The Functional Analysis of Handheld Computers Use in K-12 Classrooms

Sanghoon Park, Ph.D.
Northwestern State University

Chanhee Son
Florida State University

Abstract

There have been ongoing arguments on the concept of m-learning (mobile learning) and its distinguished features that are different from other types of learning such as CBI (Computer-Based Learning), WBI (Web-Based Learning), and e-learning. Although some researchers have tried to identify the boundary of m-learning, it has been a challenge to define the area clearly. The purpose of this paper was twofold. The first purpose was to address the issues surrounding the learning paradigm of m-learning. The second purpose was to provide a guideline for integrating handheld computers into various classroom learning activities, based on best practices collected from case studies. The guideline was constructed by conducting the functional mapping process of PDA uses in K-12 classrooms. Exemplary cases of using handheld computers in K-12 classrooms were collected and coded based on the types of learning activities and the PDA's functional uses. Three subsequent coding processes - open coding process, axial coding process, and selective coding process - were conducted to develop categories of functional uses of PDAs, to build connections among these functional uses, and to elucidate the functional categories. Finally, the functional categories and dimensions of the uses of PDA were combined to suggest how handheld computers should be used to fulfill pedagogical purposes in K-12 classrooms.

1. Introduction

The successful integration of computer technology into teaching curriculums has been a major issue in K-12 education. For several decades, traditional computers such as desktop computers or laptop computers have drawn much attention as potentially epoch-making tools to achieve successful integration. This tendency led researchers to magnificent amounts of studies on how to successfully integrate computer technology to promote teaching practices and learning outcomes. As a result, such new fields as computer-based instruction, computer-assisted instruction, and computer based training have emerged. With the advance of WWW (World Wide Web), using computers started to obtain much more attention from educators as well as from researchers. The capability of Web technology to expand communication and multimedia/hypermedia presentation especially attracted them to put more emphasis on the use of computers in educational settings. The concept of e-learning, accordingly, has emerged as a promising future of learning environments.

With this increased interest in computer technology, however, the expensive budget required to purchase enough computer systems causes a problem. Also, due to the lack of portability, the computers are commonly placed at the back of the classroom or in a separate computer lab, often hardly being used. In addition, providing sufficient infrastructure to support the educational use of the computers costs extra money. Due to these barriers and others, educators have found it hard to achieve successful initiatives to introduce computers to their classrooms to seamlessly support teaching and learning activities (Inkpen, 1999).

Recently, new handheld computer technologies such as "Palmtops," Tablet PCs, PDAs (Personal Digital Assistants), and smartphones have been emerged noticeably along with innovative mobile communication technologies including local area wireless connections using Wi-Fi, Third Generation (3G), and Worldwide Interoperability for Microwave Access (WiMAX) (Shih & Mills, 2007). eTForecasts (2006), a market research and consulting company for computer and Internet industries, reported worldwide handheld computer sales are projected to grow to nearly 210 million by 2011. As a new wave in education, much attention is being paid to such handheld computers because educators believe they may overcome the limitations that traditional computers have encountered in terms of affordability and portability. As educators are focusing on the high portability of handheld computers, a new concept of learning that emphasizes mobile technologies has appeared worldwide as "m-learning." This new trend made it possible for researchers to focus on the effective use of PDAs in classroom learning. Currently, there are many exemplary cases showcasing the effective use of PDAs in K-12 classrooms.

In K-12 classes, the use of mobile handheld computers is most widely explored in various subject areas. Many cases of integrating mobile devices into teaching and learning activities are drawn from many school sites across the nation. There are several advantages of using mobile technologies in classrooms in terms of their high portability,

affordable cost, accessibility, mobility, adaptability, and easy maintenance. Handheld computers are rapidly becoming a common technology because of their affordability and excellent portability (Bateman at al., 2001; Fasimpaur, 2002). Affordability and portability of handheld computers are the main factors that draw our attention to them as an alternative to conventional computers. In addition, accessibility, mobility, and adaptability have been emphasized as other advantages of the handheld computer apart from the desktop computer (Pownell & Bailey, 2000). First, Pownell and Bailey highlighted informational accessibility in that it refers to the ability for users to get the information they need instantly, while portability refers to the physical device, which means handheld computers are small enough to be taken anywhere. Second, mobility refers to the user who has the ability for greater movement and is not tethered to one place. Third, adaptability refers to the ability of the user to change his or her behavior because of this highly mobile technology. With greater attention to the handheld computer, many educators and researchers have been trying to find out how to best use these devices for pedagogical purposes.

