

Exploring Factors Affecting the Emotions of Middle School Students toward Using Digital Textbooks

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The purpose of this study is to investigate the emotions of students toward using digital textbooks, and to examine the factors affecting the emotions. This study examined the relationship between individual characteristics and computer usage, students' emotions, and the perceived learning effects. For this study, 2,950 1st grade middle school students participated in a survey which measured individual characteristics, computer usage behavior, emotions toward using digital textbooks, and perceived learning effects of digital textbooks. The results showed that positive emotions toward using digital textbooks were higher than negative emotions. The students' positive emotions were most affected by intrinsic motivation, self-regulated learning, and student's use of computers for learning and entertainment. Similarly, perceived learning effects were positively correlated to intrinsic motivation and self-regulated learning, but the students' positive emotions towards using digital textbooks was the strongest predictor. Digital textbook efficacy was the most influential factor that affected the students' negative emotions, while computer addiction was associated with negative emotions.

Keywords : Digital textbooks, Student's emotion, Perceived learning effect, Individual characteristics, Computer usage

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Introduction

The Korean government has been pursuing innovation in teaching and learning methods using ICT in K-12 education for the past two decades. Recently, the Korean government proposed the SMART education agenda by establishing a master plan for future education (Korean Ministry of Education, 2011). The term “SMART education” means self-directed, motivated, adaptive, resource-enriched, and technology-embedded (SMART) education. One example of SMART education is the educational use of digital textbooks for teaching and learning in K-12 education (Leem & Sung, 2019).

Digital textbooks have a special meaning in Korea. The Korean Ministry of Education has developed digital textbooks and applied it to schools in order to promote the interest and self-directed learning in students from the current digital generation. The Korean Ministry of Education defines digital textbooks as ‘a textbook for students with an abundance of learning materials as well as learning support and management functions added to the existing curriculum (book-type textbooks), such as terminology dictionary, multimedia data, evaluation items, and supplementary learning contents’ (Korean Ministry of Education, 2014). Digital textbooks are a type of electronic textbooks, but they have a special meaning in that they refer to e-textbooks certified by the government. That is, if an e-book refers to a digitized version of a printed book that can be viewed on a computer or an electronic device, e-textbooks or digital textbooks refer to e-books used for teaching and learning. The term "digital textbook" used in this study refers to an e-textbook certified by the government that was developed on the basis of a conventional textbook.

In previous studies on digital textbooks, students perceived multimedia, highlights, notes, glossary lookups, annotations, bookmarks, and search functions as advantages of using digital textbooks (Lim et al., 2014; McFall et al., 2006; Simon, 2001). According to a study that observed digital textbook classes, students had a

positive experience accessing various references on the Internet, engaging in-depth inquiry learning with experimental videos and zoom-in functions, and sharing his or her thoughts more actively with others (Sung et al., 2017). Moreover, it has been reported that these digital textbook classes had a positive effect on learning outcomes such as scientific inquiry skills, problem solving ability, communication, positive perception of instruction, class satisfaction, etc. (Lee & Hong, 2010; Cha, Kye & Jeong, 2017; Cheon, Jeon, & Bang, 2014; Choi & Seo, 2009; Han, 2014; Heo & Lew, 2015). However, lower user-friendliness and display than the printed textbooks, difficulties in installing e-textbook software, and lack of power outlets have been pointed out as limitations of digital textbooks (Embong, Noor, Hashim, Ali, & Shaari, 2012; Kropman et al. 2004). In the early stages of introducing digital textbooks, various studies have been conducted, such as those on the perceptions and effects of digital textbooks and instructional models using digital textbooks, but there has been little research on the emotions experienced by students in classes that use digital textbooks.

In particular, classes that use the technology or media not only stimulate interest in the learners but sometimes also cause negative emotions. For example, the emotion most frequently experienced by learners in online classes has been reported as frustration (O'Regan, 2003). Several studies have also claimed that students' behavior and learning effect vary with the students' emotional attitude toward media or technology (Hew & Brush, 2006; Sung & Jin, 2011). Notably, it was reported that learners in a technology-based learning environment experienced both positive emotions such as fun and enjoyment and negative emotions such as frustration and annoyance while learning with new devices like digital textbooks (Sung, et al., 2014). The result is important to implementing new technologies in education since negative emotions toward learning may adversely affect academic performance (Pekrun et al., 2002; Villavicencio & Bernardo, 2013).

