Factors influencing the Usage and Acceptance of Multimedia-based Digital Textbooks in Pilot School

Mi-Ryang Kim[1], Mi-Ae Choi[2] and Jaehyoun Kim[1]
[1] Department of Computer Education, Sungkyunkwan University
Seoul, Korea
[2] KERIS, Seoul, Korea
[e-mail: {mrkim@skku.ac.kr , cma1020@keris.or.kr]
*Corresponding author: Jaehyoun Kim

Received March 21, 2012; accepted May 16, 2012; published June 25, 2012

Abstract

Digital textbooks, considered as core textbooks tailored to the abilities and interests of students, provide them with a combination of textbooks, reference books, workbooks, dictionaries and multimedia contents. In this paper, we employ a modified version of the Technology Acceptance Model(TAM), a model which has been widely used and empirically validated to explain why individuals use a particular information technology(IT). This paper proposes that additional variables, such as educational impacts, contents quality, interaction and enjoyment, enhance our understanding of behaviors of pilot school teachers in using multimedia-based digital textbooks as a substitute for traditional paper-version of textbooks. A structural equation model is employed with survey data from 157 pilot school teachers in pilot program supported by Korean government and KERIS(Korea Education & Research Information Service), to empirically assess the strength of the relationships in the proposed model. It is hoped that the results from this study provide meaningful insight into the development and delivery of high quality digital textbooks.

Keywords: Digital Textbooks, TAM, contents quality, interaction

This paper is extended and elaborated based on paper presented at ICoME 2011, Seoul, Korea.

http://dx.doi.org/10.3837/tiis.2012.06.012

1. Introduction

Digital textbooks can be defined as core textbooks for students, with which students can learn contents that are tailored to their abilities and interests [1]. These new, digital versions of textbooks offer various interactive functions, and provide the learner with a combination of textbooks, reference books, workbooks, dictionaries and multimedia contents such as video clips, animations, and virtual reality, both at school and at home, without the constraints of time and space [2]. Digital textbooks accumulate and manage the knowledge and study achievements of students and the school community, and support teachers by providing rich and authentic resources. Students can create their own textbooks by combining the textbook contents with reliable knowledge of their own. Customization through digital text book is going to have a great impact on learning.

The fact that digital information can be processed in logical and mathematical ways enables a high level of interactivity [3][4] and provide the learners with individualized study environment. Video and animation can be controlled by the reader in much the same way that we control movies in digital forms. With multimedia-based digital textbooks, students can not only copy and paste, but they can use their computers to analyze data, or enhance images or other types of digital contents in order to develop answers to the questions [5][6][7]. Another unique characteristic of multimedia-based digital textbooks is the fact that the information can be connected in such a way that words and concepts are hyper-linked to related pages or external documents, and the textbook is constantly updated as new content is generated in the cyber space.

While these strategic advantages of multimedia-based digital textbooks over traditional textbooks seem promising and appealing [8][9][10], a critical factor for realizing long-term success is the perceived satisfaction of teachers. For example, teachers are not used to planning interactive teaching strategies in advance of planning their delivery of content. It can particularly be really challenging for teachers to change their roles to the promoters of highly interactive learning. Teachers differ from general end-users of information technology in business settings. For instance, they are independent and have complete control over what they teach and how they teach. Such characteristics affect teacher adoption of new technologies such as digital textbooks, and, as a result, the literature on technology adoption processes in private industry may not fully apply to school setting.

The goal of this paper is to help us understand the factors influencing the usage and acceptance of multimedia-based digital textbooks, particularly in Korean pilot school teachers. We employ a modified version of the Technology Acceptance Model(TAM), a model which has been widely used and empirically validated to explain why individuals use a particular information technology (IT). In studies using the Technology Acceptance Model, users' perceptions of both the usefulness of IT and its ease-of-use have been found to be key determinants of individual technology adoption [11]. This paper proposes that additional variables, such as educational impacts, contents quality, interaction and enjoyment, enhance our understanding of behaviors of teachers in using multimedia-based digital textbooks as a substitute for traditional paper-version of textbooks.