In spite of this continuous research effort, there has been little attempt to conceptually define the meaning of m-learning itself and its unique features that are different from other types of computer integrated learning. In order to understand the effectiveness of mobile technology in the classroom, the conceptual differences of m-learning from other types of learning should be addressed prior to putting m-learning in practice. Therefore, this paper attempted first to conceptualize the meaning of m-learning and then to provide instructional implications of using handheld computers in K-12 classroom settings through the functional mapping of PDA uses collected from various best practices currently established in K-12 classrooms.

2. The Concept of M-Learning

Some literature, but not too much, introduced definitions of m-learning, although there is no agreed upon definition for the concept of it. For example, Trifonova and Ronchetti (2004) defined mobile learning as a field that combines two very promising areas – mobile computing and e-learning, or as any forms of learning/teaching that occur through a mobile device. In this definition, mobile learning is considered comparable with e-learning (Ellis, 2003). Similar to this, Lehner and Nosekabel defined m-learning as “any service of facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and time” (as cited in Newhouse, Williams, & Pearson, 2006, p.290). M-learning, therefore, could be seen as e-learning through mobile computational devices. As Chen and Kinsuk (2005) indicated, a mobile education system should be capable of delivering education content anytime and anywhere the learners need it. In general, mobile devices refer to PDAs and digital cell phones. More generally any devices that are small, autonomous, and unobtrusive enough to be used for some forms of learning in every moment in our everyday life could be considered mobile devices. According to these definitions, a common agreement that m-learning is e-learning through mobile computational devices can be drawn. However, these definitions of m-learning have a lack of scope and depth in terms of the unique characteristics different from other types of learning. In other words, the previous definitions are somewhat abstract and fail to provide more detailed features of m-learning. Moreover, the relationship between e-learning and m-learning is not clearly addressed.

One of the major differences between m-learning and e-learning is the technological device used to deliver the educational contents. Of the variety of mobile devices available, personal digital assistants (PDAs) and the newer Tablet PCs are the most applicable mobile devices for delivering learning contents. Smartphones accommodate some learning aspects such as taking a quiz or receiving a small chunk of information utilizing SMS (Short Messaging System), but it has a limitation as learning contents provider. Among the PDAs, which are basically palmtop-size computers, the options are a Palm operating system or one of the Windows mobile system, a compact operating system for mobile devices. A handful of manufacturers also offer Microsoft-based Tablet PCs. These clipboard-sized, keyboardless slates are ideal for delivering schematics and other knowledge that cannot be displayed on the smaller PDA screen (Ellis, 2003). Some offer the full power of a desktop computer and have handwriting and voice recognition built in.

The unique features of m-learning also can be found in previous research on how to use mobile devices for pedagogical purposes. There have been many research efforts made on the diverse aspects of m-learning. First, investigating the cognitive and pedagogical aspects of the use of mobile devices for educational purposes has become an important topic since the concept of m-learning appeared (Trifonova & Ronchetti, 2004). Waycott (2002) conducted the research on how useful mobile computing devices could be for reading or for workplace activities, based on activity theory. A central tenet of activity theory is the notion that all human activity is mediated by the use of tools, both conceptual tools such as language and physical tools such as technological devices (Vygotsky, 1978). Some researchers have been trying to draw conclusions through analysis of adult informal learning theories (Trifonova & Ronchetti, 2004). The findings of such research shows the use of mobile computing devices is, in general, effective in educational settings in terms of learner motivation, which could be considered a temporary, yet positive, side effect.
Research projects on course development for mobile computing devices show what such courses should look like

to be accepted and used by mobile learners (Sariola, Sampson, Vuorinen, & Kynäslahti, 2001). The key is the size of the knowledge object the course intends to deliver to the learners. No one is going to take a more than one hour course on handheld, mobile computing devices. Delivering a smaller learning object, a refresher or a discrete piece of knowledge needed on the spot, is where the power of m-learning excels (Ellis, 2003).

