. The real value of for mobile learning may be course augmentation. Mobile learning provides the user with another channel for accessing curriculum in an informal learning environment and can provide the learner with additional content and practice (Quinn, 2011).

There are many definitions for mobile learning. Kukulska-Hulme and Traxler (2005) define mobile learning as the ability to engage in educational activities using a mobile device without the constraints of having to be confined to a specified physical location. Mobile learning is also defined as:

An activity that allows individuals to be more productive when consuming, interacting, with, or creating information, mediated through a compact digital portable device that the individual carries on a regular basis, has reliable connectivity, and fits in a pocket or purse. (Wexler, Schenker, Brown, Metcalf, Quinn, Thor, Barneveld, & Wagner, 2007, p.6; Quinn, 2011, p. 3; Quinn, 2012, p. 3).

Mobile devices are small, portable devices such as smartphones, PDA's, tablet PC's, laptop computers, and personal media players (Hulme & Traxler, 2005) and more recently e-books (Stephens, 2011). "Mobile devices are uniquely personal tools as well as having notable capability to support intense and ubiquitous cooperative learning, social interaction and sharing" (Kukulska-Hulme, 2011, p. 249). With the increased sophistication of mobile devices and their growing popularity, mobile learning is gaining increased attention (Chang, 2007; Demirbilek, 2010). The ubiquitous nature of learning via mobile devices may be beneficial to anyone who needs to learn on the go. Learners are no longer confined to a specific place or time in order to learn. Mobile devices give learners the choice to learn or access information when and where it is convenient for them.

Accessing information during "the moment of need" is important because people often realize they do not know how to do something when they need to do a task. Ketter (2010) says, "learning is trending to the user and the moment of need" (p. 39) and one of the main uses of a smartphone is access to current just-in-time information. Just-in-time training, or training just before or when information is needed, is becoming a growing trend because people can only retain so much information. Mobile devices may be a valuable medium for just-in-time training to help facilitate this type of learning. In addition to just-in-time training, mobile devices provide a valuable platform for accessing essential information important to the learner. This concept of

just-in-time training includes, but is not limited to, accessing information on a website, listening to a podcast, or checking emails.

This study reviews the progress that has been made in the field of mobile learning since the book Mobile Learning was published in 2005. Kukulskal-Hulme and Traxler's book is considered seminal in the field of mobile learning. In his review of this book, Sanjaya Mashra, Indira Ghandi National Open University, India ,states, "The book ... is a testimony to the current interests in the use of mobile technologies in education (http://www.irrodl.org/index.ohp/irrodl/article/view/437/877)." Another review of *Mobile Learning* in the British Journal of Educational Technology in 2006 reports, "the book should be on the shelves of all those working with corporate e-learning" (p. 493.)

Research Gap

With the increased sophistication of mobile devices and their growing utility, mobile learning is gaining increased attention (Chang, 2007; Demirbilek, 2010). As technology continues to evolve and mobile devices grow in popularity and capability, the need for more research pertaining to mobile learning is apparent. Since 2005, there have been numerous changes in the way mobile devices are used and what they are capable of doing. This research paper strives to review the literature that has been conducted since 2005 and determine if research conducted in this timeframe addressed the recommendations Kukalska-Hulme and Traxler (2005) suggested in *Mobile Learning*. And, determine *w*hat is currently happening in the field of mobile learning?

According to Rheinghold the use of mobile technology is a trending topic in education. Educators should prepare to create material with mobile devices in mind so that mobile technologies can be incorporated into their teaching (Rheingold, 2003 as cited in in Ally, 2008).

Hulme and Traxler's 2005 book on mobile learning is a very detailed and comprehensive account of the industry of mobile learning. At the conclusion of their book, the authors offered several recommendations for areas for future or continuing research. This research study seeks to investigate which suggestions have been accomplished and which ones have not. This study is important to further the ever-changing knowledge base of mobile learning.

Importance of the research study

The results of this study are beneficial to educators and trainers in higher education and the workplace settings. Teachers and trainers need to understand how mobile devices are changing the learning environment. More specifically, teachers and trainers need to learn how to effectively use this technology. It may also be beneficial for employers to look at how students use mobile devices in school to help them transition and learn in the workplace. Understanding how learners are using mobile devices to access educational information can be beneficial to instructional designers can help them cater presentation of material in ways learners need to use information. This method of presentation will make it easier for learners to access and use the information presented in the classroom, and therefore allow higher levels of learning and increased information retention.

Research question(s)

The following research question and sub-questions were developed for this research study:

How much progress has been made in the field of mobile learning since the Kukulska Hulme and Traxler's (2005) review?

- What research has been conducted since Kukulska-Hulme and Traxler's (2005) *Mobile Learning* publication?
- What progress has been made on the future-research suggestions made by Kukulska-Hulme and Traxler in their 2005 publication, *Mobile Learning*?

Hypotheses

Hypothesis 1-

Significant practitioner-based information but little empirical research has been conducted since 2005.

Hypothesis 2-

- Some progress has been made in satisfying the requirements for future research as outlined by Kukalska-Hulme and Traxler in 2005.

Definitions of terms

Term	Definition	Source
Mobile Learning	Ability to engage in educational activities without the constraints of having to be confined to a specified physical location.	(Kukulska-Hulme & Traxler, 2005
Mobile Devices	Small portable devices such as smartphones, PDA's, tablet PC's, laptop computers, and personal media players.	Kukulska-Hulme & Traxler, 2005
Learning	Any relative permanent change in behavior, cognition, or affect that occurs as a result of one's interaction with the environment.	(Werner & DeSimone, 2009)
Handheld	A hand-sized computer that can be kept in a pocket and is easily used while being held. E.g. palmtop, a pager, mobile phone, a PDA etc.	Kukulska-Hulme & Traxler, 2005
Alternate Reality	A narrative thread or created world that parallels the real world but is fictional.	Quinn, 2011
Android	Google's mobile operating system.	Gruman, 2011
App phone	A smartphone capable of extension via software applications (apps).	Gruman, 2011
Apps	Software applications able to be installed on smartphones.	Quinn, 2011
Augmented Reality	A mechanism that provides information in addition to existing senses, so auditory or visual information annotates the existing world.	Quinn, 2011
CDMA	A mobile telephony standard used broadly in the U.S. and a few other countries.	Quinn, 2011
DITA	Darwin Information Typing Architecture, and XML standard that supports structured development and flexible delivery system.	Quinn, 2011
eBooks	Delivery of books (text, images, and even media) on mobile devices.	Quinn, 2011
ePub	A standard for delivering eBooks.	Quinn, 2011
eReader	A device dedicated to reading eBooks, e.g. Amazon's Kindle, Barnes and Noble's Nook, or the Sony Reader.	Quinn, 2011
Feature Phone	A typical mobile phone with built-in Features, typically including camera and Web-browser, but not expandable with new software applications.	Quinn, 2011
GPS	Global Positioning System, hardware that uses geo-stationary satellites to triangulate position.	Quinn, 2011
GSM	Global System Mobile, the mobile telephony standard more ubiquitous around the globe.	Quinn, 2011
Handheld Game	A mobile platform dedicated to gam playing but with increasingly wide variety of capabilities: the Nintendo	Quinn, 2011

Term	Definition	Source
	DS line and the Sony PSP are prime examples.	
iOS	Apple's mobile operating system that powers the iPad and iPhone (and iPod Touch)	Gruman, 2011
iTunes University	Apple's resource for education-related media files.	
Java ME	Java Mobile Edition, a development environment for feature phone applications.	Quinn, 2012
Laptop	A computer sized to be portable.	Quinn, 2011
Media Player	A device largely dedicated to playing media, such as audio or video.	Quinn, 2011
MMS	Multimedia Messaging System: Text messages that can include media such as photos and videos.	Quinn, 2011
MP3	Compression standard developed by the Motion Picture Experts Group (MPEG) for audio files. Popular web standard.	Wu & Ming , 2012
MP4	Video compression standard developed by the Motion Picture Experts Group (MPEG) for audio and video . Popular web standard.	Wu & Ming , 2012
Netbook	A laptop computer diminished in size and capability to optimize portability and battery life.	Quinn, 2011
OS	Operating System, The platform-specific software that supports applications.	Quinn, 2011
PDA	Personal Digital Assistant, a mobile device expandable with software but without voice capabilities.	Quinn, 2011
QR Code	A standard for 2-D barcodes to store text information such as URL's, phone numbers or messages.	Quinn, 2011
SDK	Software Development Kit for specific operating system or OS.	Quinn, 2011
Smartphone	A mobile phone with a powerful data capabilities including Internet access and varied hardware often including cameras and geolocation sensors, capable of being expanded via software applications; also known as an app phone.	Quinn, 2011
SMS	Simple Messaging System, also know as text messaging, a protocol that supports text messages over mobile phone networks.	Quinn, 2011
Symbian	Nokia's mobile operating system, being replaced with Windows Phone 7 in their forthcoming smartphones.	Quinn, 2011
Tablet	A mobile device with a larger form factor than a phone, with rich data capabilities, and typically operated with a touch screen.	Quinn, 2011
webOS	Palm's latest mobile operating system now purchased by HP.	Quinn, 2011
Windows	Microsoft's mobile operating system.	Quinn, 2011

