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Review of trends from mobile learning studies: A meta-analysis

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ABSTRACT

Two previous literature review-based studies have provided important insights into mobile learning, but the issue still needs to be examined from other directions such as the distribution of research purposes. This study takes a meta-analysis approach to systematically reviewing the literature, thus providing a more comprehensive analysis and synthesis of 164 studies from 2003 to 2010. Major findings include that most studies of mobile learning focus on effectiveness, followed by mobile learning system design, and surveys and experiments were used as the primary research methods. Also, mobile phones and PDAs are currently the most widely used devices for mobile learning but these may be displaced by emerging technologies. In addition, the most highly-cited articles are found to focus on mobile learning system design, followed by system effectiveness. These findings may provide insights for researchers and educators into research trends in mobile learning.

1. Introduction

Recent developments in communications and wireless technologies have resulted in mobile devices (e.g., PDAs, cell phones) becoming widely available, more convenient, and less expensive. More importantly, each successive generation of devices has added new features and applications, such as Wi-Fi, e-mail, productivity software, music player, and audio/video recording. These developments have prompted educators and researchers to take a pedagogical view toward developing educational applications for mobile devices to promote teaching and learning, and research on mobile learning has expanded significantly (Kukulska-Hulme & Traxler, 2007).

This growing body of literature has focused on several broad areas of inquiry such as the effectiveness of mobile learning (e.g., Al-Fahad, 2009; Baya'a & Daher, 2009; Evans, 2008; Lu, 2008; Mcconatha & Praul, 2008; Shen, Wang, & Pan, 2008; Thornton & Houser, 2005) and the development of mobile learning systems to assist student learning (e.g., Chen & Hsu, 2008; Chen, Kao, & Sheu, 2003; Ketamo, 2003; Sung et al., 2005). We believe each study provides valuable insight into issues related to mobile learning, and two reviews have synthesized the results of previous studies to identify broader research trends. Hwang and Tsai (2011) took reviewed six major technology-enhanced learning journals in terms of number of articles published, research sample group selected, major contributing countries, and research learning domains. Hung and Zhang (in press) used text mining techniques to conduct a similar examination (i.e., number of articles published, major contributing countries, etc.).

We believe these two literature reviews provide a valuable synthesis of mobile learning issues, but further examination is warranted based on different research directions. The two literature reviews failed to examine or categorize research trends from the standpoint of research purposes, methodologies, and outcomes. The present study finds these factors represent the overall research trends and patterns in the field. In addition, the two literature reviews failed to examine or analyze the mobile devices from the standpoint of teaching- and learning-assistance, and their critical role in ubiquitous learning. More importantly, the development and usage patterns of technology are

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changing quickly, requiring an up to date analysis of trends in mobile device types and functionality, along with learner types and the use of mobile devices in various disciplines and courses. For example, while Hwang and Tsai (2011) showed the distribution of research sample groups and research learning domains, the present study provides a more comprehensive examination and analysis of mobile devices, learners, disciplines and courses.

In addition, this study attempts to provide an analysis of highly-cited articles by assessing the impact of published articles on practice, with findings that can provide researchers with good examples from high-quality studies in related fields. Based on an analysis process used in the e-learning field by Shih, Feng, and Tsai (2008), this study selected highly-cited articles from each research purpose category for further analysis with the expectation that the results can provide practical insights for a broad range of researchers and educators in the field, and help younger scholars not only to identify contemporary research directions, methods, and trends, but also to understand influential works and individuals in their major subject domains. Understanding trends in recent studies can also help educational policymakers to plan additional inquiries and encourage the consideration of mobile learning as a teaching- and learning-assistance tool both within and beyond the classroom.

In sum, this study systematically reviews and synthesizes the relevant literature through a meta-analysis (Glass, 1976; Hossler & Scalese-Love, 1989; Ke, 2009) to provide a more comprehensive analysis of previous studies. Specifically, the present study poses the four research questions: (1) What are the major research purposes, methodologies, and outcomes addressed in mobile learning studies? (2) What types of mobile devices are mainly used in assisted learning and what are the general types of mobile learners? (3) How are different categories of disciplines and courses represented among mobile learning studies? (4) What are the highly-cited articles in studies of mobile learning?