In this study, a structural equation model is employed with survey data from 157 pilot school teachers in pilot program supported by Korean government and KERIS(Korea

Education & Research Information Service), to empirically assess the strength of the relationships in the proposed model.

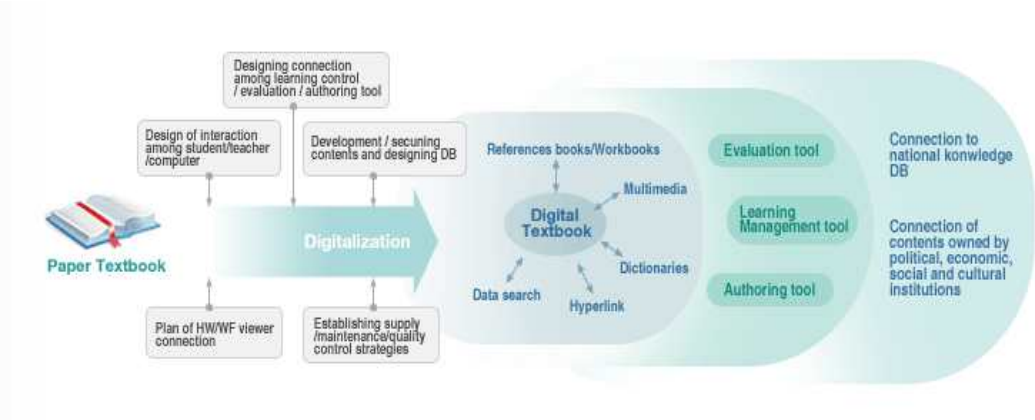

Fig. 1. The concept of digital textbook [2]

2. Development of Research Hypotheses

Technology Acceptance Model (TAM) has received considerable attention from researchers in IT field over the past two decades. TAM proposed by Davis (1989) [12] adapted the belief attitude-intention-behavior chain to understand the determinants of IT acceptance and use, and attempted to explain an individual's actual behaviors or behavioral intentions, based upon the user's perception of the usefulness and the ease of use of a particular IT.

Fig. 2 illustrates the modified version of TAM examined in this paper, with perceived benefit replacing perceive usefulness. Our model asserts that the intention to use digital textbooks is a function of its perceived benefit by teachers and perceived ease-of-use.

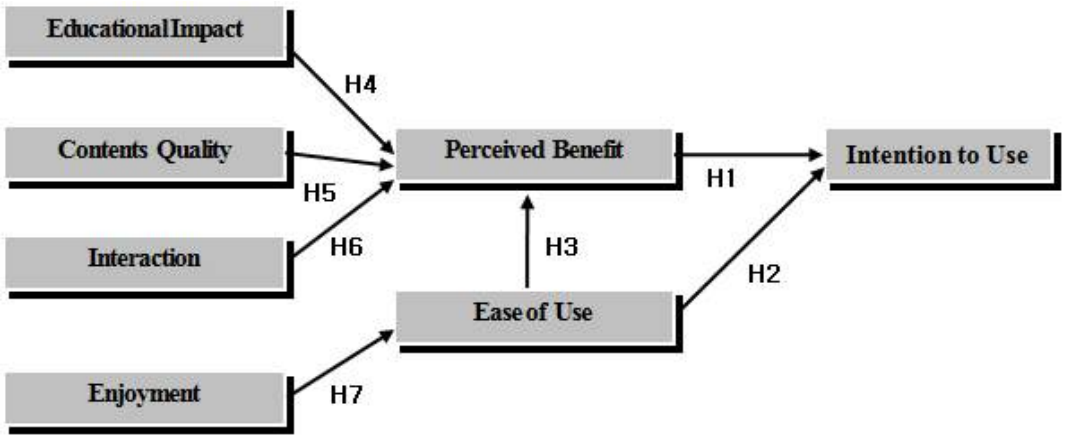

Fig. 2. Proposed model

In the context of multimedia-based digital textbooks acceptance, perceived benefit can be defined as the extent to which teachers believe that using digital textbooks in regular

classrooms would improve the quality and effectiveness of their class, whereas ease-of-use refers to the extent to which teachers believe that using digital textbooks is relatively easy to accomplish. We propose the following TAM-related hypotheses in the context of digital textbooks acceptance:

Hypothesis 1. Perceived benefit that can be expected from using digital textbooks in regular classrooms is positively related to intention to use digital textbooks.

