

# Empirical Analysis of Learning Effectiveness in u-Learning Environment with Digital Textbook

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## Abstract

The purpose of this study is to present innovative approaches for u-Learning environment in public education with Digital Textbook. The Korean Government has been making efforts to introduce the u-Learning environment to maximize the learning effect in public education with Digital Textbook. However, there are only a few studies that analyze the effectiveness of u-Learning environment and Digital Textbook. This paper reviews the current status of u-Learning environment in Korea and analyzes the satisfaction level with Digital Textbooks. The first survey regarding technological factors was collected from 197 students. The results of the survey revealed that the level of satisfaction has declined over a year. The weakness of the study is that the sample frame is insufficient and survey questions did not reflect diverse factors of learning effectiveness. To supplement these shortcomings, 2,226 students were asked about learning performance. The results of the survey showed that the satisfaction with Digital Textbooks is much higher than that of paper textbooks. However, this paper is limited to u-Learning environments in public education. Therefore, research needs to be improved by reflecting both public and private sectors of education in following studies. This paper suggests useful guidelines to educators in improving their u-Learning environment. \

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**Keywords:** Digital textbook, learning effectiveness, public education, technology enhanced Learning, u-Learning Environment

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## 1. Introduction

The educational environment in Korea is rapidly switching from the e-Learning environment to the u-Learning environment on the basis of the development of information and communication technology (ICT) and the focus of the government on this matter. In 2008, 45% of all Koreans had some experience of studying through e-Learning, and 26.2% of all educational courses were conducted through e-Learning, which shows that e-Learning has become one of the principal common methods of education [1].

The existing mode of e-Learning was offered in various forms of education, such as CBE (Computer-Based Education), Web-based education and e-Book, by combining education with computerization. However, such e-Learning tools have limitations in terms of time and place. u-Learning which is defined as an evolved concept of e-Learning refers to a form of education by which the desired educational environment is provided anytime and anywhere through diverse terminals, without limitations of time, place or environment, on the basis of a ubiquitous environment [2].

Recognizing the limitations of the existing textbook and e-Learning methods which used to be offered to learners, the Korean Ministry of Education, Science and Technology (MEST) is now establishing a new concept of public educational environment based on the u-Learning environment. Since 2007, the MEST has developed and provided services related to the Digital Textbook, a new form of textbook made by applying ubiquitous technologies to the paper textbook. The Korean Government has also made efforts to introduce a successful u-Learning environment maximizing the effectiveness of Digital Textbooks with a budget of EST USD 30 billion since 2008.

Digital Textbook should have the flexible and recyclable structure that supports type and content expansion, and served just in time for various learning environment changes, and meet various teaching and learning demands of teachers and learners. Therefore, utilization and implementation of ubiquitous technology that composes the u-Learning environment is the important factor for successful implementation of the Digital Textbook. The evolutionary u-Learning technology, in this case Digital Textbooks, is expected to boost the students' learning efficiency but studies regarding this subject is near to none.

Lee et al. reviewed Digital Textbook development cases in Korea through the case study from the 4 technical perspectives (infrastructure, software, contents, and network), and identified the problem [3]. In addition, they analyzed overall use satisfaction of the learner who uses the Digital Textbook. As this study was conducted 1 year after Digital Textbook introduction, it is expected that learner's satisfaction with the use of the Digital Textbook would have changed, when measured 2 years after introduction, compared with one year ago.

Therefore the objective of this research is to identify the human factor in an ubiquitous learning environment, measure the efficiency of the technologically innovative study method, and analyze the satisfaction among its users. Furthermore this research intends to measure the change of satisfaction level since the u-Learning environment was adopted by comparing results with previous research materials. In addition, the difference of learner's satisfaction will be analyzed, by comparing the result with precedent studies according to the time difference after the introduction of the u-Learning environment. This study intends to set useful guidelines that will contribute in improving the u-Learning environment in local regions furthermore serve as mandatory guidelines for countries adopting this innovative education technology.

This paper is composed of five parts. Section 2 reviews the literature review. Section 3 and 4 analyze a case study and detailing results. The final section draws conclusion.

## 2. Literature Review

### 2.1 u-Learning Environments

#### 2.1.1 Paradigm Shift in Learning Environment

The use of advanced computing, internet, and information communication technology in educational field has increased significantly during the last decade and promoted the paradigm shift in learning environment. The learning environment has progressed from conventional learning where learning activities are limited to paper textbook and within classroom settings to the technology enhanced learning. The concept of technology enhanced learning has also changed from e-Learning which was defined as computer-based learning, and later as networked-based learning, due to the development of the World Wide Web to the concept of m-Learning which was driven with the advancement in mobile and wireless technologies [5].