If we can understand how digital textbooks affect the learners' emotions and the factors that influence learning effectiveness, we expect to be able to present a more

effective strategy for using digital textbooks.

To address these goals, the purpose of this study was to examine the emotional response of students using digital textbooks in classes and to explore individual and computer usage factors that affect the students' emotions. Additionally, we examined how student's characteristics, computer usage, and emotions on using digital textbooks are related to the perceived learning effects of digital textbooks.

Since 2014, the Ministry of Education has designated 163 schools nationwide as research schools, including 81 elementary schools and 82 middle schools, for pilot operation in the process of development and application of digital textbooks. Digital textbooks were applied to social science and science subjects taught 3rd and 4th grade in elementary schools and 1st grade in middle schools. This study was conducted with 1st grade in middle school students from those digital textbook research school.

The research questions of this study were as follows:

1. What are the students' emotions regarding the digital textbook class?
2. What individual and computer usage factors affect the emotions on digital classes?
3. How are the individual and computer usage factors and the students' emotions related to the perceived learning effects of the digital textbook?

Literature Review

Digital textbook project

Early studies from the mid-1990s viewed digital textbooks as an extension of computer aided instructions (CAI), not as a textbook, and used as the term electronic textbook (Kwack & Kang, 1997). Naturally, "electronic books" was the commonly used term during the early stages of research (Byun et al., 2006; Son, Seo,

Kim, Kim, 2004). Since then, several other terms, such as digital textbooks, electronic textbooks, e-textbooks, and online textbooks, have also emerged (Daniel & Woody 2013; Liu 2012; Luik & Mikk 2008; Rockinson-Szapkiw et al. 2013; Weisberg 2011; Weng, Otanga, Weng, & Cox, 2018). During this period, basic studies on such electronic textbooks led to pilot programs starting in 2004. In 2007, the Ministry of Education standardized the term “digital textbook” in the Digital Textbook Generalization and Development Plan, and the Korean government officially adopted and disseminated digital textbooks since 2015, widely spreading the concept of electronic textbooks in Korea.

Digital textbooks are distinguished from other electronic textbooks by their legal status equal to the traditional book-type textbooks under the Korea’s authorized and approved textbook system (Kim, Ahn, Lee, Choi, Kim, 2016). These textbooks reinforce materials from existing curriculums (book-type textbooks) with extra functions, such as linkage to external materials—terminology dictionary, open market, etc. (Ministry of Education, 2014; KEDI, 2014). The digital textbook extends the conventional concept of a textbook by overcoming the limits of printed textbooks and assisting in learner-centered teaching and learning (Sung & Jung, 2017).

A total of 85 digital textbooks are available as of August 2018, 81 of which are digital textbooks according to the revised 2015 curriculum, and 4 of those are on social studies and science for fifth-graders in the 2009 revised curriculum. In addition, the development of digital textbooks for fifth and sixth graders and second graders of middle schools has been applied since 2019(KERIS, 2018).

In order to support teaching and learning with digital textbooks by teachers and students, service platforms such as the viewer, learning community, Wedorang, account authentication, and integration system have been established. In digital textbook classes, teachers are not limited to being transporters of knowledge; they help students learn in a self-directed manner and promote diverse activities. As a result, classes have been transformed into a site of student activities, such as

self-directed individual learning, information exploration, discussion, and project activities (KERIS, 2018).

The utilization of digital textbooks turned out favorably affect learners' performance such scientific inquiry capability, level of understanding, problem solving capability, communication, positive perception on instructional learning, class satisfaction, smart literacy, student engagement, learning attitude, and self-regulated learning capability (Lee, Hong 2010; Cha et al., 2017; Cheon et al., 2014; Choi, Seo, 2009; Han, 2014; Heo, Ryu, 2015). For example, Lee and Hong (2010) reported stronger scientific inquiry capabilities in elementary school students that used digital textbook classes compared to those used book-type textbooks, while Cha et al. (2017) reported higher self-regulatory learning and problem-solving capabilities in preliminary and post examinations of science classes using digital textbooks. Cheon et al. (2014) also suggested that a meaningful improvement in smart literacy, student engagement, and learning attitude under similar circumstances.