Hypothesis 2. Perceived ease of use in using digital textbooks is positively related to intention to use digital textbooks.

Hypothesis 3. Perceived ease of use in using digital textbooks is positively related to Perceived benefit.

Bringing texts onto a digital platform provides an opportunity to make the book customized for the needs of each individual student [13]. Since every text and lesson is editable with digital tools, it allow students to answer and markup directly on the digital document, and gives question-specific explanations to solidify understanding of each concept. The digital textbook and it's supporting platform can also provide easy access to a multitude of grade levels and subject areas [14]. Whether students need a challenge or need to review, they can utilize every skill with instant resources, and improve their problem-solving abilities. Ability to add teachers' own text, audio and visual content or utilize pre-recorded multimedia contents provides teachers with comprehensive digital lessons and textbooks, to enrich, remediate and reinforce curriculum. All these interactive aspects of multimedia-based digital textbook help students concentrate for a considerably longer time and being more creative. With properly customized digital textbooks, students have more potential to develop their concentration skills and creativity to improve academic performance and life in general. Hence we suggest the following.

Hypothesis 4. Educational impact is positively related to perceived benefit.

Considerable uncertainty and questions remain regarding the subject matter and content quality and structure of digital textbooks best suited to classrooms. The perceived value of content reflects the quality of course concepts including textbooks, reference books, workbooks, dictionaries and multimedia contents such as video clips, animations, and virtual reality etc, being likely to affect students' perceptions of learning experience [15]. Prior studies concerning e-learning contents confirmed that perceptions of the effectiveness of what constitutes a high-quality content-based relationship are multifaceted [16][17]. Since digital textbooks offer various interactive functions, and accumulate the knowledge and study achievements of students and the school community, the design and organization aspect of course structure, along with interaction and evaluation aspects of the contents are extremely important for effective learning. But the social norms, similar to those applied in the traditional classroom, are not available in classrooms using the digital textbooks, and teachers must be explicit regarding the structural aspects of the course, to maximize their expect benefits from using digital textbooks. With these perspectives in mind, we suggest the following hypothesis.

Hypothesis 5. Contents quality of digital textbooks is positively related to perceived benefit.

Conceptually, digital textbooks are expected to offer various interactive functions to fit students' personal characters and levels(KERIS). Interaction among participants in classroom is acknowledged to be an indicator of successful learning experiences, contributing to both achievement and student satisfaction**.** Research findings contend that interaction can enrich learning outcomes [18][19][20][21]. Through effective interactions among students, they gain better understanding of the knowledge and become more committed to further learning.

Digital textbooks includes practice quizzes and tests, and provide students instant scoring feedback, along with the correct answers. The benefit of digital textbook is that it makes information more accessible. For instance, students can easily watch brief videos depicting a teacher explaining each concept. If the videos are right there on the digital textbook, while the students are doing the work, they are more apt to watch them than the other students with the normal textbooks, who would have to turn on a computer and go online to watch them [22]. The digital textbook also allows the teacher to monitor students' progress. This function helps teachers to figure out whether the majority of the class is understanding the material, or what mistakes they are making. We expect these interactive aspects of digital textbooks to increase the level of perceived benefit, and propose the following hypothesis.

Hypothesis 6. The level of interaction induced from using digital textbooks is positively related to Perceived benefit.

In the context of emerging technology applications, enjoyment is defined to be the extent to which the activity of using a system is perceived to be personally enjoyable in its own right, aside from the instrumental value of the technology [23]. Venkatesh [11] and Sun, H. & P. Zhang [24] conceptualized enjoyment as an antecedent of ease of use, whose effect increases over time as users gain more experience with the system. Since the usability of new technologies such as digital textbooks is indirectly established by the significant role of perceived enjoyment [25], we propose the following hypothesis.

