I, MLEARNING: IDENTIFYING DESIGN RECOMMENDATIONS FOR A CONTEXT-AWARE MOBILE LEARNING SYSTEM

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ABSTRACT

This paper aims to explore the definition of mobile devices and identify the key differences between eLearning and mLearning such as interoperability, miniaturization, quality of service, and adaptivity. Various pedagogical methodologies to be used with mobile technology will be discussed. Additionally, an overview of context-aware strategies to be used in coincidence with mobile devices will be provided. To capitulate this elaborate overview, an idea will be put forth that for mLearning to be effective, it must be integrated within the entire system in a context-aware manner. A brief overview of methods to identify design recommendations will also be given.

KEYWORDS

mLearning, lifelong learning, context-aware, mobile technology.

1. INTRODUCTION

Mobile devices are small autonomous devices that are both personal – they can only be used by one person at a time - and mobile – they can easily travel anywhere the user chooses and used at any time. Anderson & Blackwood (2004) suggest that there are currently three major classes of products to be considered: (1) Personal Digital Assistants (PDAs), (2) Mobile (or Cellular) Phones, and (3) Personal Media Players (PMPs). Tablet and laptop computers are not considered in this definition because they give relatively the same functionality as desktop computers and are more portable but not mobile. We differentiate between these two terms by saying that they can easily be brought anywhere but not accessed anytime because of encumbering bulk and relative start up time.

The line between mobile devices is becoming ever more blurred and many of them are now able to support game play, keep an address book and schedule, play MP3s, and make phone calls. The current trend towards a single device being capable of handling multiple functions and media types is called convergence (MacManus, 2002).

There were 91 million mobile phone subscribers by the end of 2004, an estimated 1.5 billion mobile phones subscribers by June of 2005, and over over 3 billion subscribers predicted by the end of 2010 (Informa, 2005). This a penetration rate of nearly 43% of the total global population. The Mobile Technologies and Learning Report (Atwell, 2005) states that, in mid-2005, there were more than three times the number of cellular phones per person than personal computers (PCs), and today's most sophisticated phones have the processing power of a mid-1990s PC. This technology therefore presents an opportunity to affect more people in more aspects of their lives.

2. MOBILE TECHNOLOGIES EXPLORED

With the advent of the Internet and the World Wide Web, there has been a push to make learning electronic. ELearning, as it is known, can occur anywhere as long as you have a device on which to view it, usually a

PC. The difference between e-learning and mLearning is an addition of capabilities and limitations, and is more evolutionary than revolutionary (MacManus, 2002).

According to Quinn (2000), "[m]obile learning is learning through mobile computational devices". Therefore, mobile learning (mLearning) can be thought of mobile computing combined with e-learning.

MLearning can be information seeking, content delivery, ad hoc questions and answers, notes, comments between learning community, or tasks related to learning administration (Vanska, 2004). MLearning can be an educational environment in which wireless technology is used to assist students in their studies – both inside and outside the classroom.

MLearning is essentially the same concept as eLearning but with several key differences:

Interoperability: Depending on the different devices, there are various features that are available as well as drastically different Operating Systems (OS) which can help or hinder certain software capabilities.

Miniaturization: There are several important aspect of miniaturization to consider:

1. Usability: User Interface Design (UID) must be carefully considered because screens found on these devices can have pixel resolutions as small as 96 X 60.
2. Portability: The use of light components as well as small sizes leads to limited capacity which affects the software and services available to the learners.
3. Ergonomics: With limited physical space on the device, there is a limit to the number of keys that can be used to control the software.

Quality of Service: We must consider features and quality of service for any device that requires a connection to a larger network whether it is WAN or ad hoc.

Adaptivity: This aspect goes beyond the personalization of a mobile device's look and feel. Identity is closely tied with the device so this makes it possible to create user-specific and profiled services (Sharples, 2000). This allows the devices to be adaptable to the learner's evolving skills and knowledge as well as context in which it is used.

Similar considerations were brought up by other researchers (Uther, 2002; Steinberger, 2001; Csete, 2003).

3. PEDAGOGY OF MLEARNING

New technologies bring new educational possibilities based on its unique characteristics and capabilities. From a pedagogical perspective, mLearning supports new dimensions in the educational process. Characteristics (Chan & Sharples, 2002; Leung & Chan, 2003) of mobile learning include: (1) urgency of learning need; (2) initiative of knowledge acquisition; (3) mobility of learning setting; (4) interactivity of the learning process; (5) 'situatedness' of instructional activities; and (6) integration of instructional content.

These characteristics can be mapped to specific learning theories. There are many cognitivist concepts which lend themselves well to mLearning. Situated cognition (Kirshner & Whitson, 1997) is based on the concept that knowledge will remain inert and unused if the context it is taught in is separated from the material being taught. Learning is greatly enhanced when it happens in a particular location or context.

Steinberger (2001) suggests that for mLearning to work, [m]obile technologies could significantly augment some of these processes and support processes wireline solutions can not support. The above learning theories suggest cognitivist approaches but mLearning could do a better job with constructivist approaches as well.

Distributed cognition explores the interaction of learners and with one another, with their cultural and historical setting, and with the mobile technology (Laru & Järvelä, 2004). The theory emphasizes how cognitive efforts are distributed across artifacts (the technology), internal and external representations (mental models), and amongst individuals (groups of learners) and acts to dissolve the traditional boundaries between these. If a learner always has a mobile learning device with him or her, the learner and the device begin to interact, in essence becoming more than the sum of their parts as the learner offloads some of the cognitive effort onto the device, enabling the learner to free up more cognitive resources for learning (MacManus, 2002).

