

Design and Implementation of a Context Aware Contents Service Model in Mobile LMS

Jin-Hee Ku¹

¹ Department of Liberal Education, Mokwon University
Doan-Dong, Seo-gu, Daejeon, 302-729, Korea
jhku@mokwon.ac.kr

Abstract

The purpose of this study is designing and implementing a context aware service model that can collect and process learners' learning context in real time on mobile LMS. With the spread of so-called ubiquitous computing environment based on today's wireless mobile communication technology, hardware technology, sensor network technology, etc., e-learning platform is also entering into a new phase. As the next-generation e-learning platform called e-learning 2.0 is evolving from PC-based to mobile device-based, research is continued for the application of new technologies such as cloud computing and big data processing. In the field of school education, on the other hand, there is an increasing need for developing experiential education contents to stimulate students' creative synthetic thinking required in the age of creative economy. Thus, this study aimed to provide elaborative knowledge organized by teachers based on the learners' context recognized using various types of context aware information collected from the learners' mobile device. With the outcome of this study, we expect to enhance the timeliness of learning by providing contents of education organized in advance by teachers at any time and in any place, even without the learner's request.

Keywords: Mobile LMS, Context-Aware, Smart Learning, Location-Based Learning Contents

1. Introduction

Recently computing environment is evolving fast from PC-based to mobile device-based fueled by the development of wireless mobile communication technology, ubiquitous technology, multimedia processing technology, etc. As the advanced information and communication technologies enable various ways of access to information, learners have become able to search and process information at any time and in any place.

In the area of educational technology that is in the same vein as the development of information technology, traditional e-learning is going through a transition to a new paradigm of e-learning, namely, smart learning promoted by the high usability and intelligence of information devices in smart environment.

For smart learning, LMS plays a key role as it has done in traditional e-learning, but there are two major issues related to LMS in current smart learning. One is that with the transition of LMS from PC environment to mobile environment, some contents that work smoothly on the PC are not applicable in the mobile environment. For smart learning, accordingly, we need to take technological considerations for mobile LMS flexible to changes in future computing environment.

Another issue is how to provide various learning contents for diverse teaching methods based on personalized mobile devices without the limitation of time and space. This is for improving learners' educational environment and their personalized mobile device learning using context aware technology, cloud computing, big data technology, etc., which are to collect and analyze information on learners' activities and to give feedback. In order to provide learning services required by users in smart environment, we need to use context aware and processing technology, in which sensors and computers ubiquitous around the areas of daily life collect and share various types of context information and find the context of the users' and their surrounding environment[1].

Accordingly, mobile LMS for smart learning should provide optimized user interface according to wired/wireless device, and support the push of elaborative contents to be taught in connection to the learner's learning context. With the popularization of personalized learning environment, moreover, it is necessary to suggest a learning path according to the learner's academic level and competence.

Most of mobile LMS's that have been developed and in operation until now, however, are focused on the delivery and operation of contents that have been provided in PC-based LMS, and therefore they lack in functions for the delivery and operation of contents based on context aware that collects and processes learners' context information according to device.

The term 'context aware contents' denotes the synchronization of elaborative contents organized by teachers for teaching contents with the physical space. Going beyond simple experiences in knowledge permeated into daily spaces, it provides opportunities to construct elaborative knowledge and ensures the sequencing and significance of learning experience. Otherwise, learning information is nothing but the exhibition of knowledge as in an encyclopedia [2].

Accordingly, this study purposed to design and implement LMS for smart learning with which we can collect context information including the learner's location, used devices and systems, and the learner's learning history, and provide and manage learning services based on the information.

2. Introduction to Mobile LMS for Smart Learning

2.1. Current State of LMS

The term 'LMS' began to be used in the early 2000s along with the emergence of e-learning services such as course management, contents management, and learner management, which are distinguished from conventional websites that simply transmitted contents in webpages. LMS is generally defined as follows:

LMS(Learning management system) is a system that supports and manages learners' learning. When learners want to take courses of learning in the cyberspace, the teachers and the students should make some preparations such as opening curricula and applying courses. After the preparations takes place actual learning, in which the system traces the learners' learning process, manages their learning history, and provides customized learning to each individual learner. Doing these tasks, LMS consists of major functions required for online learning such as class grouping, cooperative learning, attendance management, and bulletins[3].

