What We Need for Effective Learning in Ubiquitous Environments: Lessons from Korean Cases

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This study is to analyze the implications of effective learning in a ubiquitous environment. Research proceeded according to the multiple case study analysis method. This paper is one result of the Korean case study to examine the effectiveness of and satisfaction with u-learning. We will introduce necessary conditions for effective learning in a ubiquitous environment. Each condition was elicited through the case study, and the analyzing framework was classified into hardware related to infra structure; software such as learning contents, teaching-learning activity and support, and class management; human-ware related to learner and teacher; system-ware as an education system, and administrative supporting.

Keywords : effective learning, ubiquitous environment, Korean cases

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Introduction

The development of a computing technology and Wireless Network Communications technology has transformed our society into a ubiquitous one. In the ubiquitous society, the development of ubiquitous computing technology drives changes in politics, the economy, society, and culture, while facilitating the development of a new social structure (National Information Society Agency, 2005). Ubiquitous means to "exist everywhere, anytime," and ubiquitous computing technologies enable a user-centered, omnipresent, built-in, and accommodating environment. In an educational context, this means that a learning environment can be everywhere, as long as it is possible to supply information required by individual learners through ubiquitous computing technologies. That is, auto-regulation of the studies of an individual learner is now possible technologically. Accordingly, ubiquitous learning is considered to be a new learning environment with ubiquitous technology, and we expect that the environment will support learner's self-directed learning as well as more effective learning.

We already know, however, that merely providing technology is an insufficient condition for learning. This condition can neither improve the quality of education nor change learners for the better. Therefore, we need to identify the necessary conditions for effective and efficient learning in a ubiquitous environment. And we need to discover it in practical instructional situations onsite. This paper is one result of the Korean u-learning case study. The purpose of this study is to determine the necessary conditions for effective ubiquitous learning by analyzing cases of practice in Korea.

The research questions that will guide this study are as follows. First, what are the necessary conditions of infrastructure and devices for effective u-learning? Second, what are the necessary conditions of learning contents and instructional methods for effective u-learning? Third, what kind of readiness is required of users for effective u-learning? Fourth, what are the necessary conditions of systems and

social supports for effective u-learning?

For these research questions, we classify conditions as hardware related to infrastructure, software such as learning contents, teaching-learning activity and support, class management and human-ware related to learner and teacher, system-ware as an education system, and administrative support.

Analysis of Practice Cases

Study background

In 2005, the Korean Ministry of Education designated nine (9) schools in the entire country as u-learning exemplary research schools. These target schools included one (1) elementary school, one (1) middle school, five (5) academic high schools, and two (2) specialized high schools. They preconditioned the ubiquitous learning environments and selected one research class in each of the schools to observe u-learning activities, identifying various u-learning practice plans. In June of 2006, we initiated a case study to analyze the effectiveness of various practices,

Table 1. u-learning exemplary research school status

Subject	Location	grade	Instrument	Period
1 elementary school	Seoul	fifth grade	TPC	2005.3.~2007.2.
1 middle school	Incheon	first grade	TPC	2005.3.~2007.2.
5 academic high schools	Seoul Busan Daejeon Ulsan Chungbuk	first grade ~ third grade	PDA: 2005.3. ~ 2006.8. UMPC: 2006.9. ~ 2007.2.
2 specialized high schools	Daegu Gwangju	first grade ~ third grade	PDA: 2005.3. ~ 2006.8. UMPC: 2006.9. ~ 2007.2.

while also determining evaluation criteria for the best practices of u-learning. The detailed methods used in the case study included the following: surveying to determine levels of satisfaction and effectiveness of u-learning, class observation, in-depth interviews with teachers and students, logs on online activities, and the collection of various quantitative and qualitative data. Through this study, we will examine various conditions of, and identify the best practices for, u-learning.