Hypothesis 7. Enjoyment from using digital textbooks is positively related to ease of use.

3. Research Method

3.1 Data Collection

The participants for this research endeavor were teachers of pilot schools for multimedia-based digital textbook research supported by KERIS. We e-mailed a letter asking for completing the survey to all the participating teachers, and a total of 157 teachers self-administered a 35-item questionnaire. **Table 1** summarizes the profiles of the respondents.

Table 1. Profiles of respondents

		frequency	percentage (%)
age	20-29	25	16%
	30-35	77	49%
	36-40	42	26%
	over 40	13	8%
years of teaching experiences	under 5	34	22%
	6 - 10	40	25%
	11 - 15	29	18%
	16 - 20	24	15%
	over 20	30	19%
gender	male	77	49%
	female	80	51%

3.2 Measurement

To ensure the content validity of the scales, the questionnaires were developed from the literature. The list of the items is presented in **Table 2**. The respondents indicated their agreement or disagreement with the survey instruments using a five-point Likert-type scale. In addition, we measured demographic variables such as gender, age, and teaching experiences.

Table 2. List of Scale Items

construct	Scale Items
Perceived Benefit (Usefulness)	Teaching with digital textbooks generates the educational effects not possible from the traditional textbooks. Teaching with digital textbooks provides the students with more educational contents and real world experiences than with the traditional textbooks. Digital textbooks provide students with the customized contents which they have never have been exposed. Through digital textbook-based classes, students learn and experience a lot.
Ease of Use	With proper teaching manual, it is not difficult to use digital textbooks in classrooms. It does not take too much time to prepare the class with digital textbooks. I feel comfortable with the class using digital textbooks.
Educational Impact	Classes using digital textbooks can help students to concentrate more in the classroom. Classes using digital textbooks can help students to be more creative. Classes using digital textbooks can help students to improve the problem-solving capability. Customizing digital textbooks to class subjects can help students to be more creative.
Interaction	Classes with digital textbooks increase the interaction between teachers and students. Classes with digital textbooks increase the interaction among students. With digital textbooks, it is easy to change the class toward focusing more on discussion and collaborative study.
Contents Quality	Digital textbooks provide teachers with a variety of functions for classroom. Contents and resources of digital textbooks are sufficient. The levels of study contents are appropriate.
enjoyment	Digital textbooks make the teaching experiences to be more enjoyable. Digital textbooks can transform the boring class to be more enjoyable.
Intention to use digital textbook	I feel satisfied with the contents and functions provided by digital textbooks. I intend to use digital textbooks for my classes. I am planning to use digital textbooks more for classes.

4. Data Analysis and Results

The Partial Least Squares (PLS) technique was selected to test the proposed model. This method is designed to reflect the theoretical and empirical characteristics of social sciences and behavioral characteristics. The PLS technique permits the simultaneous testing of hypotheses while also allowing measures with single and multiple items and the use of formative and reflective indicators. In this research, Smart-PLS version 2.0 M3 has been used. Reliability and convergent validity of the constructs were estimated by composite reliability, factor loading and average variance extracted, all of which are summarized in **Table 3**.

Table 3. Results from a confirmatory factor analysis

construct		loading	average variance extracted(AVE)	composite reliability	Cronbach's alpha
Intention to use digital textbook	int1	0.812	0.801	0.923	0.874
	int2	0.939			
	int3	0.928			
Perceived Benefit (Usefulness)	benefit1	0.759	0.651	0.882	0.822
	benefit2	0.791			
	benefit3	0.841			
	benefit4	0.835			
Ease of Use	ease1	0.816	0.652	0.849	0.735
	ease2	0.796			
	ease3	0.811			
Educational Impact	Impact1	0.816	0.723	0.912	0.872
	Impact2	0.886			
	Impact3	0.853			
	Impact3	0.842			
Interaction	inter1	0.920	0.825	0.929	0.886
	inter2	0.919			
	inter3	0.868			
Contents Quality	content1	0.872	0.778	0.913	0.858
	content2	0.888			
	content3	0.885			
enjoyment	enjoy1	0.867	0.771	0.871	0.704
	enjoy2	0.889			