Term	Definition	Source
Phone 7		
Wi-Fi	A standard for wireless local area networks.	Quinn , 2012
XML	eXtensible Markup Language, a; standard that supports development of delivery independent information.	Quinn, 2011

Brief overview of the study

The purpose of this study is to gain a better understanding of what research has been conducted since Kukalska-Hulme and Traxler's landmark publication, *Mobile Learning*. Specifically, the study seeks to investigate selected research on mobile devices and their use in educational settings. To do this, the researcher reviewed and analyzed the relevant literature that focuses on the recommendations for future research made by Kukalska-Hulme and Traxler. The researcher compiled the existing research in this topical area to create a comprehensive overview of the new information added to the field since the book, *Mobile Learning,* was published.

Significance of the Study

Scope

This research paper seeks to uncover what progress has been made towards answering the questions laid out for areas of future research in Mobile Learning written in 2005. Background information on the technology, hardware, and inner workings of the actual mobile device will be provided, but this research will not go into great depth of the programing or technical details of the mobile devices. Instead, it will focus on how and why mobile devices are utilized. This study will only look at existing research to analyze what types studies have been conducted on mobile learning. No new information was created in the course of this study; existing studies were compiled and synthesized to create a comprehensive review of work that has been created to address *Mobile Learning*'s suggestions for future research. The researcher limited the scope of

the paper to information solely pertaining to developments and progress made on the topical areas laid out by Kukalska-Hulme and Traxler.

The following chapter includes a discussion of this study's methodology and in-depth investigation of the conceptual and theoretical frameworks used to guide the study. Chapter two includes an extensive literature review of mobile learning since 2005.

Literature Review

Methodology

The literature review was performed to determine the progress on the literature since 2005 when Kukalska-Hulme and Traxler wrote their definitive book on mobile learning which is a new and emerging field. Kukalska-Hulme and Traxler identified 15 areas for future research.

To determine a manageable set of search terms Kukalska-Hulme and Traxler's 15 areas for future research were mapped to the 4 key areas shown in table 1: Mobile design, mobile learner, mobile devices and types of mobile learning. Because the literature review's focus is on research the following search terms were used:

"types of mobile devices" + "research"

"types of mobile learning" + "research"

"mobile learners" + "research"

"mobile learning design" + "research"

Premier be EBSCO database and Google scholar were used to conduct the literature review.

The book Mobile Learning by Kukulska-Hulme and Traxler (2005) had fifteen topics for future research. The researcher developed four categories that covered all of the fifteen areas of suggested future research. The four categories are: Mobile Learners, Types of Mobile Devices, Types of Mobile Learning and Mobile Design Considerations. Table 1 shows the fifteen topics for future research and how each area for suggested research fits into one of the four categories.

	Mobile Design Considerations	Mobile Learners	Types of mobile devices	Types of mobile learning
What the ideal mobile learning device would be like, and how many types are needed.			x	
How to specify mobile learner requirements and assess mobile usability from a pedagogical pint of view.		x		
The use of mobile devices as communication tools in education and training.				x
The benefits and constraints of mobile technology for collaborative learning and mentoring.				x
Understanding learners reasons for selecting particular technologies		x		
Why devices are most valued, e.g. be it for reference, audio notes, or location specific information.			x	
Role of mobile learning in support of e-learning, eg on courses with dispersed learners				x
Patterns and contexts of mobile use.	x			
Differences between use patterns across disciplines and across pedagogical approaches.	x			
New ways of recording learning experiences, e.g. applications involving reflective logs and personal development profiles.				x
The sharing of content and annotations between mobile users.			x	
Creating gateways between networks, integrating parts of existing institutional social and technical resources, and making them available on mobile devices.	x			
The provision of campus synch stations.	x			
The provision and display of new services, and facilities of downloading of manuals and course instructions.			x	
Portable speech recognition and text-to-speech software.			x	

Table 1: Categories for research

Conceptual Framework

The researcher developed the graphic in Figure 1 to conceptualize the process of mobile learning. Theoretically, mobile learning should begin with the learner and design considerations. The designer should understand the limits and the benefits for displaying content on a mobile device and what the learner needs to accomplish. When designing the content the designer should focus on the learners needs. Ultimately, the learner is the target audience and ultimately the learner using the mobile device to access the content they need to do is the goal of the designer. The design process is cyclical. The designer continually refines the learning to ensure the learner can learn/do what they need making the best use of the technology available. The designer must also ensure that the learners can use the device to access content. Typically the learner will not be aware of the design process or that the designer took their needs into consideration. The learner will just be aware that they can access the content with the device. They will be aware that the designer took their needs into consideration when accessing the content. If the content is not developed in such a way that the learner will retain the information or directly apply it then the designer did not take learner needs or design considerations into account.

Before mobile technology can be used effectively, digital curricula must be designed and delivered properly so that it will be easily understood and meaningful to the learner (Ally, 2008). Prior to designing the material, it is important to analyze the needs of current and future learners to see how they perceive learning from these devices.

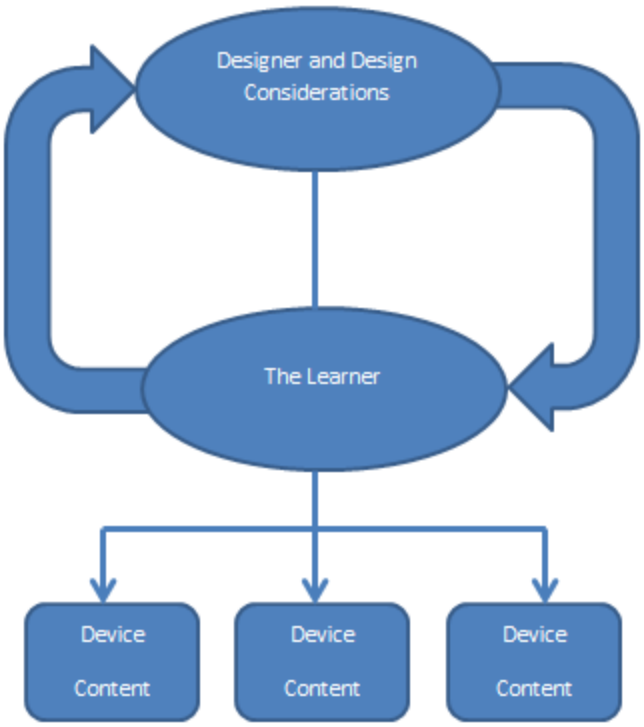

Figure 1. How mobile learning process should work.

The researcher developed a graphic in Figure 2 that depicts how the researcher perceives how mobile learning is currently being developed. The designer starts out with design considerations, in some cases the neglects the design consideration altogether. The designer takes the content and modifies it for the mobile device. This is a cyclical process were the designer steps back and reflects on what they think should be different, before finishing the changes to the device. After all the content has been modified for the mobile device it is pushed out to the learners to access without taking the learners considerations into consideration. This is not an effective model because it is difficult to crate content for the learners if you do not take their needs into consideration.