On the other hand, smart learning, which is an intelligent customized teaching-learning system demanded in the 21st-century knowledge and information society, means that learners can access teachers' elaborative contents including curricula, teaching contents, teaching methods and evaluation at any time and in any place according to their aptitude or level. What is more, in response to the development of IT such as social network and cloud computing

and the rapid spread of smart devices, its need is growing higher along with increasing demand of differentiated creating learning fit for individuals' characteristics.

2.2. Context Aware Contents Services in Smart Environment

Context aware technology denotes software and hardware technology that predicts and proposes in advance services needed by a user through analyzing the user's current position, time, life pattern, vital signs, surrounding environment, etc. and deriving functions optimized for the context [4].

Context aware technology consists of sensors collecting information on the surrounding context, network transmitting data, middleware integrating transmitted context data and connecting the data to relevant information systems, and context engine analyzing data and inferring in order to provide answers appropriate for each context. Context aware middleware is a technology that, standing between context aware applications and sensors, gathers and processes various types of information and provides them to users and applications. In this way, it plays the role of a mediator between sensors applications.

Dey defined 'context' as the whole of information related to conditions, states and objects around the user that are involved in the relation between the user and ubiquitous computing environment. More fundamentally, context can be defined as "information describing the characterized state of entities existing in the real world," and here 'entities' mean humans, places, or interactions between humans and services [5].

There may be a large variety of contexts, but context information is generally divided into user context, physical environment context, computing system context, user-computer interaction history, and other context.

In this study, we applied context aware technology in order to collect, process, and analyze representative context information such as the learner's current position (latitude and longitude coordinates collected by the GPS sensor of a mobile device), learning history (information on the learner's learning condition and interaction), and device (system environment information including the device used by the learner), and to provide learning services based on the information.

3. Design and Implementation of a Context Aware Contents Service Model for Smart Learning

The environment used in this study to develop a context aware contents service model for smart learning is as follows. Table 1 shows development and execution environment for learner services.

Table 1. Development and Execution Environment

Development and Execution Environment	Description
OS	• Windows7
Database	• Postgres8.4
Web Server	• Apache Tomcat 6
Development Tool	• Eclipse ADT
Development Language	• JSP & Servlet, Ajax, JSON • HTML5, JavaScript, Native function
Running Mobile Devices	• Tablet PC, Smartphone(Android, IOS)
Mobile Browser	• Chrome, Safari

3.1. Design of User Interface Adaptable to Various Mobile Devices

The key to context aware contents services for smart learning perceives various types of context information on an individual learner and providing learning services customized according to the context. In particular, it is quite important to provide consistent user interface and the same learning contents in different mobile devices. A learner's context information may include many different data, but in this study we considered physical learning environment such as device, time and place, the condition of the learner's learning activity, and the state of the learning process.

In smart learning environment, the user may use a desktop PC or a mobile device such as laptop, mobile phone, PDA or PMP as a learning device. Because a mobile device has a smaller screen than a PC and its type is diverse, the mobile device interface needs to filter or reconstruct PC interface modules. That is, the learner should be able to use seamless learning services through the same user interface of the same module regardless of whether in PC environment or in mobile environment.

Thus, this study attempted to implement HTML5-based contents and LMS that run in various devices, not dependent on a specific mobile platform. Contents based on HTML5, the next-generation Web standard, are highly modifiable and can be maintained and managed easily. In this sense, HTML5 may be called the most flexible contents and solution development technology [6-7].

What is more, it is necessary to allow the connection of a larger number of systems in future changed computing environment, and learners should be able to access learning contents from many different learning service providers.

3.2. Design of Context Aware Contents Service Support

The biggest characteristic of learning activities in smart learning environment is the transition from pull-type learning to push-type learning. That is, different from the traditional way of learning in which the learner searches for necessary information, the new form of learning will provide the learners with necessary information automatically through intelligent embedded devices. For smart learning, we need to build a system that interconnects the smart environment and the teaching-learning context so that the learner in the teaching-learning context can learn at any time and in any place through contents elaborated by the teacher, namely, organized for higher effect of learning.

Accordingly, it is necessary to develop contents structured by the teacher in relation to the learner's location and context so that the learner can access and learn the contents as necessary. In smart environment where the structure of knowledge has become more extensive and complex, learners want to get structured contents of education required in their current learning context and position immediately, and to interact with the teachers and be given the feedback of learning results.