Students' experiences of using digital textbook

There are several features that students perceive as advantages of digital textbooks: access to multimedia, such as video clips, photos, and sound tracks; availability of viewer functions like highlights and notes; learning support functions like supplementary materials or experiment videos; and utilization of hand-controlled pads (Lim et al., 2014). Students also viewed digital textbook learning experiences positively because such functions in digital textbooks helped them communicate their opinions more effectively with teachers and their peers while the diverse learning contents provided by digital textbooks made learning more interesting and reinforced student engagement (Sung et al., 2014). By examining digital textbook classes, another study reported that digital textbooks promoted positive experiences such as access to rich and various references on the

Internet, engagement with in-depth inquiry learning backed by videos and zoom-in functions, and active idea sharing with other people (Sung, Cho, Cho, Heo, Yang, 2017). However, it was also reported that device malfunction or error, lack of technological stability such as unstable connection to the wireless network or system failure, complexity of interface of digital textbooks, and poor quality of multimedia resulted in negative experiences of the learners with digital textbooks (Sung et al., 2014; Lim et al., 2014).

Focusing on implementation issues, factors like learners' academic self-efficacy and computer self-efficacy (Kang et al., 2010a; 2010b), self-regulated learning capabilities (Song, Kang, 2011) have been reported to affect the learners' satisfaction with digital textbook classes and learning attitudes. In middle school students, features that provided a sense of convenience, excitement, and satisfaction had an impact on the willingness to use digital textbooks, convenience being the most critical factor (Lee, Chang, 2016). In addition, parents' awareness and the frequency of digital textbook classes provided by teachers also played a role in the learner's satisfaction with digital textbooks (Song, Kim, Kim, 2015). As presented above, numerous studies focused on the learners' experiences with digital textbooks and the factors affecting those experiences were conducted, but hardly any have focused on the learner's emotions toward the utilization of digital textbooks. For example, the study Song et al. (2015) looked at the factors that affected elementary students' satisfaction with digital textbooks from the perspective of the families, teachers, and schools but did not consider the learners' emotions or attitudes toward digital textbooks as key factors.

However, the learner's emotional reaction to the learning environment is a crucial variable that affects cognitive processing and behavior (Lee, 2012; O'Regan, 2003). It is generally known that positive emotions—e.g. enjoyment, hope, and pride—favorably affect academic performance as they promote the students' motivation to learn, while negative emotions—e.g. boredom or frustration—adversely affect students' performances as they the undermine motivation and

concentration skills in students (Pekrun, 2002; Villavicencio & Bernardo, 2013). In particular, some studies suggest that the form of utilization and effectiveness of technology in classes will depend on the students' psychological and emotional attitudes toward media or technology (Hew & Brush, 2006; Sung & Jin, 2011, etc.). O'Regan (2003) broke down the types of emotions into frustration, anxiety, embarrassment, enthusiasm, and confidence, and the most widely spread emotion among these was frustration. Baker, D'Mello, Rodrigo, Graesser (2010) observed and analyzed the emotional status of students who engaged in computer collaborative learning environments and found that boredom was the most prevalent emotion among students, which was related to the poor performance of students. It was also suggested that negative emotions like fear, anxiety, anger, and frustration were triggered by the constraints existing in the learning environment such as uncertainty of non-simultaneous communication and computer or network error (Wegerif, 1998; Wosnitza & Volet, 2005).

According to the study by Sung et al. (2014), the positive emotions that students felt in digital textbook classes were represented by the sense of fun and enjoyment, and those students found class activities, learning activities, and communication using digital textbooks fun and entertaining. On the other hand, negative emotions were mostly caused by the functional error of digital textbooks and devices or network failures. Some students felt annoyed by these malfunction and felt frustrated or hopeless when they were not able to follow the classes due to such errors repeatedly disrupting said classes.