Messaging is also considered as one of direct applications of mobile computing devices as educational supporting tool. For instance, Short Messaging Systems (SMS) or texting, could be efficiently used in m-learning as a complementary media not necessarily for learning itself but for managing learning activities such as spreading information about lectures and classes, corrections in the schedule, etc. The findings from related projects show positive results (Stone & Briggs, 2002).

Finally, using WAP (Wireless Access Page) portals for educational purposes is one of the applications of mobile computing devices (Trifonova & Ronchetti, 2004). WAP portals are designed to provide information as well as entertainments to mobile handheld computer users. WAP portals do not differ from common WAP portals in terms of technical aspects. The positive results of the use of WAP portals for educational purposes were found in several projects by different universities (Kim, Mims, & Holmes, 2006).

Summarizing the above research areas, the concept of m-learning and its relationship to other similar concepts such as e-learning, WBI, and CBU are shown in Figure 1. As seen in the figure 1, the area of m-learning is extended beyond the other concepts of learning based on the type of devices supporting m-learning and the current research areas. Especially, four distinct features of m-learning are as follows: (1) uses mobile devices like PDAs, tablet PCs, and digital cell phone, (2) focuses on instant messaging and WAP portals to support itself, (3) modularizes and delivering information into smaller learning objects, and (4) provides information anytime users need it being connected to information.

Therefore, we define m-learning as an extension of e-learning providing smaller learning objects in mobile handheld devices to mobile learners anytime and anywhere needed. It means that m-learning is based on e-learning and should be implemented on the basis of e-learning**.** Enabling the learners with mobile handheld devices means not only that they need to become familiar with those devices, but also

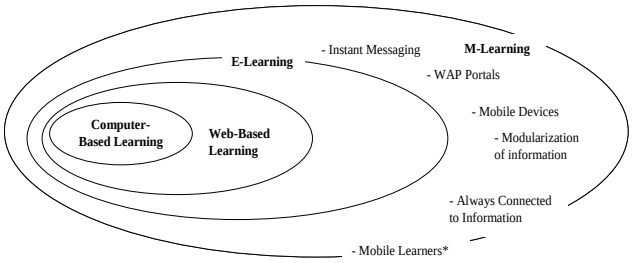

Figure 1. The concept of m-learning and its relationship to other types of learning

that they should try to change their behaviors to adopt m-learning as a new paradigm of learning. That is, mobility and adaptability of learners should be considered when defining and further implementing m-learning in practice.

3. Application of Mobile Technology in K-12 Classrooms

With these promising benefits of using handheld computers, however, there are not enough practical strategies to guide teachers in the successful integration of mobile technologies in K-12 classrooms. Considering the constant efforts to reform the school system to provide more effective and meaningful learning experiences, the importance of finding innovative technologies has become more and more critical because mobile technologies are expected to play an important role as an innovative technology to enhance cognitive powers of thinking, problem solving, and learning process. Although it is relatively easy to find practical cases of how the devices worked out, the underlining pedagogical effectiveness that makes cases meaningful is questionable. Even though there have been quite a few studies conducted with the desktop computer, the handheld computer has a fairly different interface. The considerable difference between desktop and handheld computers requires new perspectives of how to design and implement handheld computers to classroom setting.

4. Research Design

The handheld computers being interested in this study were defined as palm-sized devices that have computational power with an operational system such as Palm OS and Windows CE. The computational power is referred as a personal organizer, calculator, measuring device, etc.

For the data collection, this study attempted to collect stories of implementing the handheld computers only in classroom settings, representing instructional use of handheld computer with educational purposes. To collect the testimonial episodes, all possible data sources were searched from academic journals to Internet searches.

After the data were collected, three subsequent coding strategies were applied. The open-coding procedure was conducted by three researchers to generate initial categories

to analyze the collected stories. The open-coding is an analytic process to identify properties and dimensions of categories, which are discovered in data (Strauss & Corbin, 1998). Once the open-coding is established, three researchers conducted the axial coding process to build connections within the initial categories. Finally, this study attempted to identify functional relationships between the categories through the selective coding process. It was expected to contribute to provide better understanding of how the emerging technology should be integrated.