In this study, on the request of a service by a learner or a teacher through a mobile device, the server performs real-time storing of position information transmitted from the mobile device during the time from the device's connection to the system to its disconnection. Position information is essential for providing learning services connected to the actual context that smart environment can support, but not all learning services have to be provided in the actual context.

Figure 1 is a conceptual diagram of mobile LMS.

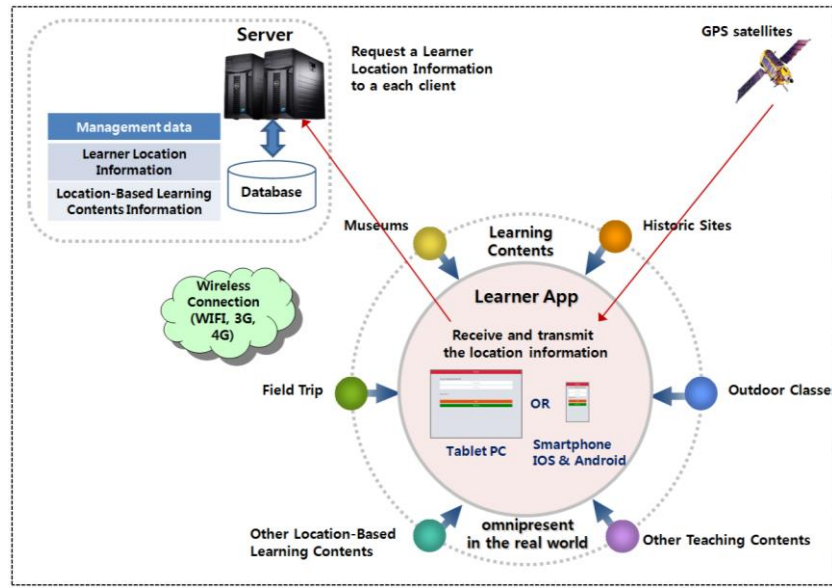


Figure 1. Conceptual Diagram of Mobile LMS

Therefore, the developed system is designed to support not only the function of searching registered contents matching with position information but also the function of transmitting general contents as well. Accordingly, context aware technology is very important for the construction of smart learning environment.

In this study, the focus of design was brought on making it possible for learners to learn through the teacher's elaboration process of learning in the teaching-learning context. For this, we need to design programs that recognize data on the learner's context and provide the learner with learning information optimized for the context.

First, we need mobile application programs and server application programs for collecting and storing position information. Because a mobile application program cannot save data directly into the server's database, there should be a communication program in addition to web application programs in the server. In a LMS server, a daemon-like communication programs runs continuously and performs the function of storing GPS data from mobile devices into the database.

Second, in order to analyze stored position information and to find and provide learning information necessary to learners, the system should prepare contents organized in advance by teachers that can be connected to teaching-learning contexts. In smart learning environment, contents should be fragmented into very small pieces and be provided immediately according to the learner's location and context.

Accordingly, we designed the systems so that, based on the position-based information, learners can search for learning contents necessary in their current position and receive them in the form of push whenever they change their location while they are in connection to the system.

In some case, learners may not want real-time push of contents list whenever they move. Therefore, the system provides the 'GPS on/GPS off' menu so that the learners can choose position-based learning and they can search the entire contents and choose necessary ones according to their plan. Furthermore, the system is designed to include a learning note function, with which the learners can organize and upload materials obtained from learning or related materials immediately at the site of learning. The learning note function can improve

the retention and transfer of learning because it helps the learners associate learning materials with the learning context by saving not only time data but also position information when uploading materials such as images and texts.

3.3. Design of the Whole Learning Process

Learners may use many different devices from PC to smart phone and tablet PC. In order to get context aware contents services, however, it should be a mobile device containing a GPS sensor that is on.

1) The learner connects to the LMS server through a mobile device or a PC containing a GPS sensor. The server collects data on the learner's physical environment, namely, context information such as whether PC or a mobile device, operating system, browser version, resolution, and the learner's current location. Then the learner is provided with user interface optimized for his/her position, learning history, and device, and gets learning services through the interface.

2) LMS searches registered contents, assignments, tests, etc. and checks if there are any contents to be learned in connection to the learner's position, and then shows the list of contents on the message window. If the learner moves out of the current point into another, it provides information on contents to be learned in that position.