Although the importance of learners' emotions has been emphasized as a factor that has a great impact on learning, studies rarely explore the link between learners' emotions from digital textbook classes and the various factors related to such emotions. Studies focusing on the emotions of learners during digital textbook utilization need to be conducted in order to drive changes in the classroom and enhance the learning capabilities of learners via digital textbooks.

Thus, this study examined how the student's individual and computer usage

factors affected their emotions toward using digital textbooks in classes. Individual factors included self-regulated learning ability (Song, Kang, 2011; Park, Lee, Bae, 2010), self-efficacy (Joo, Kim, Kim, 2010; Joo, Seol, Yu, 2013; Wang & Wang, 2008), and learning motivation (Kim & Lee, 2014) which have been shown to have a significant effect on the students' learning experiences in technology-based learning environments such as digital textbook-based classes in previous studies. Since many studies have reported that gender differences exist in attitudes toward computer, media, and ICT literacy (Lee, 2000, 2001; Bruner & Bennett, 1997; Luan, et al., 2005; Sung, 2014), gender was also considered during the analysis to confirm whether these differences appeared in the experience of using digital textbooks. In addition, studies have found that learning motivation and learning attitude vary depending on the behavior of learners using ICT in technology-based learning environments (Chang, 2012; Choi, 2008; Han, Kim, 2006; Kim, 2007; Lim & Lee, 2006; Song, et al., 2015; Yu et al., 2010). For example, a study reported that students who use the Internet as a means of learning and information gathering felt more satisfied with digital textbooks than those who do not (Song, et al., 2015). Therefore, this study also examined the effects of computer usage variables, such as computer use time and behavior, and computer addiction on the emotions toward digital textbooks use.

Research Methods

Participants

In this study, 2,950 school students participated by attending of the 82 middle schools in pilot operation. All participants were 1st grade students and had experience using digital textbooks for more than a semester. Of the 2,950 students, 53.9% of the participants were male and 46.1% female, 52.5% of the participants

Table 1. Description of participants

Category		Frequency	Percentage
Gender	Male	1,589	53.9
	Female	1,361	46.1
Total		2,950	100

belonged to schools in metropolitan cities and 42.5% of the participants belonged to schools in small and medium-sized cities and rural areas.

Measures

The independent variables were classified into two categories: student's individual characteristics and computer usage. The individual characteristics included the student's reported learning performance, intrinsic motivation, self-regulated learning level, and digital textbook efficacy; computer usage included computer usage time per day, the degree of usage computers for learning and entertainment, and the level of computer addiction. The dependent variables used in this study were the positive and negative emotions of using digital textbooks and the student's perceived learning effects of digital textbooks. The positive emotions were measured by the enjoyment and anticipation of digital textbook classes, and the negative emotions were measured by annoyance, anxiety, and boredom. All items except the computer usage time were measured on the 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Computer usage time was reported by taking the average time spent on the computer per day.

The variables used in the analysis, their examples, and reliability are shown in Table 2.

The items used in this study were developed in a study conducted by Sung et al. (2014). In the original study, items were developed based on observation and interviews of classes using digital textbooks and literature analysis. In order to validate the items, the instruments used were reviewed by a total of 12 people,

including an educational psychology researcher, teachers in digital textbook research schools, psychiatrists, and experts in digital textbook research.

Table 2. Research variables

Variables	Example of item	No of item	Cronbach α
Learning performance	Student's reported learning performance (Very good-Not very good)	1	-
Intrinsic motivation	I like to learn something, even if I need to put in a lot of effort	3	.859
Self-regulated learning	Even if the study is boring, I try to finish it as planned.	4	.813
Digital textbook efficacy	I am worried that I will not be able to take full advantage of the functions in digital textbooks.	3	.918
Computer usage time Per day	Time used to play computer game during an average day	1	-
Usage of computers For learning	The extent to which computers and smart devices are routinely used to access Internet lectures and online learning sites (Very often-Not at all)	1	-
Usage of computers for entertainment	The extent to which computers and smart devices are routinely used in games and entertainment activities (Very often-Not at all)	1	-
Computer addiction	I do not know how long I play games or find entertain using computers or smart devices	5	.911
Positive emotions	I enjoy digital textbook classes.	2	.909
Negative emotions	I am anxious about digital textbook classes.	3	.940
Perceived learning effects	Digital textbooks are effective in understanding the learning content	3	.912

Data Analysis

In this study, a hierarchical regression analysis was conducted to find out how much the independent variables can explain the dependent variables. In hierarchical regression analysis, different models are tested sequentially. In this study, three different models were used. In the first model, the independent variable was the students' individual characteristics and the dependent variables were the students' emotions and the perceived learning effects. In the second model, students' computer usage was added in the independent variables. In the third model, the students' emotions was considered as an independent variable instead.