Research Framework

To analyze u-learning cases of practice, we used an evaluation framework based on the best practices of u-learning (Kwon & Kang, 2006), which selected examples of excellent practices, offered detailed cases, and provided a specific direction for executing u-learning in schools. This framework was done by analyzing related national and international documents and forming an evaluation criteria draft based on factors extracted from the above. We then deduced ideal best practices of u-learning by opening a workshop with teachers in charge of u-learning. After this,

Table 2. Evaluation Framework on Best Practice of u-learning (KERIS, 2007)

Aspect	Specification	Aspect	Specification
Hardware (Infra)	1. Appropriateness of u-learning device	Human-ware	1. Learners' aspects
	2. Smoothness of wireless network		2. Teachers' aspects
	3. Appropriateness of server		3. Parents' aspects
	4. Speed of after-sales service		4. Educational administrators' aspects
Software	1. Learning contents	System-ware	1. Security
	2. Support teaching-learning		
	3. Teaching-learning activities		2. Problem of social support
	4. Class management		

we completed an evaluation framework on the best practices of u-learning by going through a specialist council. Based on this, we evaluated the process of applying u-learning practices in u-learning study schools.

The evaluation framework on the best practices of u-learning is classified into hardware, software, human-ware and system-ware, and specific aspects are arranged in the followings:

Research Methods

Our research methods were to analyze research documents concerning nine (9) exemplary research schools, class observations, in-depth interviews with teachers and students, and online logs on teachers' and learners' activities from June 2006 until December 2006. This study proceeded according to the multiple case study analysis method (Stake, 2005)

- Subject of study

The subjects of this study were each exemplary research school's students and class teachers in the study class, teachers of a subject that apply u-learning, and teachers involved in u-learning research.

- Class observation

The purpose of research class observation was to determine how u-learning is achieved in the classroom as well as outside the classroom. The method of study was participant observation in which the researcher participated directly in the u-learning class and observed the teaching-learning situation. Our observation emphasized the form of u-learning lessons, teaching methods and learning contents of teachers, learning methods and learning contents of students, the manner of using ubiquitous applications, and verbal and nonverbal interaction between teacher-students or student-student. To preserve objectivity, we videotaped

classroom lessons and analyzed these recordings with sessions with researchers who did not directly visit the classrooms.

- In-depth interviews with teachers and students

The purpose of the interviews was to secure information on the specific impressions and practices of teachers and students regarding u-learning. The interview method involved group or individual interviews with teachers and students. In the interviews with teachers, our purpose was to gain insights into

Table 3. Interview questions for teachers and students

To teachers	How much of your school period is devoted to u-learning?
	What is your learning objective when you apply the u-learning device and method?
	Do you have any special instructional strategies or instructional procedures for u-learning?
	If you do, what are the reasons that you use this strategy or method?
	Describe instructional events, activities, and problems in a u-learning class.
	What is your subject? Is it suitable for u-learning? Why? (Is it related to the characteristics of the subject?)
	What is the best practice in your class? Describe the situation and outline the reasons why you think this is the best practice.
	What do you think is an ideal u-learning best practice?
To students	How much of your time is devoted to u-learning?
	What is your learning objective when you use u-learning devices and methods?
	Do you have any special study strategies that you apply when you use the u-learning device and method?
	If you have, what are the reasons that you use this strategy or method?
	Describe class events, activities, and problems in the u-learning class.
	What kinds of subjects are suitable for u-learning? Why? (Is this a characteristic of the subject?)
	What is the best practice in your u-learning experience? Describe the situation and describe the reasons why you think this is the best practice.
	What do you think is an ideal u-learning best practice?

actual u–learning, teaching circumstances, and the individual teacher's instructional strategies. Interviews with students focused on their method of u-learning as well as sensory effects. We made use of semi-structured questions of the sort listed below.

- Analyze online logs on teachers' and learners' activities

The purpose of analyzing online logs is to confirm that u-learning activities and interaction (student-student and students-teacher) takes place online. Our analysis placed emphasis on online activities that occurred after school, during absences, and on weekends, in an effort to determine how participants applied u-learning inside and outside of the classroom. For this, we used teachers and students activity contents in each school's portal site or LMS site.

Necessary Conditions for Ubiquitous Environment

Hardware side

On the hardware side, u-learning can be achieved effectively when students are able to connect to the network whenever they wish. Therefore, hardware needs to support mobility, teaching-learning activities, and the learner's capacity to use the device.

Appropriateness of u-learning device

The u-learning device must be able to guarantee mobility. This not only suggests that the device should be lightweight, but also means that we should consider the kind and weight of baggage the user employs in everyday life.

- The u-learning device should be lightweight.