2. Literature review

2.1. Definition of mobile learning

Mobile learning is one of the key current trends of educational applications for new technologies. O'Malley et al. (2003: p6) have defined mobile learning as taking place when the learner is not at a fixed, predetermined location, or when the learner takes advantage of learning opportunities offered by mobile technologies. Kukulska-Hulme (2005) defined mobile learning as being concerned with learner mobility in the sense that learners should be able to engage in educational activities without being tied to a tightly-delimited physical location. Thus mobile learning features learners engaged in educational activities, using technology as a mediating tool for learning via mobile devices accessing data and communicating with others through wireless technology.

2.2. Categories of research directions regarding mobile learning

Previous studies of mobile learning fall into two broad research directions: evaluating the effectiveness of mobile learning, and designing mobile learning systems. Most research in the former showed positive effectiveness. For example, Evans (2008) used observation to describe a study of the effectiveness of mobile learning in the form of podcasting in a business course for university students, with students finding podcasts to be preferable to their textbook as a learning aid. Al-Fahad (2009) surveyed the attitudes and perceptions of higher education students toward the effectiveness of mobile learning, and found that mobile learning could improve retention among undergraduate and M.D. students. Baya'a and Daher (2009) conducted experiments to explore the effectiveness of mobile learning while using mobile phones in an Arab-language middle school in Israel, and found that students responded positively to the use of mobile phones in learning mathematics.

These positive results are counterbalanced by several neutral or negative findings regarding the effectiveness of mobile learning. Ketamo (2003) developed an adaptive learning environment entitled xTask, with results showing that mobile technologies can generally bring some added value to network-based learning but they cannot replace conventional computers. Doolittle and Mariano (2008) examined the effects of individual differences in working memory capacity (WMC) on learning from an historical inquiry multimedia tutorial in stationary versus mobile learning environments using a portable digital media player, with results showing that students in a stationary instructional environment performed better, while interaction effects indicated that low-WMC students performed most poorly in a mobile instructional environment.

For the second research direction, researchers designed mobile systems to fit their courses. For example, Ullrich, Shen, Tong, and Tan (2010) described the mobile live video learning system (MLVLS) developed at the Shanghai Jiao Tong University for computer sciences courses, and found that mobile devices were significantly more widely used than desktop or laptop computers. de-Marcos et al. (2010) presented an application designed for mobile phones designed to reinforce students' knowledge by means of self-assessment, and found it improved student achievement, especially amongst younger learners, with a relatively low impact on current teaching activities and methodologies. Smørdal and Gregory (2003) reported on a project, KNOWMOBILE, that explored how wireless and mobile technologies (e.g., PDAs) may be useful in medical education and clinical practice, particularly for accessing net-based information, and suggested that PDAs should be regarded as gateways to complicated webs of interdependent technical and social networks.

2.3. Findings and inspiration from previous mobile learning reviews

Two previous literature reviews studied research trends in mobile learning. Hung and Zhang (in press) used text mining techniques to investigate research trends in 119 academic articles on mobile learning from 2003 to 2008 taken from the SCI/SSCI database. In general, they investigated publication date, publication category, taxonomy, article clusters, and country, university and journal of origin. Results showed that articles on mobile learning increased from 8 in 2003 to 36 in 2008; the most popular domains in mobile learning studies are effectiveness, evaluation, and personalized systems and studies on strategies and frameworks are more likely to be published.

Hwang and Tsai (2011) reviewed journals (BJET, C&E, ETS, ETR&D, JCAL and IETI) in the SSCI database from 2001 to 2010, selecting 154 articles on mobile and ubiquitous learning, and noting number of articles published, research sample groups selected, research learning domains, and country of origin. Their findings included the following: the volume of research in mobile and ubiquitous learning greatly