Results

Descriptive statistics, means and standard deviations (S.D), calculated for the whole data used in this study are presented in Table 3.

Table 3. Descriptive statistics

		Variable	Mean	S.D
Independent variables	Individual characteristics	Self-reported learning performance	3.36	0.97
		Intrinsic motivation	3.52	0.87
		Self-regulated learning	3.51	0.86
		Digital textbook efficacy	3.64	1.48
	Computer usage	Computer usage time per day	1.41	1.88
		Usage of computers for learning	3.16	1.08
		Usage of computers for entertainment	3.55	0.93
		Computer addiction	2.90	0.96
Dependent variables	Emotions	Positive emotions	3.67	1.02
		Negative emotions	2.50	1.15
		Perceived learning effects	3.82	0.97

Students' emotions on digital textbook classes

The emotions that students felt from digital textbook classes are tabulated in Table 4. The mean scores for enjoyment was 3.72 (S.D=1.04) and anticipation was 3.61 (S.D=1.07). Concerning negative emotions, the mean scores for anxiety was 2.40 (S.D=1.23), annoyance 2.50 (S.D=1.25), and boredom 2.58 (S.D=1.25).

Table 4. Students' emotions on digital textbook classes

	Emotions	Mean	S.D
Positive emotions	I enjoy digital textbook classes.	3.72	1.04
	I anticipate digital textbook classes.	3.61	1.07
Negative emotions	I am anxious about digital textbook classes.	2.40	1.23
	I am annoyed by digital textbook classes.	2.50	1.25
	I am bored by digital textbook class.	2.58	1.25

Factors affecting positive emotions toward using digital textbooks

In Table 5, the results from hierarchical regression analysis shows how students' individual characteristics and computer usage predicted positive emotions toward using digital textbooks.

In Model 1 where only the individual characteristics were entered as independent variables, the student's positive emotions toward using digital textbooks were affected by gender ($t=-3.046$, $p<.01$), intrinsic motivation ($t=9.986$, $p<.001$), self-regulated learning level ($t=5.598$, $p<.001$), and digital textbook efficacy ($t=-3.206$, $p<.01$). The results showed that positive emotions scored lower in female students than they did in male students and higher when student's intrinsic motivation and self-regulated learning level were high. In addition, it was found that positive emotions scored lower for higher digital textbook efficacy.

Table 5. Factors affecting positive emotions

Model	Independent Variable	<i>B</i>	<i>S.D</i>	β	<i>t</i>	<i>F</i>	<i>R</i> ²
Model 1	Gender	-.135	.044	-.062	-3.046**	145.806***	.285
	Self-reported learning performance	.013	.023	.012	.570		
	Intrinsic motivation	.373	.037	.333	9.986***		
	Self-regulated learning	.212	.038	.186	5.598***		
	Digital textbook efficacy	-.048	.015	-.066	-3.206**		
Model 2	Gender	-.115	.044	-.053	-2.631**	88.782***	.306
	Self-reported learning performance	.007	.023	.006	.301		
	Intrinsic motivation	.329	.037	.294	8.847***		
	Self-regulated learning	.161	.039	.141	4.172***		
	Digital textbook efficacy	-.027	.016	-.037	-1.693		
	Computer usage time per day	.002	.012	.004	.208		
	Usage of computers for learning	.101	.021	.114	4.884***		
	Usage of computers for entertainment	.118	.025	.110	4.751***		
Computer addiction	.003	.023	.004	.153			

*** $P < .001$, ** $P < .01$

In Model 2 where both individual characteristics and computer usage variables were entered as independent variables, positive emotions were lower in female students than in male students ($t = -2.631$, $p < .01$) and higher when intrinsic motivation ($t = 8.847$, $p < .001$) and self-regulated learning level motivation ($t = 4.172$, $p < .001$) were high. Also, it was found that positive emotions positively correlated with the degree of computer usage for learning and for entertainment.