It is especially important to consider that students already have to carry

textbooks and notebooks to school. We should factor this in when determining the appropriate weight of the device. A regular computer is too heavy for students to carry in a knapsack with other items.

- The u-learning device should have a stable external design that will protect it from damage that might occur in accidents and everyday use.

In this case, the user will be an ordinary teenager between the ages of 12 and 19. He or she can be expected to bump or drop the machine frequently, and technical breakdowns are frequent. This is the main reason they feel uncomfortable about using the device.

- The u-learning device should be have built-in hardware and should also feature multimedia apparatus

In u-learning activities, students need to use various kinds of multimedia devices such as cameras, camcorders or CD-players. They indicated in interviews, however, that it is very difficult to carry these items separately. This difficulty impedes the user's learning activity, so we require built-in hardware with multimedia functions that will smoothly facilitate u-learning activities.

- The u-learning device should have a battery that can be speedily recharged to lengthen periods of mobility.

- The u-learning device should have convenient apparatus for the input and output of information.

In order to use information anywhere, anytime, including outdoors, the I/O device should offer the convenience of a higher cognitive power computer screen and electronic pen, featuring easy and simple output processes and higher compatibility than most other computers.

Smoothness of wireless network

- The u-learning device should offer smooth access to the wireless network

system, whether inside or outside of school, but especially in places of learning.

Appropriateness of server

▪ The u-learning server should have an easy and uncomplicated process to access and obviate network traffic, and a bottleneck situation for stable access.

The server for u-learning should function as a "store" of learning styles, providing educational guidance for each student. If a student can't access the server to gather learning information, u-learning cannot be achieved effectively.

Speed of after-sales service

▪ For effective u-learning, there must be a technical support center in the school, and students must be able to visit it directly when they have problems.

Exemplary research schools have an A/S process when students have problems such as broken-down devices. Generally, the student first reports the situation to the teacher, because the device is expensive. The teacher then calls in a technician or sends the computer to the A/S center. We have found, however, that students frequently hide any problem involving their u-learning device from teachers because they are reluctant to report damage they accidentally inflicted on the device.

For effective u-learning, there must be a shortening of repair time and a simplification of the repair process. In addition, there is a need for support backup of the basic OS and individual information.

First at all, the repair time should be relatively short. In an exemplary research school, the repair time was almost a week. Students indicated in interviews that this period was too long. Even when their computers were returned, they had to reinstall an OS and all individual files. This is a cumbersome process and can reduce user motivation. Therefore, we need an easy backup system for effective u-learning.

Picture 1. Individual learning using a tablet pen and external keyboard

Picture 2. Searching for and sharing information in city tour collaborative learning experience

Software side

U-learning must effectively support learner-directed learning. Many of those students and teachers interviewed, however, indicated that they didn't know how to apply u-learning correctly. Therefore, on the software side, it is necessary to support learner's meta-cognition, using appropriate methods of learning contents for teachers and students, evaluation, and class management. This is required for efficient learning, teacher's instruction and activities for u-learning, and communication in the following areas: student-teacher, inter-teachers, and teacher-student's parents.

Learning contents

Lack of learning contents is the biggest challenge in u-learning, which we discovered while observing the exemplary research schools. For effective learning, the contents must include activities and support for self-directed control.

▪ The contents for u-learning have a constructible format (editing, marking, reconstructing, and memo) in person.

This means that the contents for u-learning should be easy for users to reconstruct and convert according to their own learning experiences.

- The contents for u-learning must include support for learner-directed activity and indirect experience.

In u-learning, the purpose of learning contents is to induce learning activities for learning by doing as well as delivering information.

- The contents for u-learning must be designed to include current textbooks and functional notebooks.

It is too excessive to demand that the u-learning device and contents be used for all learning and classes. Today's youth is still accustomed to learning strategies that rely on textbooks and notebooks. Furthermore, Korean students are under considerable pressure to prepare for college entrance examinations. Accordingly, if we want to make effective use of learning contents, they must support students' ability to understand the current curriculum and must include the function of note taking.

- The contents for u-learning must secure high compatibility and be usable with different format contents.

When we interview teachers at exemplary research schools, they indicate that there is a problem with the compatibility of the learning contents they use. For example, teachers usually make their own contents for u-learning, which draw on the contents of the Cyber Home Learning system, the contents of the EBS educational broadcasting, and other learning resources. These contents, however, have a low compatibility to be adapted freely.