Table 4 provides the mean and variance of each construct. All of the factor loadings of the items were greater than 0.7, well above the recommended level for significance. The Composite reliability for all constructs was above the 0.70, threshold for explanatory research. Average extracted variances(AVE) were all above 0.50 meaning more than one-half of the variances observed in the items were accounted for by their corresponding constructs. Since the square root of the AVEs are greater than all the inter-correlation among constructs, the discriminant validity is also confirmed.

Table 4. Descriptive Statistics of Constructs

Construct	Mean	Variance
Intention to use	3.49	0.92
Perceived Benefit	3.74	0.60
Ease of Use	3.37	0.66
Educational Impact	3.77	0.53
Interaction	3.15	0.80
Contents Quality	3.06	0.70
enjoyment	3.82	0.59

In the PLS method, the structural model is evaluated by examining the values of R square(the explained variance of the constructs), the path coefficients and corresponding t-values. **Fig. 3** and **Table 5** show the statistical results obtained in the bootstrap test. The R square values

were all above 10%, recommended minimum level, indicating that the proposed structural model yields excellent goodness of fit.

The result shows, as expected, that the perceived benefit the most salient antecedent of teachers' intention to use the digital textbooks in the future, supporting hypothesis H1. As also expected from TAM literature, hypotheses H2 and H3 were supported in that both perceived ease of use had significant positive effects on behavior intention and perceived benefit. Three paths from the external variables to perceived benefit construct were found to be significant. Hypothesis 4, 5 and 6, concerning the effects of educational impact, perceived quality of course content and induced interaction from digital textbook on the perceived benefit, were supported. Statistical results concerning hypothesis 7 confirm that enjoyment has significant effect on perceived ease of use.

Table 5. Properties of the casual paths

hypothesis	path	path coefficient	t-value	test result
H1	Perceived Benefits → Intention	0.619	10.16	accept
H2	Ease of Use → Intention	0.227	3.24	accept
H3	Ease of Use → Perceived Benefits	0.173	2.95	accept
H4	Educational Impact → Perceived Benefits	0.386	6.63	accept
H5	Contents Quality → Perceived Benefits	0.246	4.44	accept
H6	Interaction → Perceived Benefits	0.265	4.52	accept
H7	Enjoyment → Ease of Use	0.505	7.80	accept

*) all significant at p £¼ 1%

The explanatory power of the structured model is shown in **Fig. 3**. R^2 values show that the perceived benefit and the ease of use account for 61.3% of variance in intention to use, whereas four antecedents account for 74.4% of variances in the perceived benefit. 25.5% of variances in ease of use are accounted for by enjoyment, the only external variable to ease of use.