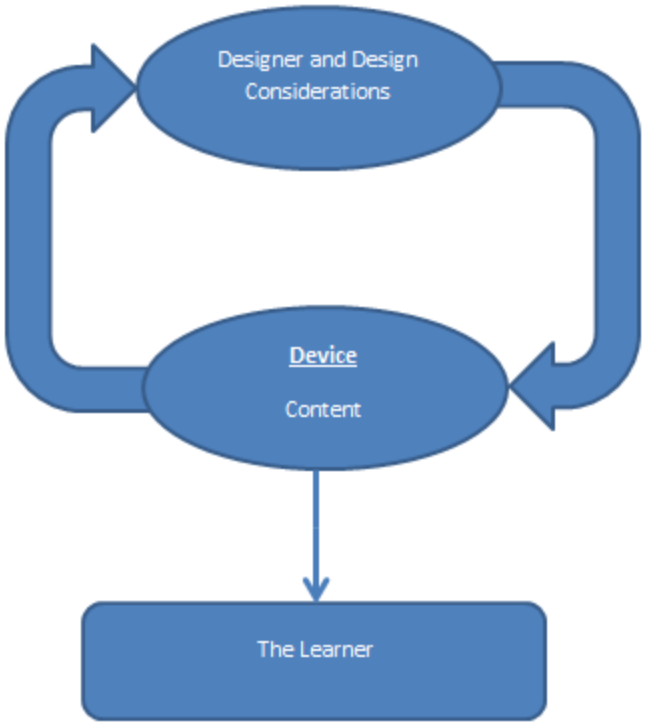

Figure 2. The Current Flawed instructional design model for mobile learning

The researcher designed the graphic in Figure 3 to convey what this paper is trying to achieve and conceptualizes the concept of mobile learning. Mobile learning originated as a sub section of e-learning. While e-learning is learning from a computer, or an electronic device. Mobile learning is learning from a mobile device. For the purposes of this paper mobile learning was broken up into four categories: design considerations, the learner, types of mobile devices, and types of mobile learning. Because these are all parts of the larger topic of mobile learning there is a lot of overlap between the categories. The relevant research in this field will be conducted and analyzed. The purpose of the data collection and analyzing the data is to find research gaps. Finding the research gaps allows the researcher to make suggestions for future

research so other researchers will hopefully target those gaps in future research closing those gaps.

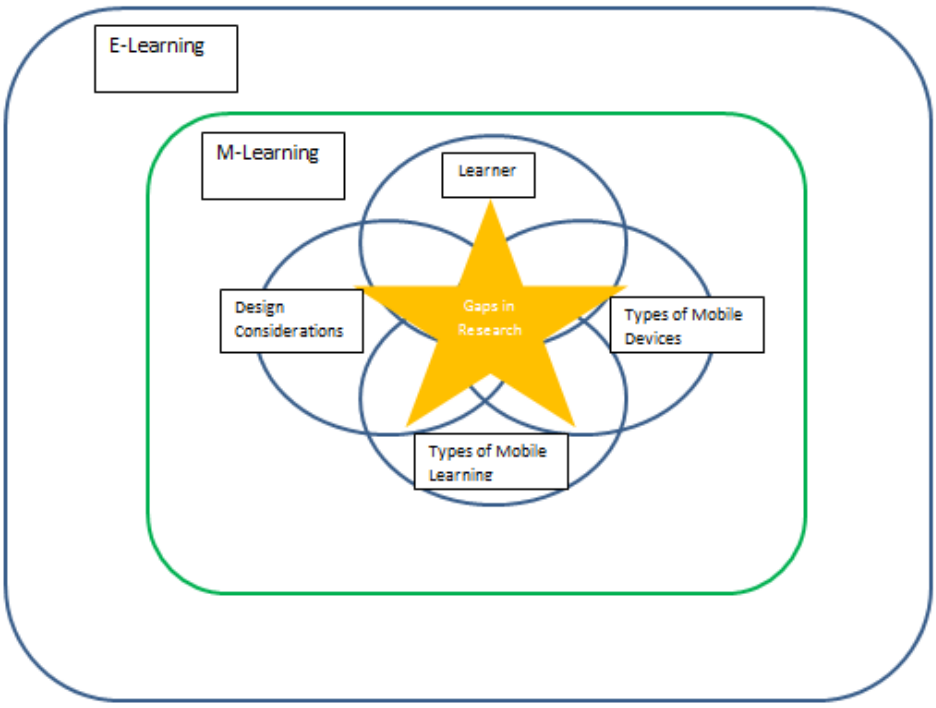

Figure 3. Conceptual framework of mobile learning.

Learning Theory and Mobile Learning

Several learning theories provide a framework for understanding how mobile devices can facilitate learning:

- Cognitive Information Processing
    - Cognitive Load
    - Chunking
- Constructivism
- Theory of Multimedia Design

Cognitive Information Processing

The Cognitivist paradigm covers how learners process and understand information. Two ideas within the cognitivist paradigm that help to explain how mobile learning are Cognitive Load and Chunking.

Cognitive Load

Cognitive Load theory is concerned with learning complex tasks and not overwhelming the learner with the steps it takes to create meaningful learning (Gog, Paas, & Sweller, 2010). The limited capacity of working memory is also a focus of Cognitive Load Theory (Gog, Paas, & Sweller, 2010). Instruction should be designed so that it reduces the load on the working memory

by cutting processes that are not essential to learning and focusing on processes that are essential to learning (Gog, Paas, & Sweller, 2010).

This is important concept to take into account when designing any kind of learning mater but especially when designing content for mobile devices. Since humans only have a limited capacity in their working memory and all information has to pass through the working memory before going to the long term memory, it is important not to overload the learners working memory. This means that and lot of content cannot be presented at one time or there is a risk that the learner will be overloaded and will not retain any more of the content. This is especially true when designing on mobile devices. Due to the small screen size not much information can be put on the screen at one time. In a way the small screens help to the amount of information that can be presented at one time.

Chunking

Miller states that a person can remember 7±2 pieces of information. If the information is chunked then they can remember slightly more information. Chunking refers to breaking the content up into meaning full units, making it easier to remember. If the content is chunked, then the user can remember a little bit more of the information than just the 7 pieces of information.

One of the advantages of mobile learning is the user can access the information as the information is needed. Thus, the users are not required to remember more information than what they need. Since, users can readily access information it allows them to free up their memory for the more complex difficult task that they use more frequently. People used to either have to remember phone numbers, write them down, or use a telephone book. Currently many people do not know very peoples phone number because the numbers are saved in their phone. All they

have to remember is the person's name, freeing up their memory for other things. Additionally, you can attach a picture to the person's name and phone number to ensure you are calling the correct number. It can also be set so the picture pops up on caller ID just in case you do not recognize the name of the person you just met who is calling you. This can help the individual focus on other tasks while the electronic device remembers the content.

> Mobile devices are suited for 'chunking' due to their smaller screen sized and storage capacity. The distillation of material into 'Knowledge bytes' to be consumed by the learner, offers true flexibility of 'time, place and pace'. The diversity of media that can now be delivered by these devices adds more depth to their application. (Mellow, 2005, need page #)

Constructivism

"Constructivism has multiple roots in the psychology and philosophy of this century" (Perkins, 1992, p.49). Central to the idea of Constructivism is that learning is active, learning is not all about respond to stimuli, but rather, engaging and seeking to make sense of ideas (Perkins, 1992). Burner (1985) stated that most powerful expressions of what constructivism is, came from Jean Piaget. According to Piaget's constructivism the world is not made by found by the learner according to preexisting rules and their past experience (Bruner, 1985). Bruner states that constructivist learning emphasizes learners that are self-propelled in their operations on the way toward mastery (1985). Learners do learn based on their past experience. One of the best models of the learner is to inquire about what the learner is doing and if there is a purpose behind what they are doing, or is it for some other reason.

Many of the principles of the constructivist learning theory apply to mobile learning. In Bruner's article he stated that constructivism emphasizes learners who are self-propelled. Much of mobile learning also requires learners to be self-propelled or self-driven. Just because a designer creates mobile accessible content does not mean that the learner will view the content. The learner has to be self-propelled or self-motivated to want to view the content.

There are multiple ways of using mobile devices to present a vast array of different styles of mobile content. One way is the notion of just-in-time training or electronic performance support systems. These types of mobile learning are targeted at providing content to the learners just before and or during the moment of need to help guide learners through a task that they did not know how to do or could not remember all of the steps. This helps to make the learning a more active process and help the learners experience by doing. It also gives learners experience that they may not have been able to get without the use of these tools. This experience can be used to reflect on and construct new knowledge.

Theory of Multimedia Design

Mayer's theory of Multimedia Design is an instructional design theory that describes how to design effective learning material rather than a learning theory that explains how individuals learn. The Multimedia Design Theory draws from several other theories: Paivio's, Dual Coding Theory; Baddeley's, Model of Working Memory, Sweller's Cognitive Load Theory, and Wittock's Generative Theory, and Mayer's SOI Model of Meaningful Learning (Mayer and Moreno, Multimedia Learning). Do I (need to cite these authors since even if I did not use their information?) Multimedia Learning theorizes "the learner possesses a visual information processing system and a verbal information processing, such that auditory narration goes into the verbal system whereas animation goes into the visual system" (Mayer and Moreno, Multimedia

Learning, p.2). Thus, "multimedia learning occurs when students receive information presented in more than one mode, such as pictures and words" (Mayer, 1997). When engaged in multimedia learning, the learner is engaged in three cognitive processes, which are selective, organizing, and integrating (Mayer and Moreno, Multimedia Learning; Mayer, 1997).