4.1. Coding Process

4.1.1. Case Study

Cases for this study were collected from a Web site, which was run by Palm and Handspring, but unfortunately is no longer available. The site presented many cases of using handheld computers for educational purposes. A total of 17 cases showing how to use handheld computers in classrooms were selected for this study.

4.1.2. Coding Strategies

After the data collection, we identified learning activities implemented in each case with the help of PDA functions and analyzed the collected cases. Then three subsequent coding strategies were applied. First, we conducted the open-coding procedure with the collected cases to generate initial categories. Once the open-codings are established, we conducted the axial coding process to build connections within the initial categories. Finally, we attempted to identify functional relationships between the categories through the selective coding process. Each coding process was conducted on a basis of mutual agreement in the coding process among three researchers, which means that three researchers had to reach an agreement in order to generate a category for this study. Table 1 shows functional categories of PDA in the learning activities found in each collected cases through three subsequent coding processes.

Table 1. Functional categories established by the open-coding and axial coding process across subjects.

Case	Open Coding	Axial Coding
(1) Green Middle School	Writing essays	Documentation
	Measuring device	Collecting data
	Data transfer/ Documentation	Information downloading
	Data analysis	Calculating
(2) Quest Academy	Establishing learning goals/tracking assignments /evaluating	Tracking or Organizing/ Evaluating/Reporting
	Document with images/discussion	Photographing
(3) Derby High School	Visualizing information	Retrieving information
(4) Centennial Junior High School	Taking notes/Writing an overview	Instant documentation/ Documenting
	Downloading/Writing drafts and reports	Information downloading/ Documenting
(5) Elmwood-Murdock Public Schools	Journaling/Taking notes/Writing essays	Document/Instant document/Document
	Creating mind maps/Organizing writing activities	Visualizing concepts/ Organizing
	Collaborative writing/ Beaming to share	Collaborative writing (Documenting)/ Information sharing
	Reading	Retrieving information
	Downloading	Information downloading
	Creating bookmarks/ Taking notes/ Looking up vocabulary words – using Palm Reader	Organizing concepts/Instant document/Looking up information
	Creating images	Visualizing concepts
	Calculating/Graphing	Calculating
	Creating images/ Mapping out/Timing	Visualizing concepts/ Collecting data
(6) Carolina Beach Elementary School	Writing summary	Documenting
	Illustration	Illustration
	Practicing drills	Taking quizzes
	Students' creating and beaming quiz	Sharing information
	Peer editing / Journal writing/ Beaming spelling words	Collaborative writing/ Documenting/ Sharing information
	Creating illustration	Illustration
	Measuring device	Collecting data
	Documentation with images	Photographing
	Keeping up class/ Parents' reporting/ Beaming	Reporting
(7) Immaculata School	Measuring device	Collecting data
	Data Collection	Collecting data
(8) Nassau-Spackenkill School	Measuring device/ Documentation with images	Collecting data/ Photographing
	Writing	Documenting
	Synchronizing Data	Synchronizing data
	Creating quizzes	Evaluation/Reflection
(9) Cold Spring School	Measuring device	Collecting data
	Taking pictures	Photographing
	Data gathering	Collecting data
	Beaming writings to the printer	Transferring data
	Tracking projects	Tracking or organizing
	Creating and recording musical compositions	Documenting
(10) Wiscasset	Creating records	Documenting