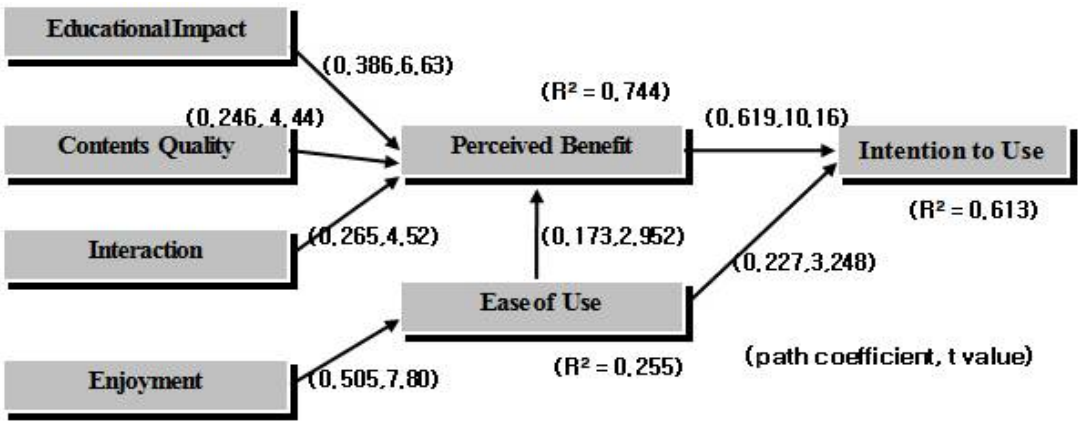

Fig. 3. Results of the Structural Modeling Analysis

5. Conclusion

This study examined the causal relationships among determinants of intention to use multimedia-based digital textbooks in classroom. As expected, our findings supported the appropriateness of using TAM to understand the attitudes of teachers. Both perceived benefit and perceived ease of use on behavior intention appeared to be significant determinants, with perceived benefit exerting a stronger influence than perceived ease of use, similar to the results from a majority of previous research comparing the relative explanatory power of perceived usefulness and perceived ease of use.

Consistent with our hypothesis, in the early stages of adopting the new technology, perceived ease of use can also be a major determinant of technology use for teachers. Once they gain experience through comprehensive support and interactive technology, perceived level of benefit and ease of use would improve, enabling them to have high levels of success in using digital textbooks. Other elements, which we assume to contribute to perceived benefit for this research include educational impact, perceived quality of textbooks and interaction. These salient antecedents of perceived benefit are all based upon the interactive and technological aspects of digital textbooks, still at the earlier stage of development. In the context of ICT applications, enjoyment or fun is often conceptualized as an antecedent of ease of use. In digital textbook case, this proposition still holds to be significant.

Results should be treated with caution for several reasons. First, the findings presented here were obtained from a single study that targeted teachers participating in the pilot research program supported by Korean government and KERIS. Caution needs to be taken when generalizing our findings to other institutions. Second, responses to this study were voluntary and thus subject to self-selection biases. Third, this research was conducted with a limited set of determinant for behavior intention. Additional research is definitely needed to evaluate the teachers' attitude with additional constructs. Longitudinal evidences may also enhance the understanding of causal relationships among factors.

References

[1] http://en.wikipedia.org/wiki/ Digital_Textbook

[2] http://www.dtbook.kr/renew/english/sub/dt_book_introduce.htm

[3] Warlick, D., Textbooks of the future, 2004.

Available at http://www.techlearning.com/article/textbooks-of-the-future/45182

[4] McCarthy, D., Mobile perspectives: On e-Books. E-Reading: The transition in higher education, *EDUCAUSE Review,* vol.46, no.2, pp.20-27, 2011. Available at http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume46/iMobilePerspectivesOnebooksibr/226161

[5] Heider, K., Laverick, D., & Bennett, B., Digital textbooks: The next paradigm shift in higher education *AACE Journal,* vol.17, no.2, pp.103-112, 2009. Article (CrossRef Links).

[6] Mardis, M., Everhart, N., Smith, D., Newsum, J., & Baker, S., *From paper to pixel: Digital textbooks and Florida's schools. A White Paper*, 2010. Available at http://www.eric.ed.gov/PDFS/ED522907.pdf

[7] Williamson, J., E-readers or traditional books: Which is better for education?, 2010. Available at http://www.distance-education.org/Articles/E-readers-or-Traditional-Books--Which-Is-Better-for

-Education--232.html

[8] Taylor, C., Editorial: Digital books can provide convenience, 2008. Available at http://www.baylor.edu/lariat/news.php?action=story&story=53559

[9] Waters, J. K., Can tech transcend the textbook? *Campus Technology,* vol.24, no.7, pp.34-41, 2011.

Available at http://campustechnology.com/articles/2011/03/01/ can-tech-transcend-the-textbook.aspx

[10] Reynolds, R., Trends influencing the growth of digital textbooks in US higher education. *Publishing Research Quarterly,* vol.27, no.2, pp.178-187, 2011. Article (CrossRef Links).

[11] Venkatesh, V., "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model." *Information Systems Research,* vol.11, pp.342–365, 2000. Article (CrossRef Links).

[12] Davis, F. D., "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly,* vol.13, no.3, pp.319–340, 1989. Article (CrossRef Links).

