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The Add-on Impact of Mobile Applications in Learning Strategies: A Review Study

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ABSTRACT

Mobile devices are more powerful and portable nowadays with plenty of useful tools for assisting people handle daily life. With the advance of mobile technology, the issue of mobile learning has been widely investigated in e-learning research. Many researches consider it is important to integrate pedagogical and technical strengths of mobile technology into learning environments. This review study focuses on the investigation of add-on impact of mobile applications in learning strategies. We surveyed recent researches including context awareness, pedagogical strategy-enhanced learning scenarios, as well as collaborative and socially networked mobile learning. Through this review study, essential characteristics of mobile learning were identified and discussed. With the essential characteristics, we emphasized on the add-on impact of mobile learning and elaborated mobile learning model in learning strategies.

Keywords

Mobile devices, mobile learning, ubiquitous learning, pedagogical strategies

Introduction

The advance of mobile technologies have turned handheld devices a part of people's daily life, such as in communication and entertainment. Meanwhile, educators strive to facilitate learning by applying mobile technology and appropriate learning strategies. Nowadays mobile devices, such as smart phones, have equipped with location information receiver, camera, RFID reader, and other environmental awareness sensors. These can provide rich and interactive multimedia learning content for educational purpose. In addition, appropriate learning strategies can help educators facilitate mobile learning process and achieve their educational goals.

Most of previous work about mobile technologies has been focused varied strength to emphasize the assistance in mobile learning activity. In this review study, we take more practical points of view to describe how mobile technologies facilitate mobile learning activity. The advanced mobile technology provides users with two important features in recent mobile learning research, situated context and ubiquitous mobility. Ubiquitous mobility has been considered and implemented in several researches in recent years (Sharples Beale, 2003; Joiner et al., 2006; Fallahkhair, 2007). With ubiquitous mobility, students can facilitate learning activity in the outside world and connect to other peers by connecting to network. Mobile technologies offer rich content of mobile learning and deliver information effectively for students during their learning activities. The feature of mobility also makes mobile learning become more and more distributed (Chang et al., 2003; Corlett, et al., 2005; Clough, 2008). Situated learning is one of mobile learning applications (Hall & Bannon, 2006; Morken, et al., 2007; Lai, et al., 2007); it is the learning that takes place in the context corresponding to the learning materials. Situated learning provides learners with authentic learning examples which suit the learner's learning context. With mobile situated learning system, learner can acquire the context-aware learning materials to enhance their learning experience. Table 1 shows the benefits of added equipment on mobile devices. Museum guide system is an extension application of mobile situated learning system. Giuseppe et al. (2009) propose a location-aware, multi-device museum guide system which integrates various types of games and context-dependent information. The proposed system help improve the visitors' experience by extending their interaction with exhibits. This kind of informal learning may draw more attention form mobile learners. Handheld devices have been deployed as learning tools in both formal and informal learning contexts. Clough et al. (2008) investigate how experienced users of mobile devices use their mobile devices to support intentional informal learning. The results show that mobile devices are used extensively in an informal learning context by mobile learners. Also, they use mobile devices in ways that correspond to the collaborative,

contextual and constructivist mobile learning activities. Moreover, the embedded GPS receiver built into the mobile devices brings new applications and opportunities to trigger content or action relevant to the learning context. This feature also causes the improvement in mobile situated learning process.

Table 1. The benefits of added equipment on mobile devices

Added equipment on mobile devices	Description	Objective
Wireless network connection	Provide the connection between mobile devices and Internet.	To communicate with remote application server which can bring the context based learning information for mobile learner in situated learning environment.
Embedded Camera	Enable the capture of current environment in mobile learning activity.	To upload the picture of current environment on the application server. With collaborative effort of mobile learners, the picture can draw discussion and comments which provide situated knowledge.
Embedded GPS receiver	Provide the current coordinate of the mobile device.	To monitor the position of mobile learner and provide location-based authentic learning materials.
Additional RFID reader	Connect to RFID tag and receive the information.	To retrieve the information corresponding to current learning activity and bring benefit in situated learning environment.