Elementary School Dedham Middle School Brewer High School	Comparing records to the standards	Comparing data
	Evaluating	Evaluating
	Beaming to teacher	Reporting
	Using the software	Documenting
	Writing reflection paper	Documenting
	Taking picture	Photographing
	Sharing the picture with others	Sharing picture (information)
(11) Northline Elementary School	Measuring device	Collecting data
	Making decision with collected data	Calculating
	Input the data	Documentation
	Creating graph	Visualizing concepts
	Measuring device	Collecting data
(12) Hayes High School	Keeping information/ Recording observation/ Recording notes/ Sharing information through beaming	Documenting (recording) Documenting Documenting Sharing information
	Synchronizing data	Synchronizing data
	Using simulation	Retrieving information/ Documenting
(13) Forsyth Country Day School	Taking notes	Instant documentation
	Writing assignment	Documenting
	Collaborating	Collaborative writing
	Using mathematics tools	Calculating
	Solving the equation	Calculating
	Collecting data/ Analyzing data	Collecting data
	Storing electronic books/ Using electronic books	Information downloading/reading
	Tracking assignment/ Tracking grades	Tracking
	Integrating information with calendar	Organizing (scheduling)
	Printing document through beaming	Transferring data
	Looking up the vocabulary	Looking up information
(14) Marysville High School	Adding to to-do list	Instant documentation
	Checking the list	Retrieving information
	Calculating	Calculating
	Measuring time	Measuring time
	Graphing calculator	Calculating
	Downloading websites	Downloading information
	Taking notes	Instant documentation
	Beaming notes	Sharing information
	Uploading notes	Synchronizing
(15) Putnam City Schools	Measuring device	Collecting data
	Collecting data	Collecting data
	Sending the data through e-mail	Sharing information
	Measuring device	Collecting data
(16) Northstar Middle School	Organizing their work and track assignments	Tracking/organizing
	Adding up the folders	Documenting
	Storing work and notes/ Organizing work and notes	Documenting/organizing
	Beaming notes and assignments	Sharing information
	Tracking works and assignments	Tracking
	Downloading software	Downloading software
	Collecting data	Collecting data
(17) Mountain Brook Elementary School	Planning investigation	Visualizing process
	Collecting data	Collecting data
	Writing notes	Instant documentation
	Organizing data	Organizing data
	Synchronizing data	Synchronizing data
	Taking picture	Photographing
	Tracking homework	Tracking
	Taking tests	Taking tests (quizzes)
	Writing paper	Documenting
	Taking tests	Taking tests (quizzes)
	Writing	Documenting
	Creating graph	Visualizing concepts

Through two subsequent coding processes, 26 categories representing educational uses for the learning activities identified in the analyzed cases were established as presented in Table 2.

Table 2. Summary of functional categories

Functional Category		
(CAL) Calculating	(IL) Illustration	(PL) Planning
(CD) Collecting Data	(IS) Information Sharing	(RI) Retrieving Information
(CO) Composition	(LK) Looking up Information	(RP) Reporting
(COMD) Comparing Data	(MCO) Musical Composition	(SYN) Synchronizing
(CW) Collaborative Writing	(MT) Measuring Time	(TQ) Taking Quiz
(DT) Data Transferring	(NT) Note Taking	(TR) Tracking
(DI) Downloading Information	(OC) Organizing Concepts	(VC) Visualized Concepts
(DS) Downloading Software	(OR) Organizing	(VP) Visualizing Process
(EV) Evaluating	(PH) Photographing	

5. Results

With these categories represented in Table 2, the final process of the selective coding was conducted to identify functional relationship between each category. The following eight inclusive dimensions were formed to provide PDA functions and matching classroom activities.

- **Data Transferring:** Data Transferring (DT) refers to the educational uses of PDA for sending or receiving various data. This functional category can include, as sub-categories, Synchronizing (SYN), Downloading Information (DI), and Downloading Software (DS). For example, Data Transferring represents activities for learning like downloading research data from the Web and specific software programs from the Web or desktop computers, synchronizing handheld computers with a database on a desktop computer, beaming writings to a printer, and so on.

- **Evaluation:** Evaluating (EV) can be defined as educational uses of PDA for evaluating student's works or understanding of what they learned and include the category of Taking Quiz (TQ). This category is very straightforward and easy to understand without any more explanations.

- **Management:** Management can be defined as educational uses of PDA for planning, scheduling, and tracking learning activities that happen in the classroom. Therefore, Organizing (OR), Planning (PL), and Tracking (TR) are included in this functional dimension. For instance, students can keep track of assignments beamed to their handheld computers from the teacher's and keep track of the progress of the projects they are involved in. They can also track their grades and plan their field trips for science classes as well as their writing activities with the management function of PDA.

- **Visualization:** Visualization means that handheld computers enable students to make graphics for specific concepts and processes so that they improve their understanding of the concepts and processes. Illustration (IL), Visualizing Concepts (VS), Visualizing Process (VP), and Organizing Concepts (OC) are under this dimension of Visualization. Students can create mind maps and graphs, and also animate science projects, like showing how a cell divides or how a seed grows into a plant using software programs. Students in a science class can also illustrate how streams are made and draw sketches of the water cycle and animations to show how deltas are formed, where runoff goes, and how erosion takes place.