- The contents for u-learning should be easy to reconstruct according to teaching methods.

In u-learning, instructional events are not fixed. Teachers can change the instructional strategy and procedures according to a changing learning environment. Therefore, the learning contents for u-learning should be formed modules for reconstruction.

Support Teaching & Learning

Aspects of students

▪ For effective u-learning, students need to supply learning activities that they themselves direct for the advancement of cognitive skills.

▪ For effective u-learning, students need a "one student/one learning management system," and they must be able to choose various learning activities according to their own learning styles.

U-learning aims at an individual's self-directed learning that is not offered by teachers. Accordingly, we need a learning management system that records and manages an individual's ability to learn, an individual's degree of mastery, an individual's learning rate, an individual's learning style, etc. Further, the system must guide students to select learning activities (from a variety of options) that are appropriate for them.

▪ For effective u-learning, students need appropriate learning models and guidance to scaffold and their learning; they need facilitators, not teachers.

According to conclusions from our observation, students often face the challenge of not knowing how to learn in person when they receive autonomy. Given that Korean students are especially unskilled in this area, they need a learning model for guidance as well as the support of a facilitator.

▪ The system should be controlled to cut off access to harmful sites and games.

When we interviewed teachers and students of exemplary research schools, they suggested that there was a need to limit access to harmful Internet sites and online computer gaming. Therefore, we need some method to block harmful Internet sites and online computer games.

Aspects of teachers

▪ For effective u-learning, teachers must offer various instructional models according to their needs, lesson objectives, teaching methods, and the properties of

subject and contents. Many teachers find it difficult to adapt their instructional styles and strategies to u-learning.

▪ For effective u-learning, teachers must provide a monitoring system for the individual and collaborative learning activities of learners.

▪ For effective u-learning, teachers must offer new evaluation criteria to evaluate students according to the domain of the subject, learning activity, and individual differences. U-learning requires other evaluation criteria because it is an entirely different learning environment than more traditional ones.

Class management

▪ For effective u-learning, we need a system to facilitate communication with students and teachers, especially supporting multimedia interactions.

▪ For effective u-learning, we need a system for supporting the sharing of information and inter-students, student-teacher, inter-teachers, and teacher-student's parent communication.

▪ For effective u-learning and control of students, teachers need a system for easily transferring student's information to their parents according to the teacher's judgment.

Picture 3. Collaborative learning in class

Human-ware side

Human-ware is related to learners' and teachers' psychological preparation for u-learning, because the u-learning methods and goals differ tremendously from more traditional approaches. This change involves all elements of society. Therefore, all participants in u-learning—students, teachers, and educational administrators—need to support pre-training as preparation for u-learning.

Learners' aspects

- For effective u-learning, we need the learner's identity, self-efficacy, and a goal of learning, because we can lead a horse to water, but we can't make it drink.

- For effective u-learning, students have to master u-learning devices and software.

- For effective u-learning, the learner needs to become aware of ethics in education such as netiquette and respect of copyright laws.

Teachers' aspects

- For effective u-learning, teachers need training to improve their ability to use u-learning, their instructional design ability, and their research competency for u-learning.

- For effective u-learning, teachers need training to master u-learning devices and software.

System-ware side

System-ware is related to the education system and administrative support. Ubiquitous technology has changed our society, and learning is closely connected

with social change. In the area of system-ware, it is necessary to support securities and to reconstruct the education system and curriculum according to social and environment changes.

Security

- For u-learning environment, we need a plan to protect personal information and a software solution for security.

Problems of social support

- We need reform in the school system and curriculum that is suited to the purposes of u-learning.

- We need to develop an environment that facilitates learning outside of school as well as inside school.

- We need a school whose dimensions support student control while maintaining a range of teachers' discretionary power.

Conclusion

This study outlines the conditions needed for effective learning in a ubiquitous environment, in accordance with an analytical framework featuring the categories of hardware, software, human-ware, and system-ware. Synthetically, the hardware aspect of u-learning must support mobility, teaching and learning activities, and the learner's capacity to use the device. In the area of software, there is a need to support learner-directed learning, efficient learning, teacher's teaching methods and activities, and communication, whether student-teacher, inter-teachers, or teacher-parent. In the area of human-ware, all participants in u-learning—students, teachers, and educational administrators—must support pre-training as preparation

for u-learning. Finally, on the system-ware side, there is a need to support security and to reconstruct an education system and curriculum.