Compared to e-Learning, the advancements of m-Learning are flexibility, cost, size, ease of use and timely application [6]. The rapid development of these mobile technologies combined with access to diverse learning contents almost in anywhere and anytime, allows learners to have new experiences regarding learning in a variety of situations and not only in classroom, but in all of the school settings. This latest view on technology enhanced learning supported by wireless technologies and ubiquitous computing is referred to ubiquitous learning or u-learning [5]. It is an extension of the idea of ubiquitous computing, a term which describes the pervasive presence of computers in our learning and it is a new educational paradigm made possible by the application of various ICT devices and digitalization of divers learning materials [6]. Therefore, the concept of u-learning can be grasped through the characteristics of ubiquitous computing. That is, the characteristics of the ubiquitous computing environment - accessibility, immediacy and interactivity - are combined with the educational environment so that the desired study materials can be obtained anytime by connecting with them anywhere, thereby raising the amount of study in everyday life by making it possible for learners and teachers to interact [4][7]. Thus, the u-learning environment is an educational environment which allows students to study anytime and anywhere through diverse terminals without limitations of time, place or environment, whatever the surroundings of the students, even if they are not conscious of doing the educational courses [4][8][9].

**Table 1.** Comparison of technology enhanced learning systems [10]

Criteria	e-Learning	m-Learning	u-Learning
Learning Occurrence	Learning occurs only when learners access to learning material (learning space is separated from daily life)		Learning occurs anytime, anywhere in everyday life when individual have willingness for learning
Learning Devices	Network-supported PC	PDA, Mobile Phone, TPC, Wireless-Handheld Devices	Next Generation PC which support ubiquitous technologies such as RFID, USN, IPv6, Telematics, LBS and etc..
Learning Types	O-line learning and off-line learning are separated and have no relations		Intelligent and networked objects in physical and learning space by diverse

			sensors, chips and labels enable integration of on-line and off-line learning
Learning Space	Learning through cyberspace in secured physical space	Learning through cyberspace while moving around in physical space	Learning through cyberspace that is embedded in everyday physical space and learners are unaware of the space limitation

### 2.1.2 Characteristics of u-Learning Environments

The term u-Learning environment is used to support the overall definition of u-Learning that is “anywhere and anytime learning” and “learning with ubiquitous computing technology” [11] [12]. With these two different views of u-learning, Yahya et al. [11] proposed the definition of u-Learning as “a learning paradigm which takes place in a ubiquitous computing environment that enables the right thing at the right place and time in the right way”. And based on this definition, several researchers have proposed the characteristics and factors of u-Learning environment.

According to Boyinbode and Akintola, “u-learning environment (ULE) refers to a situation or setting of pervasive learning” which implies the high levels of embeddedness of ICT devices such as sensors RFID and etc. in learning environment [13].

Cheng et al. [14] have attempted to identify principles and methods for introducing u-learning activities and demonstrated how a u-learning system provides adaptive services via four steps: (1) Setting instructional requirements for each of the learner’s learning actions. (2) Detecting the learner’s behaviors. (3) Comparing the requirements with the corresponding learning behaviors. (4) Providing personal support to the learner.

Brown [15] proposed the ubiquitous technologies necessary for the learning space according to the characteristics of the students and the learning principles, while Nair [16][17] asserted that the wireless network, connection with high-speed Internet, distance learning and a technology-based environment are the most important principles for when designing spaces for u-Learning.

Graschew et al. [18] addressed 8 crucial factors for successful deployment of u-Learning. Those factors are integrated heterogeneous networks with seamless transitions, transparent(or invisible)platform technology layers, tailored services for the various segments of users and scenarios, personalized avatars for assisted cognition, intelligent data mining tools, strategies for improved and wide-spread technology acceptance, strategies for collaboration in virtual communities, and user-centric continuous evaluation.

Chen et al. [4] identified the main characteristics of m-learning as urgency of learning need, initiative of knowledge acquisition, mobility of learning setting, interactivity of learning process, situating of instructional activity, and integration of instructional content. And ever since then those characteristics have been adapted by various researchers to be part of the characteristics of u-Learning environment [11]. Considering three unique key features of handheld computing, Curtis et al. [19] proposed permanency, accessibility, and immediacy to be included in the characteristics of u-Learning environment.