[13] Weisberg, M., "Student Attitudes and Behaviors Towards Digital Textbooks." *Publishing Research Quarterly,* vol.27, no.2, pp.188-196, 2011. Article (CrossRef Links).

[14] Nelson, M. A., "Is higher education ready to switch to digital course materials? The cost of textbooks is driving electronic solutions. Chronicle of Higher Education," vol.55, no.14, 2008. Available at http://www.viet-studies.info/Etextbook_CHE.pdf

[15] Peltier, J. W., Schibrowsky, J. A., & Schultz, D. E., "Interactive integrated marketing communication: Combining the power of IMC, new media and database marketing. *Internationa"l Journal of Advertising,* vol.22, pp.93-115, 2003. Article (CrossRef Links).

[16] Drago, W., Peltier, J.W., & Sorensen, D., "Course content or instructor: Which is more important in online teaching?" *Management Research News,* vol.25 no.6/7, pp.69-83, 2002. Article (CrossRef Links).

[17] Wang, Y-S., "Assessment of learner satisfaction with asynchronous electronic learning system." *Information and Management,* vol.41, pp.75-86, 2003. Article (CrossRef Links).

[18] Arbaugh, J. B., "Virtual classroom characteristics and student satisfaction with internet-based MBA courses." *Journal of Management Education,* vol.24, no.1, pp.32-54, 2002. Article (CrossRef Links).

[19] Piccoli et al., Piccoli, G., Ahmad, R., & Ives, B.,. "Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic it skills training." *MIS Quarterly,* vol.25, no.4, pp.401-426, 2001. Article (CrossRef Links).

[20] Swan, K., "Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses" *Distance Education,* vol. 22, no.2, pp.306–331, 2001. Article (CrossRef Links).

[21] Hong, K. S., "Relationships between students' and instructional variables with satisfaction and learning from a Web-based course." *Internet and Higher Education,* vol.5, pp.267-281, 2002. Article (CrossRef Links).

[22] Huang, Y., & Pollak, O., "Tech Tools: Schools transition from traditional textbooks and chalkboards to sleek, interactive tools", 2011. Article (CrossRef Links).

[23] Davis, F.D., Bagozzi, R.P., & Warshaw, P.R., Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology,* vol.22, pp.1111–1132, 1992.

[24] Sun, H., & Zhang, P., "Causal relationships between perceived enjoyment and perceived ease of use: An alternative approach." *Journal of the Association for Information Systems,* vol.7, no. 9, pp.618- 645, 2006.

[25] Shin, D., "User acceptance of mobile Internet: Implication for convergence technologies." *Interacting with Computers,* vol.19, no.4, pp.45–59, 2007.

Mi-Ryang Kim received her B.A. degree in English Language and Literature from Seoul National University, Seoul, Korea, M.S. from Lehigh University, U.S.A. and Ph.D. degree in Educational Method and Technology from Seoul National University, Seoul, Korea. Since 1999, she has been teaching as an associate professor at the Dept. of Computer Education in Sungkyunkwan University, Korea. Her research interests include instructional design for e-Learning contents, diffusion of innovation such as ubiquitous computing and robotics in education, and development of instructional strategies. (First Author)

Mi-Ae Choi received her B.A. degree in computer science from Hanseo University, ChungNam, Korea, M.S. degree and Ph.D. degree in computer education from Sungkyunkwan University, Seoul, Korea. Currently she is a researcher at KERIS. Her research interests include instructional design for digital textbook, future education, e-Learning contents such as development of instructional strategies.

Jaehyoun Kim received his B.S. degree in mathematics from Sungkyunkwan University, Seoul, Korea, M.S. degree in computer science from Western Illinois University and Ph.D. degrees in computer science from Illinois Institute of Technology in U.S.A. He was a Chief Technology Officer at Kookmin Bank in Korea before he joined the Department of Computer Education at Sungkyunkwan University in March 2002. Currently he is an associate professor at Sungkyunkwan University. His research interests include object-oriented modeling and design, software architecture, software process issues, and computer education.