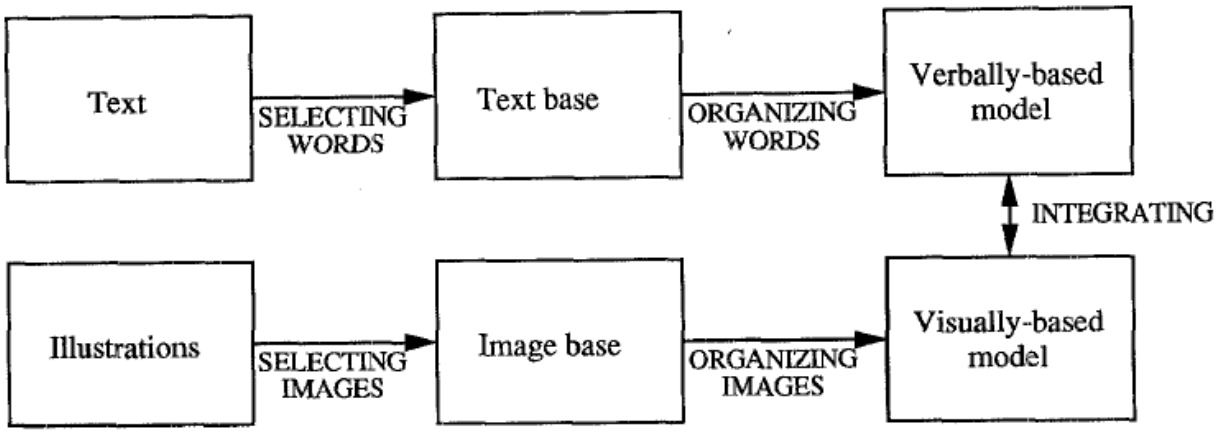

Figure 4. Conceptual framework Multimedia Design (Mayer, 1997, p. 5)

Mayer, (1997) developed a set of five principles on how to use multimedia. See Table 3, for the five principles Mayer developed. These five principles are important because it explains to the designer ways to design material to increase the learners engagement and retention of information.

Multiple Representation Principle	It is better to represent an explanation in words and pictures than solely in words.
Contiguity Principle	When Giving A multimedia explanation, present corresponding words and picture contiguously rather than separately.
Split- Attention Principle	When giving a multimedia explanation, present words as auditory narration rather than as a visual on-screen text.
Individual Differences	The foregoing principles are more important for low-knowledge than high-knowledge learners, and for high-spatial rather than low-spatial learners.

Principle	
Coherence Principle	When giving a multimedia explanation, use few rather than many extraneous words and pictures.

Table 3. Mayer's Multimedia Learning 5 principles (Mayer, 1997).

The Theory of Multimedia design is important and relevant to mobile learning because it explains design techniques to help increase the learner's retention of information when designing multimedia. Because mobile devices are electronic everything that is designed and put onto the device will be some sort of multimedia. Designing and presenting the multimedia in an effective way will help the learners to have a better experience learning from the mobile device and to retain more of the information.

Review of Seminal Literature on Mobile Learning

Mobile Learning

With the basic theoretical framework in place, it is important to look at the literature that specifically addresses mobile learning. Mobile learning gives the learner the ability to learn wherever and whenever without being constrained by learning in the classroom (Hulme & Traxler, 2005; Beckmann, 2010; Ally, 2008). Mobile devices and tools are constantly being developed (Quinn, 2012). When using mobile devices, the learner does not have to be at a fixed pre-determined location to attend training or class. Increasing usage of mobile devices by students and employees makes mobile learning a viable option. According to the International Telecommunication Union, there are 103 cell phones per 100 people in the US. In addition, 286 million have mobile broadband service. El-Hussein and Cronje agree, saying "mobile learning as an education activity makes sense only when the technology in use is fully mobile and the users of the technology are also mobile while they learn," (El-Hussein & Cronje, 2010, p14). Emphasis is place on mobility of learning since the term is "mobile learning" (El-Hussein & Cronje, 2010, p.14). The increase in wireless technology such as Wireless Fidelity (Wi-Fi) Worldwide interoperability for Microwave Access (WiMAX), Third Generation (3G), and Fourth Generation (4G) allow mobile devices to access information without being physically connected (Moses, 2008; Ally, 2008; Trinder 2005 found in El-Hessen & Cronje 2010 look up). Learners are not forced to be in a brick-and-mortar classroom and are free to customize their own learning experience, anytime or anywhere (Heiphetz, 2011). Mobile devices serve as a medium to deliver active learning curriculum such as experiential field work, simulations, role plays, and games (Leigh & Spindler, 2004). Other than email and calendar functions, the potential of mobile

application is largely untapped (Heiphetz, 2011). Heiphetz also believes "mobile technology can become an engine of business learning in the same way the worldwide web became the backbone of learning during the previous technological revolution" (Heiphetz, 2011,need page citation).

> The essence of mobile is, to me, augmenting our mental capabilities wherever and whenever we are. Our brains are very good at pattern-matching and pretty good at executive function, but very bad at rote memorization and complex computations. Computers, conversely, are the reverse and from a problem-solving perspective we are far more capable when we combine the two. Mobile devices do that and more. (Quinn, 2011, p5)

Learner

Like with all types of learning a discussion of mobile learning should begin with the learner (Basaeed, Berri, Semerly, & Benlamri, 2007). It is important to understand who learners are, what they want to learn, and what are the advantages/disadvantages of mobile learning from the learners perspective.

Mobile Learners

Mobile learners can be anybody with a mobile device and access to a training module or access to information that the user taps into at the moment of need. With a 103 mobile devices per 100 people in the United States, many people have the devices required to learn on the go. Younger people are more likely to utilize mobile devices for mobile learning (iPad study).

The American Society for Training and Development (ASTD) reports that 85% of companies give mobile devices to some or all of their employees. In addition, 65% of mobile workers use a tablet (infograph, 2013). Of the 2,793 training participants surveyed by Scullard

and Sugerman (2011), 42 % said they used mobile devices, at least sometimes to very often, to take training classes. Additionally, Scullard and Sugerman found that 24% of respondents surveyed said that they used mobile devices to develop work-related skills.

Corporations, universities, and learners themselves are making a push to leverage mobile learning. The American Society for Training and Development (ASTD) reports 65% of employers have either deployed mobile learning or are planning to develop mobile learning (Wentworth & Green, 2011). The same ASTD study found a correlation between high performance companies and companies offering mobile learning. This is supported by another study that found that in general, high-performing organizations are more likely to adopt emerging technologies to support performance (Green, 2011).

Clough, Jones, McAndres, & Scanion, surveyed all PDA and Smartphone users age 18 to 65 plus and found innovative use of mobile devices to support informal learning (2008). Advancements in technology make it easier for users to tap into social networks, device apps, websites, etc. to learn what they need to know at any given time (Maxwell, 2012; Meigan and Shellenbarger , 2012). Learners from grade school to medical doctors are taking advantage of the devices to pursue formal learning as well (Meigan and Shellenbarger, 2012).

Dresselhaus and Shrode (2012) surveyed 25,000 students at Utah State University (USU) and found that 54% of undergraduates and 50% of graduate students used their mobile device or phone for formal academic training with the business school 63% and 54% of engineering school; while students from the other schools reported using mobile devices for academic purposes 50% of the time. Also of note from the USU study, when asked, “If the library resources were easily accessible on your devices, and if you had such a device, how likely would you be to use any of the following for assignments or research? The students reported that they

would likely or very likely use: Smartphone--70.2%, iPad—46.9%, e-book reader--45.9% other devices—63.2% (USU study).

Reasons for using Mobile Learning

Mobile technology plus high-speed access to vast amounts of information on the Internet via smart phone, tablet computer, netbook and e-reader has empowered learners to seek out just the information that they need; anytime, anywhere (Kukulska-Hulme, 2010). Learners use mobile devices for informal learning more often than formal learning (find source).

While still second to informal learning, formal mobile learning is also on the rise. Scullard and Sugarman found that more than half their survey participants reported downloading mobile apps with the purpose of improving their job performance (2011). When asked what kinds of app they used respondents reported: 47% apps to help review content of the course,47% apps to connect with online training courses, and 39% apps to rehearse a new skill (Scullard and Sugarman, 2011).