Sung [6] proposed that the ubiquitous learning environment should provide learners with an interoperable, pervasive, and seamless learning architecture to connect, integrate, and share

three major dimensions of learning resources: learning collaborators, learning contents, and learning services and identified six main characteristics of u-Learning environment as permanency, accessibility, immediacy, interactivity, situation of instructional activities, and adaptability.

Hwang et al. [20] found that the view that the definition of u-Learning is to provide anywhere and anytime learning is hard to clearly differentiate the u-Learning from m-Learning and proposed that it is more appropriate to apply “context-aware u-learning” when defining the term u-learning. Regarding the definition, they proposed several significant characteristics of u-learning which include seamless services, context-aware services and adaptive services.

Finally, Yahya et al. [11] analyzed and compared the definitions of u-Learning and characteristics of u-Learning environment from above mentioned studies and proposed conclusive definition of u-Learning and characteristics of u-Learning environment. The characteristics of u-Learning they proposed are as followings:

**Table 2.** The characteristics of u-Learning environment [11]

Criteria	Description
Permanency	The information remains unless the learners purposely remove it
Accessibility	The information is always available whenever the learners need to use it
Immediacy	The information can be retrieved immediately by the learners
Interactivity	The learners can interact with peers, teachers, and experts efficiently and effectively through different media
Context-awareness	The environment can adapt to the learners real situation to provide adequate information for the learners

## 2.2 Digital Textbook

### 2.2.1 Characteristics of Digital Textbook

There are various definitions of the ‘Digital Textbook’, generally going beyond the meaning of simply digitalized study tools. Byeon et al. define the Digital Textbook as “a digitalized study material which has a search function and can use multi-media materials, in addition to having the merits of the paper textbook, by making electronic materials with the existing paper textbooks” [21]. Gwak et al. defined the Digital Textbook as a total teaching and learning tool which encompasses not only the basic functions of the paper textbook but also those of computer-aided learning, educational databases, multimedia materials, evaluation and the management of students [22]. According to Jeong et al., the Digital Textbook has study support and teacher support functions in addition to the basic functions of the paper textbook [23].

In light of such a range of functions, the Digital Textbook differs from paper textbook in terms of the form of the materials, the collection of materials, the direction of information, and the desired effects. KERIS compares the differences between paper textbooks and Digital Textbooks, as shown in Table 3 [24].

**Table 3.** Comparison between Paper Textbook and Digital Textbook

	<b>Paper Textbook</b>	<b>Digital Textbook</b>
Type of material	Print-based learning materials consisting mainly of texts and images	Multimedia study materials including sound, video, animation, virtual reality, etc.
Data collecting	Considerable time and expense required to find materials out of textbooks	Provide sufficient study experience through hyperlink with various educational materials connected with Digital Textbooks
Media for education	Print media	Information Communication Technology devices (Tablet PC / Desktop PC)
Direction of information	One-way learning mainly for knowledge transmission	Multidirectional study is possible among teachers, students and computers
Effects of lesson	Teach the whole class; it is difficult to teach according to the abilities of the individual students	Realize student-oriented class activities and self-regulatory study

Since 2007, the Korean government, especially MEST has been developing and providing the Digital Textbook in an effort to implement u-Learning environment in a public education. Various ubiquitous computing technologies are combined with paper textbook to increase leaning effect, learning performance and learning satisfaction. Therefore, it is important to identify the current status of Digital Textbook and how it fits the key requirement factors of u-Learning environment. **Table 4** explains current status of Digital Textbook and compares with concept of u-Learning environment.

**Table 4.** The Status of Digital Textbook for u-Learning environment [11]

<b>Criteria</b>	<b>Concept of u-Learning environment</b>	<b>Status of Digital Textbook</b>
Permanency	Learners can never lose their work.	Learners can export and store the data which were written on the Digital Textbook contents, and can upload those data on LMS
Accessibility	System access via ubiquitous computing technologies.	Learners can access to the Digital textbook system anytime via wire/wireless network.
Immediacy	Learners get information immediately.	Learners can immediately access to various web-based learning materials using learning contents for Digital Textbook or using internet.
Interactivity	Learners' interaction with peers, teachers, and experts effectively through the interfaces of u-learning systems.	Learners can experience interactive communications with teachers and other learners using functions of Digital Textbook such as instant messenger and LMS.
Context-awareness	The system can understand the learner's environment via database and sensing the learner's location,	Digital Textbook viewer implemented on each user's device provide personalized learning and



	personal and environmental situations.	information about learners is sent to and stored in main server.
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### 2.2.2. The Status of Digital Textbook in Korea

According to the MEST's plan to commercialize the Digital Textbook, a prototype of the Digital Textbook and the contents of such a textbook have been in development since 2007. Now, as of the first half of 2009, the infrastructure for Digital Textbook learning has been established and is ready for use in 184 classes at 92 schools.