From the pedagogical aspects, mobile learning offers context of authentic learning materials in the learning activities. Therefore, the pedagogic strategies can be utilized in mobile learning activities through the advanced mobile technique. Collaborative and cooperative mobile learning activities facilitate mobile technique as the learning tools (Lundin & Magnusson, 2003; Ng, et al., 2005; Järvelä, et al., 2007; Huang, et al., 2008 & 2009). Yang (2006) constructed three systems in the context aware ubiquitous learning environment, which include peer-to-peer content access and adaptation system, personalized annotation management system, and multimedia real-time group discussion system. In that environment, researcher utilized the effective and efficient advantage of ubiquitous learning to design the strategy of peer-to-peer collaborative learning to the learners. The author addresses the newly concept of collaborative activity can fully support the needs of peer-to-peer collaborative learning.

Situated context and ubiquitous mobility are important features when developing the educational mobile activities. The add-on impact of mobile application in learning strategies will also put emphasis on the two features. This study is organized as follows. In literature review, we collect recent researches focusing on technology and pedagogy supported mobile learning examples in facilitating mobile learning process. In the third part of the study, the essential attributes of mobile learning will be summarized to emphasize the add-on impact of mobile technology in learning strategies. We conclude this study by reflecting impact and learning models associated with mobile learning in education.

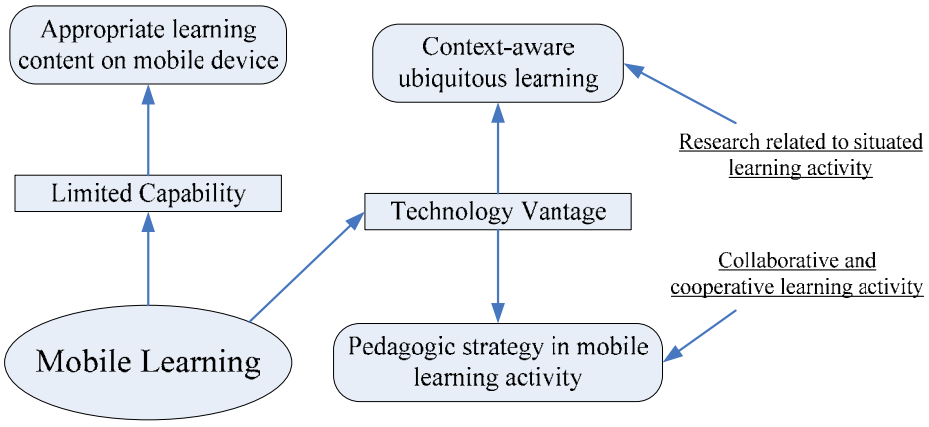

Figure 1. Architecture of the literature review

Literature Review

Figure 1 shows the architecture of this literature review. Firstly, in order to deliver the appropriate learning content on mobile devices, some researches focus on the adaptive content investigation. Moreover, right learning content corresponding to mobile learner's context is more important than a transparent learning content. Then, the pedagogic strategy in mobile learning activity is illustrated and investigated.

The rapid development of wireless network technologies and various mobile products have enabled people to conveniently access the information resources anytime and anywhere without constraints of time or place. The advanced available technologies, such as high bandwidth wireless communication networking infrastructure, wireless technologies, and advanced handheld devices, have extended online learning modes from E-learning to M-learning, in which learning objects have started to extend traditional learning manner towards widely used in daily life for various purposes (Sharples, 2000). However, mobile devices for learning are limited by screen size, computational power, battery capacity, input interface and network bandwidth (Chen, Chang, & Wang, 2008). Thus, how to adapt information for delivery to mobile devices has become a critical issue in mobile learning environment. To address this concern, many researchers have investigated the issue in different ways and have proposed several solutions (Gaedke et al., 1998; Goh, Kinshuk, & Lin, 2003; Huang & Sundaresan, 2000; Lemlouma & Layaïda, 2003). Yang, Chen, & Shao (2004) developed a universal access mechanism which can provide a transparent and seamless browsing experience of adaptive content based on XML/RDF, CC/PP, and UAProf techniques. Besides, content server can create adaptive multimedia content used on Dublin core/MPEG-7 and SMIL for multimedia content description and composition. Lemlouma and Layaïda (2004) proposed the system using the XQuery language and delivering the SOAP services to achieve automatic adaptation of the content based on its semantic and the capabilities of the target device. Zhang (2007) proposed several perspectives to discuss the web content adaptation for mobile devices. Huang, et al. (2008) utilized Fuzzy Weighted Average (FWA) algorithm to design a context-awareness synchronous learning system. The proposed manner provides various content styles to make learning contents appropriate to be displayed on diverse learning devices.