Whether informal or formal, learner satisfaction is linked to whether or not learners get what they are seeking from the training (Joo, Lim, & Park, 2010).

Advantages and disadvantages of mobile learning

The advantages and disadvantages of mobile devices are numerous and the interplay between the two can be unexpected. For example, 8.6 trillion SMS text messages are sent each year (Kelly, 2012). Sending texts from small keypads is not easy but still 75% of teenagers send an average of 60 texts a day (Kelly, 2012) . Another example, is professionals who read massive amounts of information from small screen devices at a much slower reading speed over big screen devices because it may be more convenient to access the information via the mobile device.

Advantages

Mobile learning offers significant advantages over traditional instructor-led training. Users say mobile learning: offers anytime anywhere access, supports informal learning and collaboration, provides learning just in time or at the moment of need, offers opportunity for just-enough, and just-in-time training and electronic performance support systems (EPSS).

The primary benefits touted for mobile learning is that it offers anytime, anywhere access. Learners do not need to be located in a specific geographic location to be able to participate in either informal or formal learning. This means a tremendous opportunity to provide meaningful training to field support staff. For example, what better time to review installation instructions than in the field while installing the equipment?

Another advantage of mobile learning is that it supports informal learning, collaboration, and learning. The pervasiveness of mobile devices paired with increasing number of avenues for social network is providing what Kukulsa-Hulme (2010) describes as invisible tutoring. There is no limit to what people can learn, share, and collaborate.

Just-in-time training enables user to access training when and where they need it. EPSS systems go one step further and actually help users do the task at hand while providing opportunities for training.

Mobile learning provides an excellent opportunity for the use of just-in-time training and Electronic Performance Support Systems (EPSS). EPSS systems combine learning and doing. Employees can use EPSS to accelerate job performance while at the same time limiting the amount of training they need to do their job. Not only do organizations benefit from employees getting productive work done while they learn but learners retain more; learners retain up to 90% of what they do compared to retention rate of 10% of what they read (Trotter, 2007). Trotter

found that this type of training is an effective way to diagnose and fix mechanical problems and can accelerate learning. Researchers are just beginning to tap into this vast potential. Foley, A. & Luo, H. (2011) have begun large prototyping projects for an EPSS.

Disadvantages

There are several disadvantages of m-learning over traditional instructor-led classes: Usability issues, direct own study and execute long term strategies, difficult to facilitate interactions between instructor, student, and classmates, no control over the learning environment or type of device, and costs more to develop (Find Source).

Usability issues have been cited as the primary disadvantage of mobile learning. Researchers have called for enhancing human-computer interaction design (HCID) for years (Faiola & Matei, 2010). Just the physical limitations of size and the impact of reading speed is enough to give instructional designers pause for consideration. Neilsen (2010) found iPad users read 6.2% slower than they read a printed book; Kindle users read 10.7% slower on the Kindle than a printed book. There are also technical and physical limitations of small-screen hand-held devices (Jeng, Wu Huang Tan and Yang, 2010). Mobile devices have limited screen size, battery length and for most applications require a high-speed internet communication.

Unlike instructor-led training, most forms of mobile learning require self-directed or self-regulated studies. It is up to the learner to determine, what, when, and how to study. Kornell and Bjork (2007) , researchers at the University of California, looked at the self-regulated studies strategies of undergraduate psychology students. While students knew strategies for long-term learning, left to their own devices, they reported that they did not follow the strategies but rather resorted to a triage strategy. The success of remote learning is predicated on the learner's ability to direct their own learning. However, it is important to note that a learner can do a good job of

managing their learning without completing an entire mobile course. Remote learners who clicks out of an mobile learning session, after they learn what they need to complete a job task, but before they complete the module may be doing a good job of self -directed learning.

Mobile learning researchers have noted the importance of incorporating interactivity into mobile learning (Boticki, Chee-Kit, & Lung-Hsiang, 2011; Ismail & Azizan, 2012).. Ismail & Azizan found that users want to be able to interact with their instructor as part of the mobile learning experience (2012). The researchers also noted that future studies should look at the type of interaction that would best suit the learner's needs.

Another disadvantage that in some cases is the instructional designer has no control over the learning environment (Magal-Royo, Peris Fajarnes, Montanana and Garcia, 2007). Stone (2010) points out that the instructional designer must be aware that there is no dedicated equipment, network, or training space. There are also no standard interfaces or operating system across all mobile devices so the learner must adapt to an interface that is not specific to the device that they are using or the designer must create unique mobile learning modules for each device.

Design Considerations

Mobile design is a necessary act in training by m learning professionals (Murphy, 2006). When designing learning content it is important that the m-learning professional design for learning and is creative so the learner does not find the content dry (Murphy, 2006). A creative approach to mobile learning design can help to encourage learner participation and interest (Murphy, 2006).

In an article Lima, Filho, Riberio, Andre, Viana, and Junior present four catagoies of design considerations when designing content for mobile devices (2011). The four categories are: pedagogical, socio cultural, economical, and technical.

Pedagogical

Lima et. Al. discuss the important points of the pedagogical perspective are: "learning theories, presentation and quality of content, organization, and support of student feedback" (2011, p.4). To effectively design learning content for mobile devices principles of instructional systems design (ISD), learning theories, learner styles, and preferences need to be taken into consideration (Bhalausesa and Arshad,2012). ISD helps the designer to create standard learning modules based on the instructional design guidelines (Bhalausesa and Arshad,2012). Learning styles and preferences refers to the learners wanting to learn in one of three ways: individual, collaborative, or situated learning (Bhalausesa and Arshad,2012).

Learning material alone will not be enough, the material needs to be surrounded with information directing the learner on how to use or apply the material being presented (Bhalausesa and Arshad,2012). Since the mobile learning field is still so new, pedagogical are still being developed for implementing with mobile devices (Bhalausesa and Arshad,2012).

Socio Cultural

The socio cultural aspect refers to "attitudes, social trends acceptability, methods of interactions, and sociability" (Lima et. Al., 2011, p.4). These are all important design considerations. The learner's attitude toward mobile learning makes a big difference on the success. If the learner does not like the training because it is different than they expected based on social trends, or they do not like the method of interaction and refuse to use the mobile training then it is not effective method of learning. Conversely, if the learner as a good attitude

and is really excited and eager to use the tool they will be more likely to learn. How the mobile training is designed based on cultural norms and expectations can have a big impact on the learners experience.

Economical

This section is about the costs associated with mobile learning. It is important to consider all of the costs that go into a mobile learning initiative including, "per use cost of the application, licensing, data storage, agreements with software developers, and cost benefits" (Lima et. Al., 2011, p.4). Cost is an important factor to consider deciding if funds are available to afford the initiative and if the inactive will provide benefits to warrant spending those funds.

Technical

There is a need to review the technology capabilities of the device to make sure the device is compatible or capable of delivering what the designer is trying to design (Bhalausesa and Arshad,2012). Mobile device technology increases every day, storage and processing power is continuing to get better (Bhalausesa and Arshad,2012; Corbeil and Valdes-Corbeil, 2007). Because the technology is changing so rapidly it is important to check the specifications for the device the content is being designed for to truly understand the capabilities for that particular devices.

Limitations of the mobile devices can make it difficult to develop and present effective learning material (Bhalausesa and Arshad,2012). Mobile devices cannot save and transmit large amounts of information, have a limited scree size, and have limited processing power (Bhalausesa and Arshad,2012). This is important information to know when designing content for mobile devices. Content should be designed so that it has a small file size that does not

require too much processing power, and a limited amount of information should be placed on the screen because of the small screen size (Bhalausesa and Arshad,2012).

There is a lot that goes into designing mobile training. The designer has a lot of things to consider and implement to produce successful mobile learning experience. Lima et. Al presented the design considerations in four categories pedagogical, socio cultural, economical, and technical (2011). Another big factor in mobile learning is the learner. Ultimately, the learner is the audience who the designer is putting the content together for. The next section is all about the learner.