- **Scientific Tool:** Scientific Tool refers to the functional dimension of PDA for Calculating (CAL), Collecting Data (CD), Measuring Time (MT), and Photographing (PH). Calculating (CAL) and Measuring Time (MT) are done by the basic functions along with embedded applications into handheld computers. Collecting Data (CD) means that handheld computers cans be used as a measuring device especially in a science class. Students can attach probes to the handheld computers and using specific software programs for measuring they are able to measure pH, dissolved oxygen, temperature, and turbidity. They can also photograph their activities as well as specific objects or phenomenon.

- **Data Sharing:** Date Sharing can be enabled by the beaming function of PDA. The functional categories of Collaborative Writing (CW), Information Sharing (IS), and Reporting (RP) can be included in the functional dimension of Data Sharing in that these use the beaming function of PDA. In language arts, students can use handheld computers for journal writing and peer editing. That is, they can share their works each other and feedback on them to complete their writings using the beaming feature of PDA. Students can also report their works to the teacher's handheld computer for him or her to evaluate them with the beaming function of PDA.

- **Documentation:** Documentation is a basic application of handheld computers in learning activities. The functional dimension includes Composition (CO), Musical Composition (MCO), and Note Taking (NT). This refers to all kinds of writing activities done with handheld computers.

- **Retrieving:** Retrieving can be defined as the functional dimension of PDA uses for referring to information or data, which may be created by students themselves or stored as the content of software programs in the handheld computer. This functional dimension includes Comparing Data (COMD), Looking up Information (LK), and Retrieving Information (RI). For example, in physical education, students can create their own personal fitness records and compare those to the Healthy Fitness Zone standards already stored in the handheld computer. Students can also look up electronic dictionaries installed into the handheld computer for specific words.

6. Conclusion

In this paper, we conducted a functional analysis to suggest specifically how handheld computers including PDAs could be implemented into teaching and learning activities across subjects. Eight dimensions of strategies for integrating handheld computers in classroom were defined and listed. In order to put them in practice, however, a number of issues need to be further explored. First, although the use of

handheld computers in classroom can support various types of learning activities, it does not necessarily ensure successful learning outcomes. Prior to considering mobile technologies in classrooms, the culture of classes, learning subjects, and the learners' needs should be considered. Second, successful integration of mobile technologies depends on how much class members are ready for such technology. Teachers and students still view mobile technologies as an innovative technology. Thus, various functions of mobile technologies need to be introduced to teachers and students in an appropriate way to immerse them into mobile class activities. Finally, building an appropriate guiding model based on the successful cases is necessary to expand educational functions of mobile technologies to diverse and creative ways of classroom integration.

References

Bateman, B., Crystal, J., Davidson, H., Holzberg, C. S., McIntire, T., & McLester, S. (2001). Top ten technologies breaking through for schools. *Technology and Learning, 22*, 22-32.

Chen, J., & Kinshuk (2005). Mobile technology in educational services. *Journal of Educational Multimedia and Hypermedia, 14*(1), 91-109.

Ellis, K. (2003). Moving into m-learning. *Training. 40*(10), 56-59.

eTForecasts. (2006). *Worldwide PDA & smartphone forecasts smartphone forecast.* Retrieved September 5, 2008, from http://www.etforecasts.com/products/ES_pdas2003.htm#start

Fasimpaur, K. (2002). *The power of using "Palm Size" handheld computers in education*. Proceedings of the Computer Using in Education (CUE) conference, Anaheim, CA.

Inkpen, K. M. (1999). Designing handheld technologies for kids. *Personal Technologies, 3* (1 & 2), 81 – 89.

Kim, S. H., Mims, C., & Holmes, K. P. (2006). An introduction to current trends and benefits of mobile wireless technology use in higher education. *AACE Journal, 14*(1), 77-100.

Newhouse, C. P., Williams P. J., & Pearson, J. (2006). Supporting mobile education for pre-service teachers, *Australasian Journal of Educational Technology*, *22*(3), 289-311

Pownell, D., & Bailey, G. D. (2000). Handheld computing for educational leaders: A tool for organizing or empowerment. *Learning and Leading with Technology, 27*(8), 46-49.