3) While the learner is learning in an actual context, teachers should understand the purpose of learning and the learning context, and prepare contents with related questions and assignments for enhancing the transfer and retention of learning.

Through such a series of teaching-learning process in smart learning environment, the system can increase opportunities for motivating learners with practical assignments instead of learning with vague expectation to utilize the context, and moreover, it clarifies the significance and purpose of learning, and helps the students obtain useful knowledge applicable in their real life.

4) The learner makes a brief report using the contents learned at the current position or related materials, and uploads it through the learning note menu. When materials are uploaded onto the learning note, position information is also stored. Then linked to a mobile application map, learning materials corresponding to a specific learning position can be viewed together.

5) When a learner connects to the system, learner information is an important element indispensable for the level-based personalization of learning. If learner information is changed, the new information is entered and updated through the basic learner information management menu and the preferred information management menu. In addition, the learning history information menu shows details on the learner's completion of courses.

4. Results

4.1. Application Program for Collecting Learners' Position Information and Transmitting to the Server

Mobile devices such as smart phones are major platforms of learning in smart learning environment. In order for the server to recognize the user's context in real time, it should collect various types of context information while the user is in connection to the system.

This study used a smart phone as a learner device, and for confirming the learner's position in collecting context information we need an application program that reads data collected from the GPS sensor built in the mobile device and transmits the data to the server.

Figure 2 is screens showing the receiving status of a GPS sensor. If a learner logs in for learning, the sensor communicates with the middleware in the server that is for collecting context information.

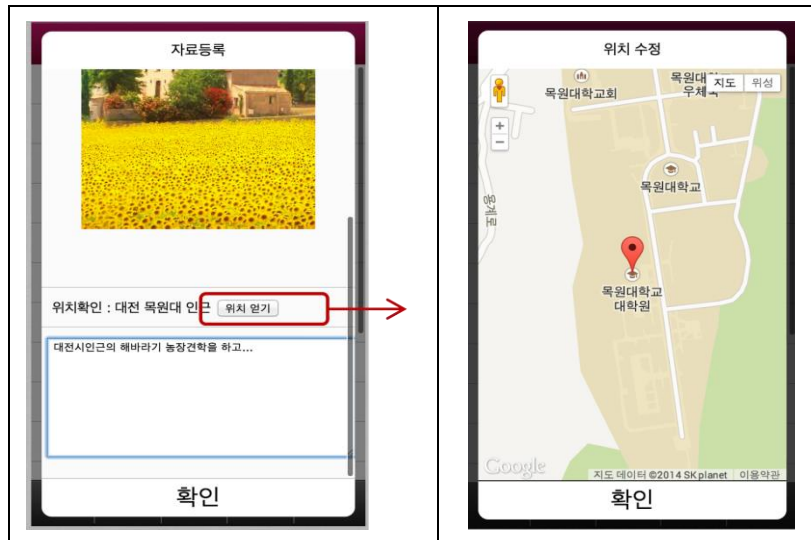


Figure 2. Receiving Status of a GPS Sensor and Collecting Context Information

4.2. Application Program that Stores Position Information Collected from a Mobile Device into DB

In order to store data collected from a mobile device into the database in the server, we need middleware that receives data and stores in the database.

Figure 3 shows middleware running on the server. This program was designed to run in the background as a daemon, not directly controlled by the user.