Types of Mobile Devices

Mobile learning gives the learner the ability to learn wherever and whenever without being constrained by learning in the classroom (Hulme & Traxler, 2005; Beckmann, 2010; Ally, 2008). Mobile devices and tools are constantly being developed (Quinn, 2012). When using mobile devices, the learner does not have to be at a fixed pre-determined location to attend training or class. Increasing usage of mobile devices by students and employees makes mobile learning a viable option. According to the International Telecommunication Union, there are 103 cell phones per 100 people in the US. In addition, 286 million have mobile broadband service. El-Hussein and Cronje agree, saying "mobile learning as an education activity makes sense only when the technology in use is fully mobile and the users of the technology are also mobile while they learn," (El-Hussein & Cronje, 2010, p14). Emphasis is place on mobility of learning since the term is "mobile learning" (El-Hussein & Cronje, 2010, p.14). The increase in wireless technology such as Wireless Fidelity (Wi-Fi) Worldwide interoperability for Microwave Access (WiMAX), Third Generation (3G), and Fourth Generation (4G) allow mobile devices to access

information without being physically connected (Moses, 2008; Ally, 2008; Trinder 2005 found in El-Hessen & Cronje 2010 look up). Learners are not forced to be in a brick-and-mortar classroom and are free to customize their own learning experience, anytime or anywhere (Heiphetz, 2011). Mobile devices serve as a medium to deliver active learning curriculum such as experiential field work, simulations, role plays, and games (Leigh & Spindler, 2004). Other than email and calendar functions, the potential of mobile application is largely untapped (Heiphetz, 2011). Heiphetz also believes "mobile technology can become an engine of business learning in the same way the worldwide web became the backbone of learning during the previous technological revolution" (Heiphetz, 2011,need page citation).

> The essence of mobile is, to me, augmenting our mental capabilities wherever and whenever we are. Our brains are very good at pattern-matching and pretty good at executive function, but very bad at rote memorization and complex computations. Computers, conversely, are the reverse and from a problem-solving perspective we are far more capable when we combine the two. Mobile devices do that and more. (Quinn, 2011, p5)

Growing Mobile Device Market

The mobile market has over 4 billion subscribers making mobile devices one of the most accessible forms of computing in the world (Ellis, 2011). Morgan Stanley predicts that within the next 5 years mobile devices will be used more often to access the Internet than PC's (Ketter, 2010). Between September and November 2011, 56% of people who purchase a new phone chose a smartphone (Neilson, Android Phone and iPhone dominating app downloads 2011). Between May 2011 and July 2011 Neilson reported that 40% of mobile phone users had a smartphones in the United States. Apple's iOS and Google's Andrioid are the two most popular

operating systems (OS) in today's smart devices (Yoon, 2012). A breakdown of the operating systems used in all smartphones is as follows: Android, 40%; Apple iPhone; 28%; RM Blackberry, 19%; Windows Mobile, 7%; Other, 5%; and Windows Phone 7, 1% (Neilson Website, Mobile and Smartphone trends, 2011). The Android and iPhone combine to account for 83% of all the application downloads (Neilson, Android Phone and iPhone dominating app downloads 2011). While the android operating system is the most popular, Apple is the largest manufacturer of smartphones (Neilson). Smartphone sales continue to grow, increasing 61% from 2011 to 2012 (mobiThinking, 2012, found in Quinn 2012 p8).

Mobile devices are increasingly becoming part of everyday lives (Jeng, et. Al., 2010; Ahmad, 2010; Looi et. al., 2010). One of the reasons that the use of mobile learning is increasing is the increasing use and sophistication of mobile devices (Chang, 2007; Demirbilek, 2010). Mobile devices are often cheaper than the cost of desktop computers used for computer-based training (Hulme & Traxler; 2005; Demirbilek, 2010; Looi et. al., 2010). Mobile devices can be easily transported in an individual's hands or pockets. From coffee shops to the subway, these devices are used to access information (Hulme and Traxler, 2005). However, mobile devices do have some constraints that can limit their effectiveness for learning (Moses, 2008; Kukulska-Hulme, A. (2007). Mobile devices tend to be used to consume or deliver small amounts of information, while desktop computers continue to be used to process larger amounts of information (Chang, 2010; Ahmad & Orton, 2010; Quinn, 2012). Traxler (2007) says that this ability to deliver small chunks of information that is, just enough information to perform the task at hand, enables training to be delivered just in time which is redefining the nature of learning itself.

It is not easy to discuss the various types of mobile devices based on their features. In order to compete for sales, vendors are offering as many features as possible on all the devices. For example, users can now access the internet with their e-readers and ipods. And smart phones come with browsers, gps, camera, audio recorders, e-mail, cameras, and apps for doing just about anything. This convergence of features makes it possible to access mobile learning on a wide variety of devices (Quinn, 2011). While the capabilities of the devices are converging, it is not likely that a single hardware platform will emerge (Traxler, 2007). Manufactures are holding on to proprietary hardware and software designs for mobile devices.

In an article published by the eLearning Guild Quinn (2012) places mobile devices into three categories: pocket devices, tablets, and laptops (2012). Pocket devices are just like they sound small devices that can fit into the users pocket such as a PDA or smartphone. Tablets are larger touch screen devices without keyboards such as the iPad, Nexus Tab, or Kindle Fire. Laptops are larger computers than the tablet and possess screens with full keyboards, fold up, and can be used on the users lap or table.

Pocket Devices

Pocket devices are often used for quick access to content on the go when other devices are not available (Quinn, 2012). Pocket devices are ideal for short just-in-time training, required to perform a specific task.

A University of British Columbia study tested the viability of smart phones for mobile learning for management training. The study found that smart phones are best used to enhance learning for experiences smart phone users. Users rated the video content with narration as the most effective form of supplemental training on the smart phone (Macdonald, I. and Chiu, J., 2011). Song and Fox (2008) looked at the use of PDAs to teach vocabulary skills to

undergraduate students. The research found that students did make use of the PDAs to learn vocabulary and suggested that the PDAs should be used to teach English as a Foreign Language vocabulary at the University level. Similarly, when Oberg and Daniels (2013) looked at the use of the iPod Touch to provide mobile learning to supplement the *Science English: Communication skills for scientist and engineers* text book, they found a significant improvement for experimental group using the self-paced mobile learning. Oberg and Daniels attributed the increase in performance to mobile learning because it enabled students to review the materials anytime. Medical researchers found that mobile learning for surgical teams produced similar increases in pre-test /post test scores when compared to in-class lecture control group (Schulman, Garcia, Wyckoff, Duncan, Withum, and Graygo, 2012).

However, researchers note the usability issues associated with delivering training on the small screen devices (Kukulska-Hulme, A. (2007). These types of devices are not often used for producing information due to the small size of the screen and speed of data entry (El-Hussein & Cronje, 2010).

Tablets

PC Magazine describes a tablet computer as a computer built into a single panel (‘Tablet Computer’, 2013). The distinguishing characteristic of a tablet computer is the use of a touch screen as the input device. In terms of capabilities, the tablet falls between the pocket device and a laptop computer. Even though the way a tablet is used is similar to a laptop computer, most will still consider a tablet a mobile device. Tablets are similar to the smartphone in that they run similar operating systems, are touch screen, and are hand-held similar to the smartphone (Quinn, 2012). The tablets are similar to the laptop in the screen size and the way that they are used. A

user is more likely to consume a larger amount of information on a tablet than on a smartphone (Quinn, 2011).

Tablet computers have been on the market since the early 1980s. However, it was not until the ipad was introduced in 2010 that there usage has become widespread enough to become a viable option for mobile learning.

Researchers found that ipads helped doctors keep up with training and finish tasks fasters (Mearian, 2012). Nielsen, J. (2010) found that reading speeds for iPads are increasing but still slower than reading from a book. Seoi, Sharp, Kim found that students reported increased Scientific discovery learning with the use of eBookMaker Ipad application (2012).

While there are many benefits of learning on mobile devices, researchers report usability issues for tablet computer (Kukulska-Hulme, Traxler, 2005; Kukulska-Hulme, A, 2007). While the usability issues are not as great for the larger-screened tablets compared to small screen pocket devices they are a consideration for mobile learning developers. Chaparro, Nguyen, Phan, Smith, & Teves (2010) found 20 wpm decrease in typing speed on touch keypad for the iPad vs. the keyboard entry on a netbook. The same study also found an increase in data entry error rates with the iPad vs. netbook.

Laptop

Laptops, which are the largest mobile device, are usually used when learners must use be online for longer periods of time to consume more information (Quinn, 2012). Laptops are used at arms lengths and are not held in close to the body like tablets or mobile phones (Quinn, 2012). Laptops are not as intimate or personalized as the other types of mobile devices. This is one reason some scholars do not consider laptops a mobile learning device.

In addition to the different size of device, devices can also be distinguished by the operating system (OS) used. Computers typically run Microsoft's operating system while there are several different OS available for mobile devices such as: iOS by Apple, Android by Google, Blackberry 10 by Blackberry, S40 (Series40) by Nokia, Windows Phone by Microsoft, and Windows 8 by Microsoft. For tablets the Apple iOS is overwhelming more popular; while in pocket devices Android is slightly more popular with iOS slightly in second place (Quinn, 2012). Microsoft is also developing their own mobile OS, which is transitioning into a strong contender (Quinn, 2012).