Sariola, J., Sampson, J., Vuorinen, R., & Kynäslahti, H. (2001) *Promoting m-learning by the UniWap project within higher education*, Paper presented at the International Conference on Technology and Education, Florida State University, Tallahassee, Florida.

Shih, Y. E., & Mills, D. (2007). Setting the new standard with mobile computing in online learning. *The International Review of Research in Open and Distance Learning, 8* (2).

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research* (2nd ed.). Thousand Oaks, California: SAGE Publications.

Stone, A., & Briggs, J. H. (2002). *SMS and interactivity – Some results from the field, and its implications on effective uses of mobile technologies in education,* Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education, IEEE, August, Vaxjo, Sweden.

Trifonova, A., & Ronchetti, M. (2004). A general architecture for m-learning. *International Journal of Digital Contents, 2*(1).

Waycott, J. (2002). *An evaluation of the use of PDAs for reading course materials.* Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2002), Växjö, Sweden.

Vygotsky, L. (1978). *Mind in society*, Cambridge, MA: Harvard University Press.

Author Information

Sanghoon Park, Ph.D.
Assistant Professor
Educational Technology Program
College of Education
Northwestern State University
Natchitoches, LA 71497
318-357-5774
parks@nsula.edu

Sanghoon Park, Ph.D., is an assistant professor of Educational Technology program at Northwestern State University, Natchitoches, Louisiana, USA. Dr. Park obtained his M. A. degree in Educational Technology from the Hanyang University, Korea, and Ph.D. degree in Instructional Systems from Florida State University, U.S.A. His main research is focused on design and development of technology tools to promote a dynamic learning process combining emotional and motivational aspects of learning. His interests also include developing of frameworks for design and assessment in implementing the mobile technology of handheld computers and the effects of handhelds computers in classroom settings.

Chanhee Son
Doctoral Candidate
Instructional Systems
College of Education
Florida State University

Tallahassee, FL, 32303
Cs02k@garnet.acns.fsu.edu

Chanhee Son is a doctoral candidate in Instructional Systems program at Florida State University, Tallahassee, FL, USA. He obtained his M. A. degree in Instructional Systems from Florida State University, U.S.A. As a research assistant, he is involved in several projects at the Center for Research on Innovative Technologies for Learning at Florida State University. His research interests are in design and development of effective online learning environments as well as student support.

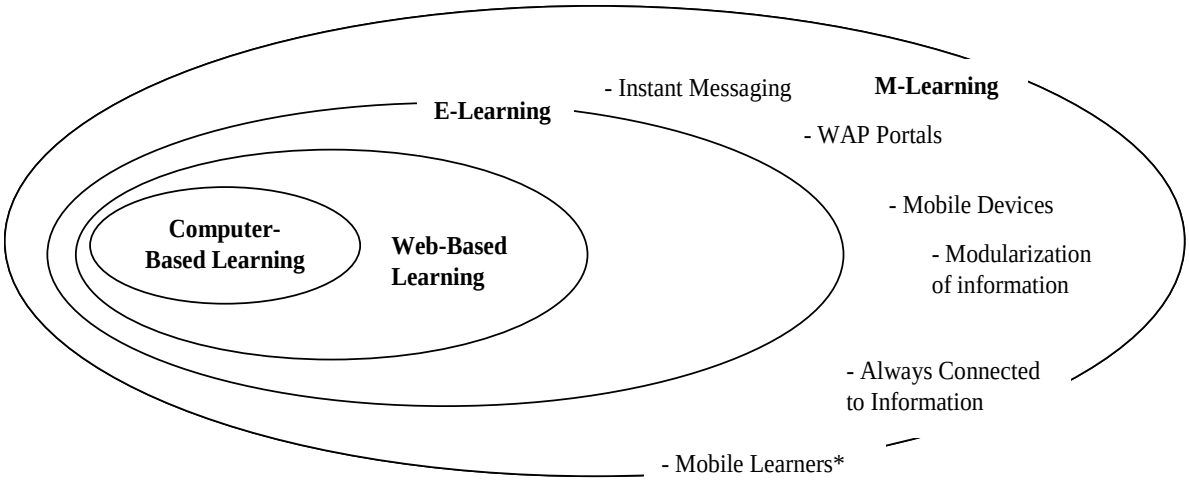

Figure 1. The concept of m-learning and its relationship to other types of learning