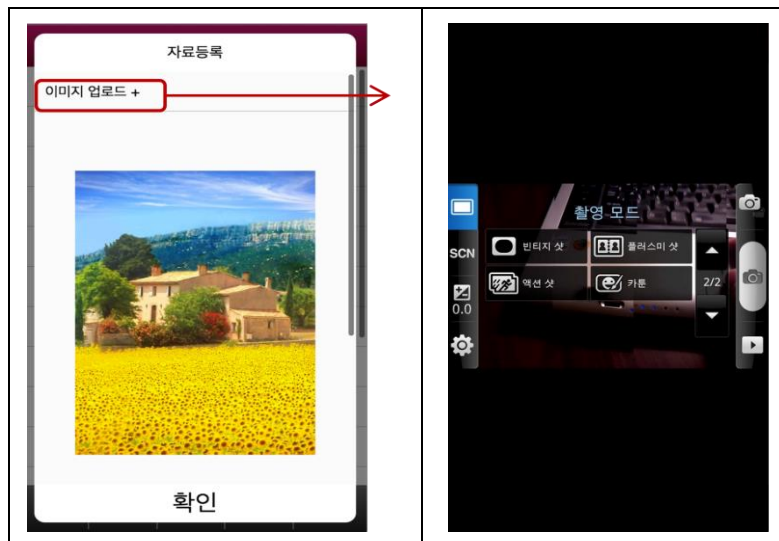


Figure 3. Registration Location-Based Contents

4.3. Development of Interface for Tablet PC and Mobile Devices

In smart learning environment, if a user connects to the learning domain and logs in, the server should provide the requested page based on various types of context information. Figure 4 shows Tablet PC interface and mobile device interface used according to the type of device recognized.

LMS in this study was developed based on .NET development environment, which is a software development environment. .NET development environment can handle each segment separately on the design screen. Accordingly, it is effective in developing adaptable interface that composes interface differently using the design of the same functions because frames partitioned on the desktop screen needs to be redeployed on the small screen of low resolution as in a mobile device.

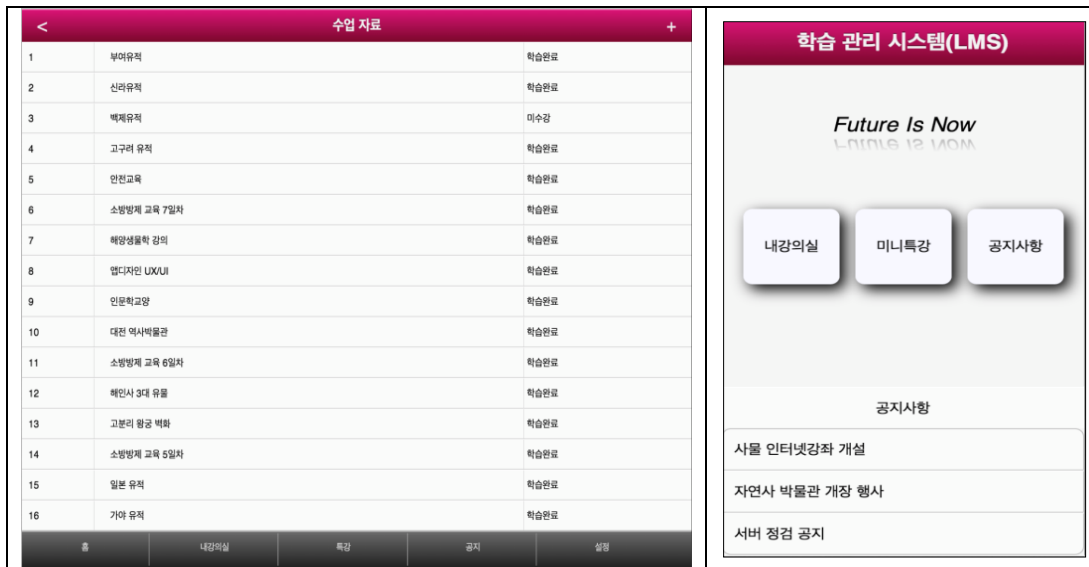


Figure 4. Tablet PC Interfaces and Mobile Device Interfaces

4.4. Real-time Provision of Contents According to the Learning Position of Mobile Device

In smart learning environment, the learner can learn while moving with carrying a mobile device. If there are contents organized intentionally by the teacher in every position and if the learner moves to another registered point beyond the boundary of contents in the current registered point, he/she should get the registered contents in the new point. The LMS implemented for context aware contents services in this study is designed to save the learner's position on the server every 30 seconds, and if the learner's position is removed from the registered point the system searches the contents again.

Figure 5 is a screen showing that a learner, carrying a mobile device at a specific registered point, interacts with contents corresponding to the position.