Model 1 accounted for 28.5% of the variances in the positive emotions and Model 2 accounted for 30.6%.

Factors affecting perceived learning effects of digital textbook

In Model 1, the variables that influenced learner's perceived learning effects were intrinsic motivation ($t = 7.363$, $p < .001$), self-regulated learning levels ($t = 6.454$, $p < .001$), and digital textbook efficacy ($t = -3.047$, $p < .001$). Perceived learning

effects decreased with higher digital textbook efficacy. On the other hand, perceived learning effects increased with higher intrinsic motivation and self-regulated learning level.

In Model 2, digital textbook efficacy was no longer significant, and intrinsic motivation ($t=5.993$, $p<.001$), self-regulated learning ($t=5.144$, $p<.001$), and the degree of computer usage for learning ($t=4.549$, $p<.001$) and entertainment ($t=5.550$, $p<.001$) were positively correlated to perceived learning effects.

Table 6. Factors affecting perceived learning effects

Model	Independent Variable	<i>B</i>	<i>S.D</i>	β	<i>t</i>	<i>F</i>	<i>R</i> ²
Model 1	Gender	-.095	.042	-.049	-2.296	107.937***	.228
	Self-reported learning performance	-.031	.021	-.031	-1.424		
	Intrinsic motivation	.258	.035	.255	7.363***		
	Self-regulated learning	.229	.036	.223	6.454***		
	Digital textbook efficacy	-.043	.014	-.065	-3.047***		
Model 2	Gender	-.079	.041	-.041	-1.934	68.987***	.255
	Self-reported learning performance	-.033	.021	-.034	-1.561		
	Intrinsic motivation	.208	.035	.206	5.993***		
	Self-regulated learning	.185	.036	.180	5.144***		
	Digital textbook efficacy	-.020	.015	-.030	-1.305		
	Computer usage time per day	.012	.011	.023	1.084		
	Usage of computers for learning	.088	.019	.110	4.549***		
	Usage of computers for entertainment	.129	.023	.133	5.550***		
Model 3	Computer addiction	.017	.021	.020	.814	231.737***	.585
	Gender	-.067	.031	-.034	-2.183		
	Self-reported learning performance	-.007	.016	-.007	-.445		
	Intrinsic motivation	.054	.026	.054	2.069		
	Self-regulated learning	.055	.027	.053	2.023		
	Digital textbook efficacy	.004	.013	.005	.265		
	Computer usage time per day	.001	.008	.001	.068		
	Usage of computers for learning	.033	.015	.042	2.291		
	Usage of computers for entertainment	.024	.018	.025	1.374		
	Computer addiction	.033	.016	.038	2.044		
Positive emotions	.656	.018	.674	36.602***			
Negative emotions	-.050	.015	-.068	-3.437**			

*** $P<.001$, ** $P<.01$

When the students' emotions on digital textbooks were added as independent variables (Model 3), positive ($t=36.602$, $p<.001$) and negative emotions ($t=-3.437$, $p<.01$) toward digital textbooks were found to have a significant influence on the perceived learning effects. In particular, positive emotions was the strongest predictor of the perceived learning effects.

Model 1 accounted for 22.8% of the variance in the perceived learning effects; Model 2, 25.5%; and Model 3, 58.5%.