"Learning [is] a continuous, life-long process resulting from acting in situations." (Brown *et al.*, 1989) In the end, it is important to consider that mobile learning is the first technology integrated fully into everyday activities to support lifelong learning, as can be seen in Table 1, no matter what specific pedagogy is used.

Table 1. Associating mobile technology to lifelong learning. (Adapted from Sharples, 2000).

Lifelong Learning	Mobile Technology
Individualized	Personal
Learner Centered	User Centered
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

Although pedagogical considerations are important if learning is to occur, profiling learners and identifying the context at the time of access is necessary to allow for maximum efficacy.

4. CONTEXT-AWARE MLEARNING

Assumptions we have about stationary applications no longer apply to the number of mobile devices. These devices are most often used in changing environments, and the current interfaces and services do not adapt well to these changes. To further complicate this, a problematic arises from accommodating users with different skills, age, gender, disabilities, socio-economic status, etc.

Context, as defined by Dey & Abowd (2004), is any information that characterizes a situation related to the interaction between users, applications, and the surrounding environment. The challenge is to create a system that will adapt to the set of constraints imposed by the corresponding context of use. These constraints are set by various internal and external factors or dimensions of context. Prekop & Burnett (2003) provide a thorough overview of what various authors have put forth in Table 2.

Table 2. Internal and External Dimensions of Context.

Internal Dimensions of Context:	**External Dimensions of Context:**
Human Factors 1. users (emotional/physical state, personal events, beliefs, previous experiences) 2. social environment (work context, business processes, communication) 3. activity (goals, tasks)	*Physical Environment* 1. conditions (light, sound, movement, touch, acceleration, temperature, air pressure, proximity to other objects, time) 2. infrastructure 3. location *Technological Dimensions of Context* 1. device 2. product design

The learning context as defined by Wang (2004) reads “any information that can be used to characterize the situation of learning entities that are considered relevant to the interactions between a learner and an application.” In computer applications, context is acquired either explicitly by requiring users to specify it, or implicitly by monitoring users and computer-based activity. What is most important is to find the relationship between these variables, no matter how they are collected, so that the system can determine how to react.

Dey & Abowd (2004) have suggested that there has been little advancement in context-aware computing over the past five years because of a poor understanding of what constitutes context. “We lack conceptual models and tools to support the rapid development of rich context-aware applications that might better inform the empirical investigation of interaction design and the social implications of context-aware computing.” (Dey & Abowd, 2004) Based on these premises, a context-aware mLearning system is needed that integrates within the entire phone system transparent communication between detection devices, mLearning applications, and the mobile phone core services.

5. METHOD

An analysis of context sensitive tasks linked to contexts such as work, leisure, and school is proposed. For this to be successful, it will be imperative to identify various tasks that users may complete with a device,

and not simply with a specific application. It will then be determined how the device should handle these events by surveying users of mobile applications.

One way of involving users in the design process is through user-centered design (UCD) which is a broad term to describe a design processes. My process will be inspired by participatory design, a subcategory of UCD. Löwgren & Stolterman (2004) define participatory design as "...a process of mutual learning, where designers and users learn from and about each other." In this method, designers participate in the user experience and users participate in the design. Bødker *et al*. (2004) specify by stating that designers need to grasp the environment in which their design will function, and users need knowledge about possible options. This study would not be the first to use participatory design in this emerging field. Danielsson *et al.* (2004) used this method to develop a collaborative learning environment for university students.

In the study, there will be fifteen university students. Participants will be chosen from different age groups and with different backgrounds. An important part of the criteria will be getting participants that are in a various stages of their lives (i.e. undergraduate degree, adults learner, learners with a family, etc.) It will not matter whether participants currently own a mobile phone or not since the former may provide information on how to improve current systems and the latter may explain how to make a mobile system more alluring and useful. Participants will be interviewed about their time management skills and their use of mobile technologies. They will then be asked how they think a mobile system should act in certain context and during specific activities. Users should be able to have multiple profiles based on the context in which they are using their device to allow them to be more efficient in all aspects of their lives. As a final step, design recommendations will be presented to a focus group as well as a subject matter expert for review.

6. CONCLUSION

Mobile devices are becoming evermore commonplace and the quality and capability is increasing while costs continue to drop. Still in its early stages, mLearning using these devices is comparable to where eLearning was a few year ago. MLearning will not replace traditional learning but it does provide other ways of learning using new mobile technology. To do this, however, we must keep certain issues in mind such as interoperability miniaturization (i.e. usability, portability, ergonomics), quality of service, and adaptivity.

The increase in access and the flexibility associated with mobile learning will move students from passive to active roles using situated cognition and distributed cognition. While mLearning research is still in its infancy, it is obvious that the trend towards ubiquitous computing needs to be matched with a sound theoretical model for educators to make the most of the new technologies (MacManus, 2002).

Context, whether location-specific or time-specific, is a key part of how technology can help us manage our lives more efficiently. Formal learning is becoming a greater part of user's lives. Whether students completing their 1st undergraduate degree and preparing for a career or an adult learner adding to their employability while taking care of their family, learners have more factors to keep track of. mLearning applications will not integrate easily into student lives unless the entire mobile menu system helps manage their tasks and time. This concept would allow mLearning to be a holistic system which would not solely dependent on any specific application; the concepts will be usable in any type of application.

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