Recently, the concept of context-aware ubiquitous learning has been further proposed to allow students learning with variety of mobile devices and facilitate a seamless ubiquitous learning environment (Chang, Sheu, & Chan, 2003; Sakamura & Koshizuka, 2005; Rogers et al., 2005), which learning situation focuses on emphasis the characteristics of learning at the right time and right place with right resources in the right ways and conducts real-world learning activities with adaptive supports from the learning system (Hwang, Tsai & Yang, 2008; Peng et al., 2009; Yang, 2006). In order to achieve context-aware and seamlessly learning environments, some ubiquitous computing technologies and devices were usually utilized to detect or sense users' context information, such as RFID, GPS, specific sensors, contact-less smart cards, wearable computers, and wireless communications. (El-Bishouty, Ogata & Yano, 2007; Hwang, Tsai & Yang, 2008). The acquired context information was not merely used to identify learners' situations but also utilized to support personalized learning guidance. Through physical integration, students can learn physical materials in the real world and conduct authentic activities based on learner-centered and situated learning pedagogies (El-Bishouty, Ogata, & Yano, 2007; Hwang, Tsai, & Yang, 2008; Shaw, Turvey & Mace, 1982; Young, 1993). For example, Chen, Kao, & Sheu (2003) constructed a mobile scaffolding-aid-based bird watching learning (BWL) system which provides cognitive tools to support outdoor nature and science education afforded by mobile personal digital assistants. Chen, Kao, & Sheu (2005) developed a mobile butterfly watching learning system which supports independent learning and outdoor learning based on a wireless network, data mining technologies and using PDAs. Yang (2006) constructed three systems and utilized the effective and efficient advantage of ubiquitous learning to design the strategy of peer-to-peer learning model to the learners. El-Bishouty, Ogata, & Yano (2007) proposed the Knowledge Awareness Map which provides personalized learning condition to the students according to their current need and location and recommends the best matched materials according to learner's current task and current location. Tan, Liu, & Chang (2007) developed an Environment of Ubiquitous Learning with Educational Resources (EULER), which allow students observing real learning objects and sharing learning experiences to each other. Chen & Hsu (2008) proposed a personalized intelligent mobile learning system which utilized the fuzzy Item Response Theory presenting the appropriately English news articles and suitable vocabularies to the learners. Hwang et al. (2009) developed a context-aware u-learning environment to assist inexperienced researchers in learning single-crystal X-ray diffraction operations, and used the knowledge-based systems developed for instructing the learners based on the contexts sensed in the real learning environment. Peng et al. (2009) proposed a Ubiquitous Performance-Support System which combines digital and physical resources and

the manner of data-driven decision making to assist with administrators and educators for understanding the perceptions of experts and students.

In addition to the integration of suitable software and novel mobile technologies, how to combine appropriate pedagogical strategy for enhanced learning application was another critical important issue in mobile learning environment. Some of the studies proposed the navigation mechanism and intelligent tutoring system supporting suitable tutorial strategies for students increasing learning opportunities (Ghiani et al., 2009; O'Grady, O'Hare, & Sas, 2005; Pianesi et al., 2009; Virvou & Alepis, 2005). Moreover, the high interaction strategy was proposed to use for promoting social interaction and enhancing user experience in several studies (Hourcade & Berkel, 2008; Paterno` & Santoro, 2003; Wessels et al., 2007). Collaborative and cooperative learning are generally the first method chosen in mobile learning environment. Collaborative and cooperative learning is based on the constructivist theory which prompts students to learn by doing and construct knowledge for themselves (Schunk, 1996), and that pedagogical strategies have been widely applied in mobile learning activities (Dearman, Hawkey, & Inkpen, 2005; El-Bishouty, Ogata & Yano, 2007; Huang, Huang, & Hsieh, 2008; Huang, Jeng, & Huang, 2009; Lundin & Magnusson, 2003; Patten, Sa´nchez, & Tangney, 2006; Yang, 2006). Besides described above, Peng et al. (2009) proposed the approach of data-driven decision making as a mindtool which should facilitate critical thinking and higher-order learning by adapting to the learners. Zurita & Nussbaum (2004) developed a constructivist learning environment by providing each child with a share of the necessary information to accomplish the educative activity goal. Chen, Kao, & Sheu (2003) utilized the method of scaffolding which can enhance comprehension, improve independent learning and application, and promote knowledge transfer. The main research applications of situated learning and ubiquitous learning have been discussed in this paragraph. The next section will discuss the essential attributes of mobile learning then conclude the researches.