#### 2.2.2.1 Infrastructure

To take the Digital Textbook class, students use an electromagnetically induced Tablet PC (TPC) with a 12-inch monitor, and a computer is installed in the classroom for the teacher to conduct the class. Remote support and management functions are included in the teacher's TPC to check the students' learning activities. Each student has an extra battery and an exclusive charger to minimize the time of learning stoppage due to the lack of a TPC battery.

The electronic board supports a pressure-sensing touch screen. It is larger than 70 inches and has WUXGA (1,920 X 1,200) of resolution to protect students' eyesight. It is made of non-reflective material to solve the problem of blind spots. Moreover, it has a built-in speaker of more than 15 Watts for multimedia classes. To minimize the network's load, which occurs whenever contents and software are updated, a set of contents servers has been installed at each school. In addition, to prevent fire caused by electricity after classes, a power timer has been installed to cut off the power automatically after a certain time while the terminals are being charged. As a result, a safer learning environment has been established.

#### 2.2.2.2 Software

The software for the Digital Textbook service is composed of a Digital Textbook contents viewer, support system, and an exclusive operation system based on Linux. The Digital Textbook contents viewer was developed in early 2008 as a Windows version, but due to the heavy licensing fee of the Windows operation system, and in an effort to prevent its subordination to a certain operation system for the development of the platform, additional platforms were developed in the latter half of 2008 using open source software, so now two versions are in service. Efforts are being made to integrate the two versions during 2009.

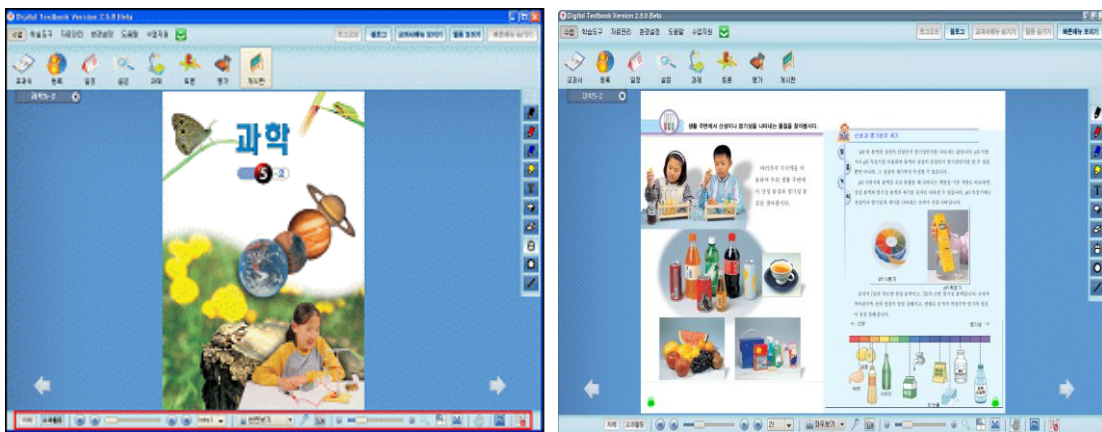


Fig. 1. Integrated version of Contents Viewer

The Digital Textbook Support System is a web-based application composed of the Learning Management System (LMS) and the Learning Contents Management System (LCMS). It supports interactive classes between teachers and students with functions for

managing students' learning histories, as well as for managing evaluations, class levels, and classes.

As the Tablet function is not provided in the ordinary commercial version of Linux, a device driver was developed to support the Tablet function in Linux, and additional functions such as quick booting, remote control and strengthened GUI environment have been developed to ensure an optimum Digital Textbook service.

#### **2.2.2.3 Contents**

Digital Textbook contents have been produced for the application of multimedia technologies such as video and animation, enabling learner and computer to interact through the learning contents, and complementing the function and role of the paper textbook whose purpose is the 'transmission of the contents of education'.

Digital Textbooks are currently in service with six subjects for 5th grade students (Korean language, English, Math, Society, Science and Music) and with four subjects for 6th graders (Korean language, Math, Society and Science). The contents and structure of the Digital Textbook are the same as those of the paper textbook.

