Chapter 88
Complex Mobile Learning that Adapts to Learners' Cognitive Load

Robin Deegan
Cork Institute of Technology, Ireland

ABSTRACT

Mobile learning is cognitively demanding and frequently the ubiquitous nature of mobile computing means that mobile devices are used in cognitively demanding environments. This paper examines the use of mobile devices from a Learning, Usability and Cognitive Load Theory perspective. It suggests scenarios where these fields interact and presents an experiment which determined that several sources of cognitive load can be measured simultaneously by the learner. The experiment also looked at the interaction between these cognitive load types and found that distraction did not affect the performance or cognitive load associated with a learning task but it did affect the perception of the cognitive load associated with using the application interface. This paper concludes by suggesting ways in which mobile learning can benefit by developing cognitive load aware systems that could detect and change the difficulty of the learning task based on the cognitive state of the learner.

INTRODUCTION

Current mobile device use is presenting previously unconsidered problems. Mobile devices are now ubiquitous. The size, portability, battery life and computational power of mobile devices suggest that they can be used for a diverse range of uses in an equally diverse range of environments (Weilenmann *et al.,* 2007, Reed and Green, 1999, Middleton *et al.,* 2013, Boulos *et al.*, 2011). Usability, or HCI (Human Computer Interaction), is primarily concerned with "ease of use" and "learnability" (e.g. how easy a system is to learn to use) (Neilsen, 1994). Mobile devices are challenging this notion of Usability as these devices are used in new ways. *Firstly,* mobile devices are used in complex distracting environments and these distractions interfere with the user's cognitive resources. *Secondly,* mobile devices are becoming advanced and powerful and this allows more sophisticated applications to be used on them.

DOI: 10.4018/978-1-5225-0783-3.ch088

Such applications are already cognitively demanding but the use of mobile devices for learning also brings a much higher demand for cognitive resources. Couple this demand to situations when the mobile device is used in a distracting environment and this leads to scenarios where the user's cognitive resources become overloaded or stretched. Cognitive Load Theory explains how the human mind interacts with instructional materials for learning and has several guidelines that are used to assist in the design of instructional material used for learning. These guidelines suggest methods to discourage extraneous cognitive processes and encourage germane cognitive processes. This paper will present the results of an experiment that demonstrate how mobile learning, Cognitive Load Theory and mobile usability interact.

LITERATURE REVIEW

Learning is considered to be the acquisition and development of memories and behaviors, including skills, knowledge, understanding, values, and wisdom. Specifically, from the perspective of the Information Processing Model (Broadbent, 1958, Neisser, 1967), it is the changes made to long term memory, usually schema creation or automation. Learning has traditionally taken place in learning institutions or schools. However, this may not be the best place for learning (Dewey, 1916, Bloom, 1964). In modern times, not only is high literacy demanded of everyone but the ability to think and reflect is now a valued attribute in the workplace. "Knowing" has shifted from being able to remember and repeat information to being able to find and use it (Simon, 1996). The role of education now should be the development of intellectual tools and learning strategies needed to acquire that knowledge (Bransford *et al.,* 1999).

Mobile learning can address some of these challenges. Mobile learning is defined in this paper as *"Learning with the aid of a Mobile device"*. In this definition a mobile device is simply a computer that is not restricted to a specific stationary environment or location. Specifically, mobile devices can be used in multiple environments; anytime, anywhere. It is this notion of anytime, anywhere, that is causing a dichotomy. On the one hand it is great that technology can enable learning to take place in multiple environments and contexts, but on the other hand it is these multiple environments and contexts that may have unintended effects on mobile learning. Some of these effects have been explored in recent research (Coens *et al.,* 2011) where jogging can be seen to have an effect on learning from a podcast via a mobile device.

Attempts have been made to explore the design of mobile learning applications (Eliasson *et al.,* 2011, Pemberton and Winter, 2011) with guidelines being created from an interaction design perspective. (Eliasson *et al.,* 2011). Although these guidelines refer to interaction design they also refer to the learning content / pedagogical aspects of the application e.g. "let teachers assume roles, and encourage face-to-face communication." Quite often applications are not developed or designed by teachers or pedagogues and therefore it is also beneficial to explore these applications from a purely interaction design, HCI or usability perspective.

Previously, the current authors investigated mobile learning from a usability perspective and put forward a classification of mobile learning applications based on Usability (see Deegan and Rothwell, 2010a). Usability is defined by the ISO as "*the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments.*" (ISO 9241, 1998). A usable system should be easy to use (utility) and easy to learn (learnability) (Nielsen, 1994). In recent years the notion of 'ease of use' has been applied to Usability where the general philosophy is based on making things 'easy' for the user. This approach stemmed from work done by Miller (1956) which determined