Essential Attributes of Mobile Learning

Learning through mobile devices is the trend of digital learning field. Generally, learning that happens on any pervasive computing devices can be referred to mobile learning. Therefore, mobile learning includes portable technologies and mobile contexts in mobile learning society. This section describes the add-on impact of mobile learning based on four dimensions as shown in Figure 2. The four dimensions are situated learning environment, virtual group awareness/strategies, enhanced pedagogical learning process and mobile learner/coacher.

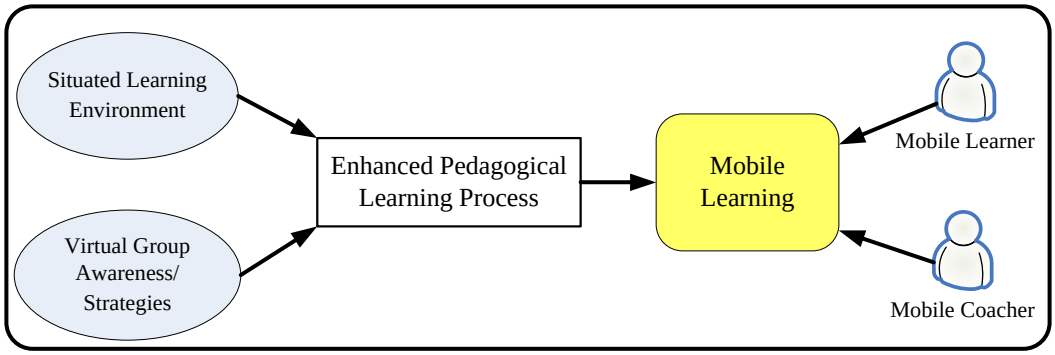

Figure 2. Essential attributes of mobile learning

Mobile learner and coacher

The advance of pervasive technologies brings opportunities for educators to design interactive learning activities. Such environment encourages learners to utilize the learning tools and explore the knowledge (Price, & Rogers, 2004; Monahan, et al., 2008). Learners can learn the knowledge and access the information anytime and anywhere without too much additional efforts. In mobile learning process, learners' learning portfolio will be recorded and the relevant information around learners will be tracked in mobile applications. Accordingly, the authentic learning materials or the appropriate contextual learning content will be provided according to the learner's learning context. The mobile application needs feedback from learner to provide personalized learning suggestions. The mobile

learning system is adaptive to the mobile learners, which can offer right learning content in right places to right learners. The mobile learning scenario to mobile learners should be natural without carrying additional devices.

The mobile coacher could be a mobile application agent or a real lecturer who guide learners to problem solving in mobile learning activities. Mobile learning applications are expected to offer learners the sharing of their learning portfolio, learning context, and learning feedback to their mobile coacher. After receiving the relevant learning information of learners, mobile coacher can provide adaptable personalized learning contents and suggestions. Besides, the mobile coacher scaffolds the learning assists according to learner's ability and learning progress in their learning activities. The mobile coacher is expected to monitor learners' needs and provide them with appropriate aid in the learning activity.

Enhanced pedagogical learning process

Mobile learning is diverse from traditional electronic learning, thus the conventional pedagogical theory should be revised to fit the characteristics of mobile environment. The enhanced pedagogical learning process is utilized to facilitate the learning in mobile learning activities. For example, blog articles were applied to construct a learning map called blog-based dynamic learning map (Wang et al., 2008). It is designed to provide informative and structured blog articles to assist students' learning. Therefore, a collaborative learning process can be facilitated by utilizing a mobile blogging system (Huang et al., 2009). In this mobile collaborative learning process, the blogging system is employed as a data collector and an information sharing platform for mobile learners. A revised pedagogical learning process associated with mobile technology has formed the pedagogical foundations of mobile learning. Chen, et al. (2003; 2008) have designed mobile application system for modeling, coaching and scaffolding the authentic activities and faded the support during the mobile learning process. They facilitate collaboration and support some of the social practices associated with learning. Therefore, the traditional pedagogical theory can take advantage of mobile technology and bring more efficient learning process to mobile learners. The combination of collaborative, contextual, constructionist and constructivist principles should be derived from augmented pedagogical learning process.