#### **2.2.2.4 Network**

To provide the wireless network service in the classroom, 2 or 3 wireless AP-supporting IEEE802.11 a/b/g/n are installed on the ceiling. For the Internet connection, a 100-Mbps optical cable network is offered to each school by ISP. Within the school, the TPC, electronic board and teacher's PC are connected with the network switch and can use the Internet service. However, it is currently composed of the IEEE801-based wireless LAN only and therefore, there is a limitation that service may not be available if these devices are out of wireless LAN coverage.

### **2.3 Studies on Learning Performance and Effect**

Many studies have been performed regarding the factors that measure the learning effect and satisfaction of learners when e-Learning is employed, and diverse studies are under ways regarding satisfaction with u-Learning as the ubiquitous environment is supported. Most of these studies measured the learning effect by taking learning performance, learning attitude, satisfaction, and participation as the dependent variable. For the independent variable, measurements were conducted from several viewpoints.

Piccoli, Ahmad & Ives separated effectiveness of e-Learning into the personnel perspective (student and teacher) and design perspective (learning model, technique, learner control, contents, and interaction) [25].

Another study separated the factors into the system quality, service quality, and information quality, based on the successful information system model proposed by DeLone and McLean [26], the measurement items for each factor were developed and applied that fit into e-Learning [27].

Studies on effectiveness and performance of the Digital Textbook, which is under way in Korea, were mainly conducted for research schools by the specialized research group [28][29]. These studies have been analyzing how the use of the Digital Textbook affects the learning effect from the diverse perspectives.

In this study, learner factors are selected that affect the learning effect of e-Learning and u-Learning, using precedent studies, and satisfaction with each factor is measured and analyzed. Items of satisfaction with learning performance of the Digital Textbook are composed of ease of use from the system viewpoint, content configuration from the contents viewpoint, interest and flow of the learner, and interaction among subjects.

Reviewing existing studies on each item, Wang [30] and Lee [31] analyzed the effect on learning satisfaction by adopting "ease of use" as the main factor that affects the learning



environment provided by e-Learning item to the learner, as described in the system quality section of the IS success model proposed by DeLone and McLean [26].

When analyzing the learning contents from the information system perspective in the e-Learning environment, it is the information produced by the processing of the information system [26]. The learning contents were the important factor that affects learner's satisfaction in most studies regarding effectiveness of e-Learning [30][31].

Lee et al. compared and verified how the class using the Digital Textbook affects inducement of student's learning motivation, understanding on the course, participation, and interest, compared with the class based on the paper textbook. It was found that students are more interested in the Digital Textbook with better learning effect [3].

The concept of flow was developed by Csikzentmihalyi in 1975, and has been applied to a broad range of areas, and studied as a useful concept in describing interaction between human and machine [32][33].

Many studies proved that flow in learning acts as an important factor in the e-Learning environment, which affects learning performance and learning effect significantly by inducing self-driven learning and motivation of the learner [34][35].

"Interaction" refers to all actions exchanged among peoples, or between people and object in the certain environment given to the people, and the media that provide the possibility of these actions are said to be "interactive" [36]. Bork [37] interpreted interaction from the education technology perspective in such way that it can be the input required by the learning while responding to the computer, computer's analysis of the response by the learner, and computer's activity itself. In addition, various studies have been made with respect to interaction subjects (learner-teacher, learner-contents, learner-learner, etc.) [38][39]. Some studies claimed that interaction is an important factor that measures effectiveness of e-Learning [25][39][40].

### 3. Research Model

In this study, to find out effects of Digital Textbook on learners' performance and learning satisfaction, we propose research model and hypothesis based on the previous research result. Research model and hypothesis that we propose are as follows:

- H1: Ease of use in Digital Textbook systems will have a positive impact on the learning satisfaction
- H2: Content composition of the Digital Textbook will have a positive impact on the learning satisfaction
- H3: Interest in the Digital Textbook will have a positive impact on the learning satisfaction
- H4: Learners' Immersion in the Digital Textbook will have a positive impact on the learning satisfaction
- H5: Interaction on the Digital Textbook will have a positive impact on the learning satisfaction