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From a mobile learning perspective, it is also important to understand the design implications of the various types of operating systems running on various mobile devices.

Apple Operating System

Apples mobile devices (iPad, iPhone, and iTouch) have become very popular and "have grown faster than any other technology in history" (Ellis, 2011). By September 2010 the iTunes store had developed more than 250 thousand applications available with around 2.5 billion downloads (Ellis, 2011). Many people believe that Apple took the operating system from the iPhone and enlarged it to work on the iPad, or the iPad is a follow up to the iPhone (Griffey, 2012). But this is actually reversed, Apple started out developing an operating system for a tablet (iPad) and then realized the phone market was a higher priority so they tweaked the OS to make it run on the smaller device (Griffy, 2012).

The announcement of the iPad took place in January 2010 with the iPad being available for sale three months later in April. The original iPad was released with several different choices for the user. The user could select WiFi only or WiFi and AT&T 3G connectivity and storage

sizes of 16, 32, and 64GB. The iPad utilizes a high definition screen that is higher than desktop and laptop screens making reading easier on the users eyes (Rafols, 2011). With the success of the original iPad, in March 2011 Apple announced the release of the new iPad 2 (Griffey, 2012). There are a few small differences in the new version of the iPad. The iPad 2 is thinner, has a front and back camera, a more powerful processor, and the ability to connect with Verizon (Griffey, 2012). Even with the thinner design and a more powerful processor the iPad 2 still supports a similar battery life (Griffey, 2012). The iPad and iOS operating system was designed to for personal use for one person (Griffey, 2012). The iPad can be used in a Library setting by multiple people but it is more difficult.

Android Operating System

Unlike the Apple devices the android operating system is open source software (Yoon, 2012). Googls's vision is that the Android based mobile devices will have the same capabilities as the PC (Gandhewar & Sheika, 2012). To help facilitate this vision Goolge started the Open Handset Alliance (Gandhewar & Sheika, 2012). The android software was developed maintained by OHA (Open Handset Alliance) (Yoon, 2012; Gold, 2012). "Android is a software stack for mobile devices that includes an operating system, middleware, and key applications" (Yoon, 2012, p.1; Gandhewar & Sheika, 2012). Many different companies make devices that run on the Android operating system such as: Sony, Dell, Asus, Leveno, Samsung, Motorola, Archos, Toshiba, and Vizio (Griffey, 2012). "Even if the platform is common and has the same software capabilities, the actual performance varies with hardware and other software components" (Yoon, 2012, p. 1). Even though the devices are similar and are running on the same operating system, each different device works slightly differently.

Similar to the Apple devices, Google has a central hub where applications can be downloaded (Gold, 2012). But, application may also be obtained from other sources including the developers website (Gandhewar & Sheika, 2012). Unlike Apple, the applications are not pre-screened and only taken down when there has been a problem (Gold, 2012). After several security scares in 2011, Google is taking their security more seriously (Gold, 2012). Next a review of the ways to train using a mobile device.

Types of Mobile Learning

For the purposes of this study, the study is covering six ways to deliver content using mobile devices.

- Self-paced e-learning/m-learning
- Virtual Classroom
- Just-in-time Training
- Context/Location based m-learning

Self-paced learning

Definition

Self-paced learning is where the students determine their own schedule and pace (Oberg & Daniels, 2013).

Research

Truly self-paced learning where the learner is in full control of scheduling and pacing requires a large degree of motivation from the learner (Oberg & Daniels, 2013). When engaged

self-regulated learning the learner has to make a series of decisions including: what to study, how to study, and how long to study (Kornell and Bjork, 2007).

Supporting self-paced learning

There are several ways to present material on a mobile device for self-paced learning. This sections will cover Blackboard, iBooks, Podcasts, and iTunes U. Blackboard is a LMS often used in education. Professors can upload material to Blackboard and students can access the material at their convince. iBooks are electronic e-books that have the benefit of wigits. Wigits are embed videos, diagrams, interactive graphics, etc. that help to augment the text and make the book more engaging. Podcasts are recorded audio or video that can be downloaded and viewed at the learners convenience. iTunes U are podcasts but are recorded lectures from colleges.

Bb Mobile

Blackboard mobile offers students and teacher the ability to access information at their convenience and on their choice of device (Blackboard Website, http://www.blackboard.com/platforms/mobile/overview.aspx). “Going mobile is the most efficient way to instantly teaching, learning, and campus life” (Blackboard Website). There are two different options for Blackboard Mobile. Blackboard Mobile Learn and Blackboard Mobile Central.

Blackboard Mobile Learn allows users to access the Blackboard courses, content, and organization similar to the way they normally would on a computer. Blackboard mobile learn allows the user to see announcements, access discussion threads, and many other functions of

blackboard all from their mobile device (Blackborad website, http://www.blackboard.com/platforms/mobile/overview.aspx).

Blackboard mobile central gives users access to what is going on in the campus. Blackboard Mobile Central can show campus resources, bus schedules, or interactive maps. It can help new students find their way across campus to the library and even help find the library books. When combining Blackboard Mobile Learn with Blackboard Mobile Central it gives students and faculty everything that they will need all in one place, and it is on the go (Blackboard Website, http://www.blackboard.com/platforms/mobile/overview.aspx).

iBook Author

iBook author is a free application from the mac store that allows you to create multi touch textbook or any other kind of book that can be viewed on the iPad (iBook Author, Apple website, http://www.apple.com/ibooks-author/). One benefit of iBook Author is that you can include galleries, video, interactive diagrams, 3D objects, mathematical expressions and more interactive ways to bring the subject to life in ways that printed text cannot (iBook Author, Apple website). Creating iBooks using iBook author is easy. You just select a template then drag and drop picture and text into the corresponding areas.

Podcasts

Podcasts are recorded digital audio that are placed on a website (Podcast Production, Harvard.edu). Podcasting has been instrumental in shaping new mobile learning communities (Curran, Jennings and Collins, 2010, found in in Kukulska-Hulme, 2011). The term podcasting is a combination of ‘iPod’ and ‘broadcasting’ (Campbell, 2005, Podcast Production, Harvard.edu). The term podcasting is somewhat controversial since the name refers to the iPod, but the user does not have to use an iPod, any MP3 player or computer can be used (Campbell, 2005).

Podcasting is not a completely new idea, downloadable audio files have been around almost as long as the World Wide Web (Campbell, 2005). What is new about podcast are the ease of publication, the ease of subscription and that the podcast can go across multiple environments (Campbell, 2005). The user can play the podcast form computer speaker, head phones, or the car stereo while preforming a range of activities such as working out our commuting to work (Campbell, 2005). Some of the commonly used compression include: MP3, Windows Medio Audio (WMA), and Apple's Advanced Audio Coding (AAC) (Campbell, 2005). It is important to understand the different files and file sizes because of the trade off of quality and file size (Campbell, 2005). It is good to try to balance the file size and quality to find a compromise of good sounding audio with a smaller file size. (Campbell, 2005). Finding a balance of file size and quality help to reduce the storage space necessary to host the podcast on the internet and the bandwidth needed to download the podcast.

Subscribing to podcasts can be made easier by RSS aggregator, which is sometimes known as podcatcher (Campbell, 2005). The RSS aggregator or podcatcher, allows the user to subscribe to the podcast they like and those podcasts will be automatically downloaded as new episodes are available (Campbell, 2005). These podcasts will be available as long as the user wants and the user can delete the podcast whenever they want (Campbell, 2005).

Podcasts can be created using a variety of different software. Some common free versions of software to create podcasts are Garageband and Audacity.

iTunes U

iTunes University (iTunes U) is a website sponsored by Apple Computers, Inc. that hosts downloadable educational podcasts (Mckinney, Dyck, & Luber, 2008). Apple states that some of the benefits of iTunes U are that is the iTunes U store is open 24 hours a day so student can go

download the content when it is convenient (Mckinney, Dyck, & Luber, 2008). Students can then listen to the podcast whenever and wherever they choose (Mckinney, Dyck, & Luber, 2008).