Situated learning environment

Mobile technologies gradually facilitate and enhance learners' interaction by means of accessing, discussing and sharing associated information through social networks. A situated learning environment aims to contextualize learning activities by enabling the learners to interact appropriately with their environment (Patten, et al., 2006). The advanced function of mobile devices make it possible for detecting learner's learning environment by embedded mobile sensors. Yang, (2006) proposed a context aware ubiquitous learning environment to provide contextual information and support peer-to-peer collaborative learning. The mobility, communication features and computational capacity of handhelds provide learners with authentic learning activities by simulating a situated learning environment. In cognitive apprenticeship, knowledge is situated within authentic activities and taught through interaction with instructors (Brown et al., 1989). Therefore, a vivid learning interaction with the environment makes the add-on impact of mobile learning in situated learning environment.

Virtual group awareness/strategies

Various studies (Danesh, et al.,, 2001; Inkpen, 1991; Mandryk, et al., 2001) describe the benefit for bringing mobility, and portability to face-to-face CSCL environments when students are wirelessly interconnected by handheld devices. Zurita, Nussbaum, & Salinas, (2005) proposed dynamic grouping methodology which is like re-composition group members during the collaborative activity. The results let future research understand which group composition should be favored in a given set of circumstances. Therefore, the member of virtual group should be deployed in particular given learning context to facilitate learners engaging in the learning topics. Uzunboylu, et al. (2009) investigated the use of integrating mobile telephones, data services to increase students' use of mobile technologies and develop environmental awareness. The result of grad analysis was found that students had more positive attitudes toward environmental issues. With the development of mobile applications, virtual group

awareness can be emphasized and augmented. This improvement in mobile learning draws more opportunities in utilizing pedagogical learning strategies.

With the integration of the four attributes, a mobile learning activity would be sturdy in perspective of learning model. A mobile learning environment should have learner and coacher combined with enhanced pedagogical learning strategies. To address the mobility in mobile learning, the technologic advantages should be valued. The situated learning environment utilizes the strength of mobility and brings context awareness learning materials for mobile learner and coacher. In this environment, mobile learner can have the awareness of group membership which could increase the learning motive or improve the learning efficiency.

Conclusions and Discussions

This review study focused on pedagogical learning strategies applied in mobile learning environments. Through the survey of recent researches on mobile learning, we investigated the add-on impact of mobile applications in learning strategies and concluded the following observations.

Mobile technology brings the impact of mobile learning on traditional pedagogical learning strategies. The mobile learning model emphasized on mobile users, learning strategies, situated environments, and virtual group awareness. The advance of mobile technology assists the development of "situated classroom" which is an augmented knowledge context environment pertaining to learners' daily life. The situated classroom is able to convey information between learners and coachers while the learning strategies are deployed. With the enhanced pedagogical learning strategies, learners obtain skill and knowledge in situated classroom. Many currently available mobile learning applications highlight the mobility, ubiquitous computing, and portability features to facilitate learning process by utilizing those features. Nevertheless, a more important issue is to rationalize the customized mobile learning applications in the proposed pedagogical learning strategies. Mobile technology does not aim to complicate learning process but facilitate mobile learners' learning process. To create new innovative learning opportunities, one needs to take into account the usability and the rationality. We believe that the appropriate application of mobile devices is to be developed in the combination of appropriate use of mobile technology and enhanced educational underpinning.

Future studies with the support of mobile technology could be directed towards the integration of learning strategies and emerging mobile sensor technology. More and more mobile devices in the future will be equipped with sensors and accelerometers which mean the track of mobile learners will be more precise. Combine the personal learning portfolio with physical learning behavior would bring new issues in the field of mobile learning.

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