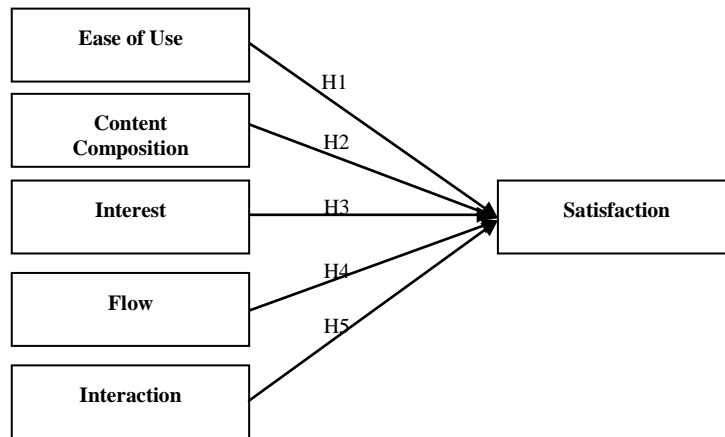


Fig. 2. Research Model

### 4. Empirical Analysis

#### 4.1 Satisfaction with Technological Factors

Lee et al. [3] analyzed the satisfaction concerning four technological factors of Digital Textbooks in 2008. Ever since the Digital Textbook was first developed and applied in 2008, software and contents continued to develop thanks to ongoing investment on infrastructure. Therefore it can be assumed that the satisfaction with technological factors has changed in 2009. In this chapter, the u-Learning environment of the Digital Textbook was analyzed from four technical perspectives identical to of Lee et al. [3] research. Annual comparison of overall satisfaction and satisfaction with each technological factor were reviewed.

The study sample includes 64 5<sup>th</sup> and 6<sup>th</sup> grade students in 2008 and 197 students in 2009 at Korean elementary school which adopted Digital Textbook service. Through analyses in terms of regarding infrastructure, software, contents, network, implications are derived for the critical success factors in u-Learning environment.

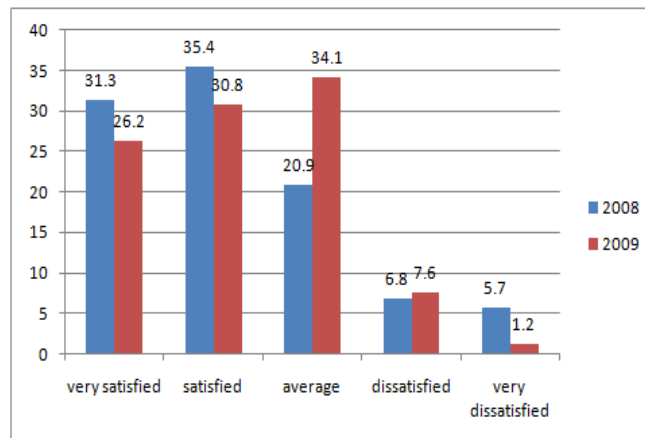


Fig. 3. Yearly Comparison of Overall Satisfaction

Fig. 3 shows student’s overall satisfaction with 4 technical factors in 2008 and 2009. The overall satisfaction (very satisfied + satisfied) was 66.7% in 2008. However, the satisfaction

decreased to 57% in 2009. According to the comparison, it can be inferred that insufficient experience with Digital Textbook results in lower satisfaction, because after a year a considerable number of new students new to the technology, join the Digital Textbook classes. Furthermore, increased complexity of use caused by a variety of new contents and features added to Digital Textbook in 2009 may have caused the lower satisfaction in 2009. Further research to find out what caused the decrease of satisfaction in 2009 must be conducted.

Even though overall satisfaction with 3 factors were low (very satisfied + satisfied), satisfaction with the network factor increased significantly (from 32.8% to 71.6%), which can be explained by improvement of speed degradation and network instability factors at the time of simultaneous access to the wireless AP, which was the problem of the model school in 2008, as well as 100Mb speed upgrade of the wireless Internet for each class, which ensures stable utilization of the Digital Textbook in learning and teaching. It can also be explained by the effort to minimize disconnection while connected to the network, by considering user’s movement line when establishing the infrastructure [41].