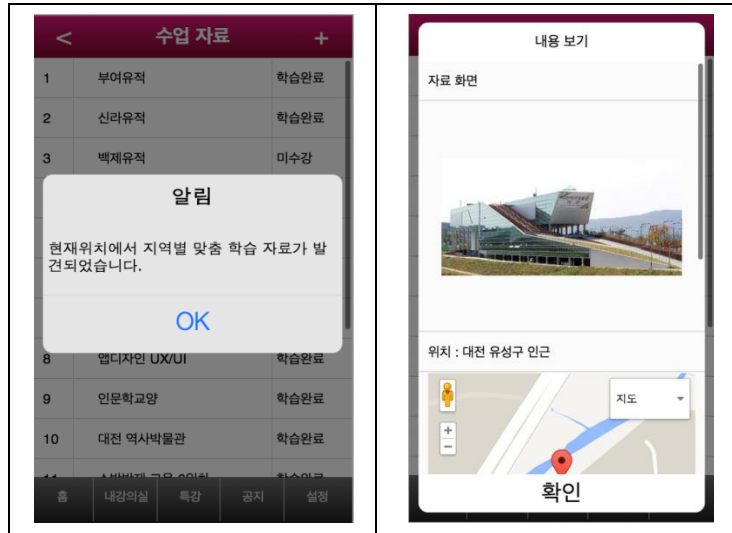


Figure 5. Location-Based Contents Corresponding to the Position

5. Conclusions

With the recent rapid transition of computing environment from PC-based to mobile device-based, there are active discussions for applying up-to-date information technologies to adapt LMS for e-learning services to new smart environment. However, e-learning in smart environment, namely, smart learning has encountered the major problem that PC-based contents do not work in mobile environment. Solutions are being proposed for the problem, but research has not been made much on the use of various functions and advantages of high-tech smart devices such as context aware contents services.

This study proposed a context aware contents service model that recognizes different learning contexts of learners based on personalized mobile devices, ubiquitous computing environment, etc. and provides knowledge constructed by teachers according to their teaching philosophy. For this, we suggested directions for the design and development of LMS supporting individual teachers to display their educational expertise in smart learning environment, and designed and implemented core functions and interface.

In LMS designed for smart learning in this study, context aware contents services were implemented as hybrid apps rather than as native apps, which are dependent on a specific platform. Therefore, they are usable in all smart devices including Android and IOS. One of current issues in LMS for smart learning is difficulty in application development on the OS platform of smart devices, and another problem is in the maintenance and repair of systems whose life cycle is short. In order to overcome these difficulties, our system consists of HTML5-based hybrid apps (Web apps). Of course, source-dependent native functions should be avoided as much as possible for the flexibility of the system, but some functions without standard had to be used inevitably. In addition, this system allows learners to manage their learning more actively than before using a smart device, but teachers also can register and manage organized contents to be taught at any time and in any place.

The context aware contents service model implemented in this study is a system in which learners' actual teaching-learning context is linked to elaborative contents to be taught by teachers. In the teaching-learning process, the learner is provided with contents services customized to the learner's context and learning level. Moreover, LMS implemented in this

study aimed to provide common user interface usable in any devices including PC and mobile platforms such as Android and IOS.

In addition, it is flexible LMS that delivers contents efficiently and manages learning processes in an integrated way even despite future changes in computing environment, and is expected to provide various education methods and learning contents based on contemporary information technologies.

References

- [1] G. Banavar and A. Bernstein, "Software infrastructure and design challengers for ubiquitous computing applications", *Communication of the ACM*, vol. 45, no. 12, (2002), pp. 94-95.
- [2] J. H. Ku, "A Study on the Development of Learning Management System based on Context-Aware for U-Learning", *Korea Technology Education Association*, vol. 10, no. 1, (2010), p. 237.
- [3] Korea Education and Research Information Service, "Issues Analysis of the Learning Management System in Smart Education", *RM 2012*, vol. 18, (2012), p. 11.
- [4] Korea Communications Agency, "The Applications and Future Prospects of Context Awareness Technology", *Issues & Prospects*, vol. 7, (2013), p. 2.
- [5] A. K. Dey, "Understanding and Using Context", *Personal and Ubiquitous Computing*, vol. 5, no. 1, (2001), pp. 3-4.
- [6] Korea Education and Research Information Service, "Html5 (Web standard languages) Trends and Prospects", *RM 2011*, vol. 4, (2011), pp. 7-10.
- [7] <http://skcceconsulting.tistory.com/m/post/112>

Author



Jin Hee Ku, she received the B.S. degrees in computer science from Hanbat University, Korea, in 1994. And She received the M.S. degree and Ph.D. degree in computer science Education & Industrial Education from ChungNam University, Korea in 2001 and 2010, respectively. Currently, She is an assistant professor of the Dept of Liberal Education, Mokwon University. Her main research interests include Smart Learning and Context-Aware and Learning Management System.