In fact, the definition of u-learning remains ambiguous, so we need to conduct further research to produce a clearer definition of u-learning, its purposes, and its anticipated effects. At this time, we have determined what students and teachers think about u-learning through interviews and observations. The general consensus was that u-learning is kind of extended ICT education with added mobility. We think that the key concept of u-learning is "everywhere, anytime, anyone," because the approach is user-centered and facilitates an individual's self-directed learning according to his or her own needs. The goals of u-learning, however, can only be achieved if society changes along with the educational sector. Therefore, it is essential to have political support, continuous research and development, and performance to expand u-learning. In this way, we can realize the vision of u-learning in Korea (Kwon, Lee & Kang, 2006), "Substantial education faithful to the essence of education." For that purpose, we must establish a model and criteria to accomplish our goals in phases.

References

Kwon, S. & Kang, K. (2006). *Analyzing on best practices of u-learning research school*, Issue Reports, Seoul: Korea Education & Research Information Service.

Kwon, S., Lee, J. & Kang, K. (2006). *A Study on Roadmap of u-learning in Korea*, Seoul: Korea Education & Research Information Service.

Kim, J., Kwon, K. (2004). *The Future of Education under the Ubiquitous Computing Environment,* Seoul: Korea Education & Research Information Service.

Seo, J., & Kim, Y. (2005) *u-learning teaching-learning model for the future education*, Seoul: Korea Education & Research Information Service.

KERIS (2005). 2005 *U-learning first operational Report: ubiquitous based exemplary research school.* Seoul: Korea Education & Research Information Service.

KERIS (2006). *2006 summer u-learning workshop report.* Seoul: Korea Education & Research Information Service

National Information Society Agency (2005). A *Current and Future of ubiquitous society*, Research Series of Ubiquitous society vol. 1

Bienkowski, M. A., Haertel, G., Yamaguchi, R., Molina, A., Adamson, F., and Peck-Theis, L. (2005). S*ingapore Tablet PC Program Study: Executive Summary and Final Report.* SRI International.

Dunleavy, M., Dexter, S. and Heinecke, W. F. (2006). *What added value does a 1:1 student to Laptop ratio bring to technology-supported teaching and learning?* [Online] Available: http://edutechcases.info (Oct, 2006)

Jeong, H., & Lee, E. (2005). *Design and implementation of a PDA-supported instructional model in inquiry-based learning.* In Proceedings for the Conference KAEIM 2005. p. 423-427.

Hill, J., Reeves, T., Grant, M., Wang, S. & Han, S. (2003). *The impact of portable technologies on teaching and learning: Year three report.* [Online] Available: http://lpsl.coe.uga.edu/Projects/AAlaptop/pdf/aa3rd/Year3ReportFinalVersion.pdf (Oct, 2006)

Lee, I. (2005). *Ubiquitous learning: Its challenges and opportunities*. In Proceedings for the Conference KAEIM 2005. p. 25-41.

Ogata, H. & Yano, Y. (2004) *Context-aware support for computer supported ubiquitous learning*. In 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04) p. 27.

Park, D. (2005). *A study on the current u-learning status in Korea: Focus on u-learning model school project*. In Proceedings for the Conference KAEIM 2005. p. 414-418.

Perry, D. (2003). *Handheld Computers(PDA) in Schools*. British Educational Communications and Technology Agency (Becta).

Sheely, K., Kukulska-Hulme, A., Twining, P., Evans, D., Cook, D., and Jelfs, A. (2005). *Tablet PCs in Schools: A Review of Literature and Selected Projects*. British Educational Communications and Technology Agency (Becta).

Stake, R. (2005). *Multiple case study analysis*. Guilford Pub.

Twining, P., Evans, D., Cook, D., Ralston, J., Selwood, I., Jones, A., Underwood, J., Dillon, G., and Scanlon, E. (2005). *Tablet PCs in Schools: Case Study Report*. British Educational Communications and Technology Agency(Becta).

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