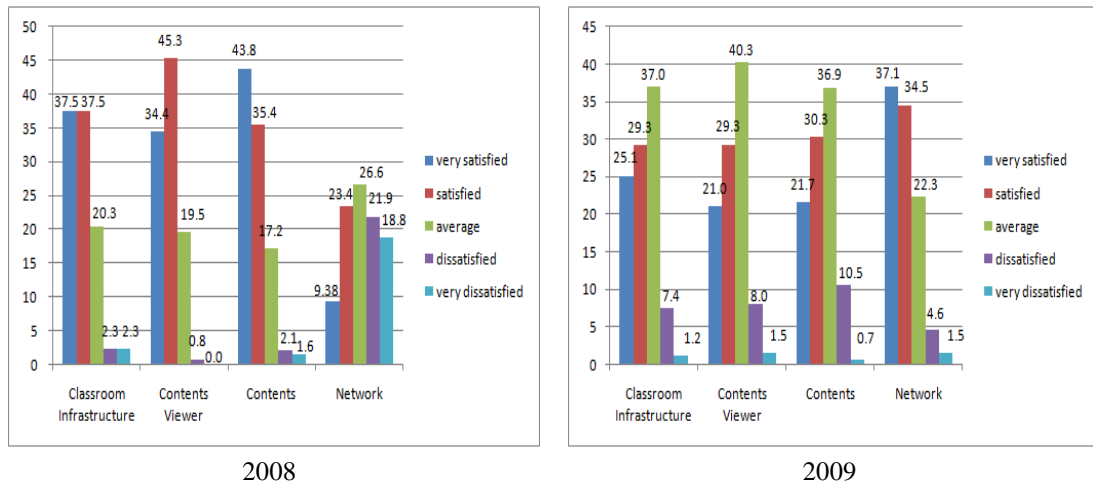


Fig. 4. Yearly Comparison of Satisfaction with each Technological Factor

## 4.2 Satisfaction with Learning Performance

### 4.2.1 Characteristics of the Sample

The collected answers to the questionnaire were processed using factor analysis, reliability verification, and regression analysis, using SPSS Win v12.0.

According to the result of satisfaction with technological factors, overall satisfaction decreased in 2009 compared to the previous year, but note satisfaction with technological factors does not offer information or insight on satisfaction with learning efficiency.

In this study, various items were used to measure satisfaction with the Digital Textbook, such as ease of use, content composition, interest, flow, interaction, and overall satisfaction. The research subject was 2,226 5<sup>th</sup> and 6<sup>th</sup> grade primary school students at the national-level school that offers Digital Textbook service. For comparison among groups, the same questionnaire (5 score scale) was given to 1,398 students at the same school who use the paper textbook. The questionnaire was distributed and collected between November 26, 2009 and December 1.

#### 4.2.2. Construct Validity and Reliability of Measurement Scales

In this study, internal consistency was checked using Cronbach's  $\alpha$  coefficient of the questionnaire items. Confidence of the items that measure overall satisfaction and satisfaction by item was over 0.8, which is the acceptance level according to Nunnally. Nunnally sets 0.7 as the threshold value of confidence [42].

To verify construct validity, factor analysis was conducted. The result of the analysis identified five independent variables which represent learning effectiveness and one dependent variables which represent overall satisfaction. And factor loadings of all six variables are over 0.5 whereas communality of all six variables are over 0.4 which explains high levels of significance [43].

**Table 5.** Result of Factor Analysis and Reliability Analysis

Variables	Items	Factor Loading	Communality	Eigenvalue	% of Variance	Cronbach's $\alpha$
Ease of Use	EOU_1	0.751	0.668	4.376	15.627	0.879
	EOU_2	0.770	0.732			
	EOU_3	0.744	0.697			
	EOU_4	0.750	0.701			
	EOU_5	0.657	0.599			
Content Composition	CC_1	0.551	0.674	4.030	14.392	0.877
	CC_2	0.524	0.651			
	CC_3	0.582	0.692			
	CC_4	0.668	0.751			
	CC_5	0.612	0.728			
Interest	INTEREST_1	0.547	0.615	3.500	12.501	0.890
	INTEREST_2	0.666	0.717			
	INTEREST_3	0.619	0.627			
	INTEREST_4	0.733	0.778			
	INTEREST_5	0.685	0.766			
Flow	FLOW_1	0.709	0.718	3.228	11.530	0.908
	FLOW_2	0.750	0.779			
	FLOW_3	0.626	0.610			
	FLOW_4	0.715	0.757			
	FLOW_5	0.618	0.713			
	FLOW_6	0.610	0.682			
Interaction	INTERACT_1	0.695	0.711	2.556	9.128	0.887
	INTERACT_2	0.715	0.785			
	INTERACT_3	0.727	0.728			
	INTERACT_4	0.685	0.745			
Overall Satisfaction	SAT_1	0.730	0.843	2.440	8.716	0.910
	SAT_2	0.745	0.868			
	SAT_3	0.673	0.795			

#### 4.2.3 Model Verification and Result of Analysis

To verify the hypothesis, regression analysis was conducted by taking the degree of overall satisfaction as a dependent variable and the five levels of learning effectiveness as independent variables. The following table shows result of analysis. The model was found to be significant (F-value = 735.479,  $p < 0.01$ ) where as  $R^2$  value is 0.624, which implies that it explains 63.4% of the distribution at the learning effectiveness level.