Examples of iTunes U/ Podcast Study

A study on the effectiveness of podcasts was conducted in a small college in New York (Mckinney, Dyck, & Luber, 2008). Students in a general psychology class were given extra credit to participate in the study. The study divided the 66 participants into two groups. On group attended an in class lecture and what given the PowerPoint slide to take notes on. The presentation lasted about 25 minutes and the students were asked to maintain a log describing length of time studied and what they studied. The second group was given the same lecture but in podcast from instead of actually attending the lecture. After one week the students took a 50 question exam on the material. After the exam the students in the podcast group were given an additional questionnaire to see how they used the podcast to study. When the exams were graded it showed the students who listened to the podcast doing significantly better than the students who attended the in class lecture. The results were broken down further and the researchers noted that in both in class group and the podcast group the students who took additional notes obtained a significantly better score on the exam. The results of this study are not meant to suggest that podcasts should be used instead of professors. The podcasts only worked well when students listened to the podcast more than once and take notes as if they would when they are actually there. The advantage of the podcast is that student can listen to them more than once (Mckinney, Dyck, & Luber, 2008).

Virtual classroom m-learning

Definition

A virtual classroom is a classroom that is online where the instructors and students log into the location at the same time to hold the class or meeting in virtual environment (FIND SOURCE).

Research

Synchronous tools, such as virtual classrooms, are a relatively new concept (Dammers, 2009 found in Falloon, 2011). Universities and institutions have been exploring the potential of synchronous tools in a range of contexts (Fallon, 2011). According to Schullo et. al's (2007) study indicated that regular interaction between teacher and student encouraged student to complete their coursework earlier than if the students and teachers had not met (found in Fallon, 2011). Now, most learners have smartphones that support video allowing users to access real time video lectures or real time virtual classrooms (Majumder & Biswas, 2012).

Software

One commonly used software for virtual classrooms in the academic world is Blackboard Collaborate. This software replaced Blackboard Illuminate and offers students many of the same features that are in a physical classroom. Students can raise their hands to ask questions, click emoticons to show emotions, type in the chat box to communicate with other students, and click the talk button to verbally communicate with the entire class. Blackboard Collaborate is mobile assessable so student can join the class on a mobile device and have many of the same features that are available on the computer.

Examples

Fallon (2011) discusses a research study with 30 postgraduate students studying online for a master's degree. The objective of the study was to gain the students perceptions of virtual classrooms centered around three key areas: relationship formation, knowledge development, and communications of information (Fallon, 2011). Data was collected by conducting two interviews during the course of the online virtual classroom class.

Just-in-time Training

Definition

Just-in-time training provides users with knowledge as they need it to complete a task (Tucker & Winchester, 2009).

Research

Learning is experiencing a trend toward the learners and the moment of need, which is just-in-time training (JITT) (Ketter, 2010). JITT is most effect for procedural functions with short easy to define tasks (Tucker & Winchester, 2009). JITT with mobile can help to streamline education and training by cutting costs associated with instructors and class materials (Tucker & Winchester, 2009). After traditional classroom training learners do not retain much of the information 2-3 days after the training especially if they have not applied what they learned right away (Garg, 2013). When designing JITT for mobile devices it is important to consider three things: easy access, mobility, and training effectiveness (Tucker & Winchester, 2009). JITT can include one or all of the following methods: audio, video, graphic, animation, interactive tools, and a feedback system (Tucker & Winchester, 2009).

One method of JITT is performance support tools. McManus and Rosett (2006) note that there is more than one term to describe this concept. For the purposes of his paper Electronic

Performance Support Systems (EPSS) and Performance Support tools both describe the same topic, the Researcher will refer to Performance Support Tools (PSTs) to encompass both of these terms. Performance support tools (PST) are accurate, consistent, and helpful information that can be accessed by the user during the moment of need (Rossett & Mohr, 2004). McManus and Rosett define PSTs as critical information needed by the user a specific time in order move forward (2006). For the purposes of this paper the researcher is going to use McManus and Rosett's(2006) definition. Mobile performance support applications are great tool for employees to have (Garg, 2010). Performance support tools can range from a calculator to aid complex calculation or an application with procedural information that aids in decision making (Garg, 2010). In some industries, PSTs have been found to maintain quality and reduce training costs (Thomas & McDonald, 2006). There is often a direct link between performance support tools and performance (Garg, 2010).

Example

How do mobile phones affect performance in the workplace? An IBM study was published in T&D magazine that looked at how smartphones are used to improve performance within IBM. One of the biggest uses of the smartphone at IBM was to access current information when it was needed (Ahamad & Orton, 2010). IBM has a service called BluePages which gives a list of all employees, reporting structure, areas of expertise, contact information, and other current information about employees. A version of this was developed for access by mobile phones that was similar to the version that every employee accesses with their computers. When IBM employees were dealing with a customer or needed information right away they could use their mobile phone to look up that information or find the person who would know the answer. IBM employees wanted to only access essential information to be able to quickly to answer

industry or consumer question on the go (Ahmad & Orton, 2010). The results of this study caused IBM to change their approach to mobile learning. They shifted from mobile skill development modules to focusing on networking, collaboration and just-in-time skills improvement (Ahmad & Orton, 2010).

Cutting Edge Performance Support tool applications

Aurasma

Aurasma is a program that is new, cutting edge, and could become a very beneficial tool for companies to create performance support tools. "Since its launching in 2011 Aurasma has quickly risen to become the world's leading augmented reality platform… operating in over 100 countries" (Aurasma website, http://www.aurasma.com/about-us/). Aurasma's vision is to create and augmented world where everything has an aura (Aurasma website, http://www.aurasma.com/about-us/).

Aurasma works by using object/image recognition software to recognize and object or image telling the application to play the content or Aura (Different aruasma web page, http://www.aurasma.com/wp-content/uploads/Aurasma-Partner-Guidelines.pdf). The initial object that Aurasma recognizes is called a trigger. It is called a trigger because once the Aurasma application recognizes it, it tells the software, or triggers the playing of the corresponding video. To create a trigger you just take a picture of an object or image that you want to start the video. Next you record or link find a prerecorded video and link the trigger image using the Aurasma application. When in the Aurasma application, whenever the mobile device is pointed at the image or object Aurasma will recognize it and play the associated video (Aurasma website, http://www.aurasma.com/wp-content/uploads/Aurasma-Partner-Guidelines.pdf). This could be a

very useful application if users could point the mobile device at the device they want to use or learn more about and it triggered a video conveying that information to the user.

Context /location based m-learning

Definition

Context aware mobile learning refers to using context aware technologies such as location tracking devices for automatic retrieval of content (Yau, Joy, and Dickert, 2010).

Research

Now mobile devices are equipped with location information receiver, or GPS, that can communicate to the device the location of the user (Jeng, Wu, Huang, Tan, & Yang, 2010). The point of the device knowing the users location is to provide location-based authentic learning materials (Jeng, Wu, Huang, Tan, & Yang, 2010). The context and location aware software not only determines the learners location but supports personalized learner guidance (Jeng, Wu, Huang, Tan, & Yang, 2010). Learning context are defined by the situation and location aware applications help to present the learner with content that is suitable for the situation or environment (Yau, Joy, and Dickert, 2010).

Example

An example of Context/Location based Mobile Learning is hand-held devices that guide visitors through the American Museum of Natural History. Instructional technologists developed an interactive map on an iPad that educates visitors as they are guided through the museum without the assistance of an actual person (Ellis, 2011).

Another example was in a research study by Hwang, Yang, Tsai, and Yang who looked at context aware learning environment to guide students to conduct an experiment on single-crystal

X ray diffraction (2009). There were sensors around the room and computers could communicate wirelessly with the device the student was carrying. When the student moved close enough to the microscope the device would register as “crystal selecting” and provide information to the student on selecting the appropriate size and quality crystal structure. The device would guide the student to the X-ray diffractometer and provide guidance on how to use this device (Hwang, Yang, Tsai, and Yang, 2009). The sensors in the room allow the device to know where the student is and what step they are on. The learners are consistently provided guidance throughout the entire process.

Analysis

Drawbacks of mobile learning.

Limitations of mobile devices can be broken into three categories: technical limitations, psychological limitations and pedagogical limitations (Cheon et. Al., 2012).

Technical limitations

Small screen size, low resolution display, inadequate memory, slow network speeds and lack of standardization and comparability(Cheon et. Al., 2012).

Psychological limitations

Ex: Students are more likely to use the mobile device for tasks other than instructional purposes (Cheon et al. 2012).

Pedagogical limitations

Ex: using mobile devices in class may hinder student concentration and interrupt class progress (Cheon et al., 2012).

"Instructional models that consider both advantages and limitations of mobile devices are still in the early stages of development" (Cheon et. Al., 2012, p 1055).

Conclusion and Recommendations

References