Judging from the significance level 0.05, all of the independent variables (ease of use, content composition, interest, flow, interaction) have significant effect on dependent variable

(overall satisfaction) among which the independent variables, 'interaction' has the most significance effect (0.319) on learning satisfaction. According to the regression analysis, all of 5 proposed hypotheses were accepted and those accepted hypotheses generated a significant level of t-values and standardized coefficients scores.

**Table 6.** Result of Regression Analysis

Variables	Std. Error	$\beta$	t-value	Sig.	Statistics
(Constant)	0.069		-0.148	0.882	R= .790, R <sup>2</sup> = .624, Adjusted R <sup>2</sup> = .623 F= 735.479, p= .000
Ease of Use	0.024	0.061	3.137	0.002**	
Content Composition	0.030	0.210	8.770	0.000**	
Interest	0.026	0.242	10.193	0.000**	
Flow	0.027	0.102	4.354	0.000**	
Interaction	0.023	0.284	13.880	0.000**	
Dependent Variable: Overall Satisfaction, **p<0.01					

### 4.3 Comparison of User Satisfaction

According to the satisfaction measurement result, the average satisfaction level of the students using the Digital Textbook was 3.65, whereas that of the students using paper textbook was 3.17. Students using the Digital Textbook have 15.2% higher satisfaction.

**Table 7.** Comparison of User Satisfaction

	Respondents	Cronbach's $\alpha$	Mean	Percentage
Students using Digital Textbook	2226	0.996	3.65	72%
Students using Paper Textbook	1398	0.962	3.17	62%

## 5. Conclusions

This study presented useful implications regarding the introduction of u-Learning in the future public education environment, by describing the Digital Textbook environment in Korea with four separate technical factors – infrastructure, software, contents, and network, and by measuring satisfaction of students in the actual school.

First, it was found that students' satisfaction with the Digital Textbook, which is the new learning media, is higher than the paper textbook, when the satisfaction level is compared between book-type textbook and Digital Textbook. It confirms the possibility that the Digital Textbook can replace the paper textbook, even though only 2 years have passed since the model service was provided.

In addition, there was no improvement in the overall satisfaction level when it is compared for 2 years. The reason is that 5<sup>th</sup> grade students use the Digital Textbook each year, whereas 6<sup>th</sup> grade student could not accumulate the experience in the Digital Textbook. However, the increase in satisfaction with the network, which is one of the technical factors that enable learning in the ubiquitous environment, is quite meaningful in successful future implementation of the Digital Textbook in Korea.

Moreover, among the variables that have significant effect on learning satisfaction, 'Interaction' has the most significant effect on learning satisfaction. The other variables 'Interest', 'Content Composition', 'Flow', 'Ease of Use' in an order also have significant effect on satisfaction. It explains that interaction which is one of the key factors of u-Learning

environment is strongly correlated with learners' satisfaction and a diverse ICT based learning tools and content composition for Digital Textbook such as multimedia player, hyperlink and instant messenger for interactive communication have positive effect on learners' interest which then affect the learners' satisfaction.

The currently implemented u-Learning environment provides the learning environment through the computer connected to the Internet only, which imposes the physical limitation. Traditionally, learners were required to adapt themselves to the given learning environment. However, the paradigm will be shifted in the future intelligent u-Learning environment that the learning environment is customized to each individual learner.

This study is meaningful in that it can be the initial study of understanding technical factors, which must be available while the educational environment is changing to the ubiquitous environment, by analyzing the deployment case of the Digital Textbook – the actual part of the ubiquitous learning environment in Korea.

However, this study is limited to analysis of overall satisfaction with 4 factors by students and teachers using the Digital Textbook, and findings of identified problems. Therefore, more in-depth studies are needed to figure out more items that can measure satisfaction of each factor, and the method of resolving identified problems when establishing the future ubiquitous educational environment. Lastly, the study is needed regarding how to apply SOA, web 2.0, Symantec web, and next-generation network technology to the Digital Textbook service environment, which can supplement the u-Learning environment further.

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