Discussion and Conclusion

This study explored the relationships between student's emotions toward digital textbooks in classes, student's individual and computer usage factors, and the perceived learning effects of digital textbooks. The study was conducted with 1st grade middle school students who had experience using digital textbooks for more than a semester. The results of this study are as follows:

First, positive emotions such as enjoyment and expectation toward using digital textbooks was generally more important than negative emotions such as anxiety, annoyance, and boredom, and male students showed higher positive emotions than female students did. It can be understood that the difference in positive emotions towards digital textbooks between male and female students is driven by the gender-based differences in the perception of computer or IT devices. Generally, male students are more attracted by technologies, such as computers, smartphones, and smart pads, and perceive technology to be positive while expressing keen interest and engagement more often (Augner & Hacker, 2012; Bianchi & Philips, 2005; Byun & Kim, 2007). Consequently, male students present better attitudes toward computers or instructional media and higher ICT utilization capabilities (Lee, 2000, 2001; Bruner & Bennett, 1997; Luan, et al., 2005). However, a recent study suggests that female students show higher strength in smart media utilization

capabilities than male students did (Sung, 2014). Further studies need to be conducted in a more specified manner in order to understand the gender distinctions leading to different emotional responses from male and female students regarding smart devices and classes using smart devices.

Second, higher students' intrinsic motivation and self-regulated learning contributed to increased positive emotions and perceived learning effects of digital textbooks.

In the case of digital textbook classes, learners can use built-in functions, like note-taking, underlining, and highlighting, that enable learners to organize and manage the curriculum on their own. Naturally, a digital textbook environment requires more self-regulated learning capability from its students than a conventional learning environment does (Ministry of Education, 2011). Many studies have already reported that self-regulated learning capability is the key variable that affects learning satisfaction in computer-based learning, e-learning, or mobile learning environments where learners need to actively direct their own learning (Song, Kang, 2011; Park, Lee, Bae, 2010). In addition, this study found that self-regulated learning capability is a factor that results in positive emotions towards digital textbook classes.

Third, high digital textbook efficacy was the most influential factor in lowering negative emotions. This implies that a learner less confident in using digital textbooks will have higher negative emotions from the classes. Self-efficacy refers to an individual's belief in his or her capacity to execute behaviors to produce specific performance attainments (Bandura, 1977), and task-specific self-efficacy such as computer self-efficacy and mobile self-efficacy (Joo, Kim, Kim, 2010; Joo, Seol, Yu, 2013; Wang & Wang, 2008) has been identified as a key factor that affects learning outcomes in various technology-based learning environments. For example, digital textbook efficacy was a variable that positively influenced learning satisfaction in science classes using digital textbooks (Joo, Lim, 2015). In this study, the learners' confidence in their ability to utilize digital textbooks was indicated as

the most powerful variable in lowering negative emotions. In other words, low digital textbook efficacy could have a negative impact on the effectiveness of learning due to the negative emotions formed toward classes.

Fourth, the more a student used computers for learning and entertainment, the higher the positive emotions and perceived learning effects were. However, computer use time was not a significant factor.

It was reported in a previous study that students who used the Internet as a means of learning and information gathering felt more satisfied with digital textbooks than those who did not (Song, Kim, Kim, 2015). However, this study found that using computers for entertainment also positively affected the students' emotions towards digital textbook classes and recognition of learning effects. That is, having diverse experiences with a computer or smart devices itself plays a significant role. This is probably because such experiences influenced the students' confidence in utilization during the process of learning how to use digital textbooks. The relationship between learners' experiences with a computer and smart devices, digital textbook efficacy, emotions, and learning outcomes need to be explored further in follow-up studies.

Notably, computer addiction was an influential factor leading to negative emotions. We found that computer addiction was a variable that strongly affected negative emotions along with digital textbook efficacy. Several studies on learners' computer and Internet dependency and addiction have been conducted and found computer addiction has a negative impact on learners' self-command, attitude towards learning, self-regulated learning, and academic achievement (Kim, 2007; Yu et al., 2010; Chang, 2012; Choi, 2008; Han, Kim, 2006). The studies suggest that students who are heavily dependent on computers and the Internet have poor self-command and self-regulated learning capabilities, which result in poor academic achievements. This study shows that computer addiction results in negative emotions towards digital textbook classes which can lead to adverse impacts on learning effects.

Lastly, when positive and negative emotions toward digital textbooks were considered as possible predictors of perceived learning effects, individual characteristics and computer usage variables were no longer significant. Positive emotions was the strongest predictor of high perceived learning effects, while negative emotions was the strongest predictor of perceived learning effects. These results suggest that emotions on digital textbooks may mediate the relationship between individual characteristics and computer usage and perceived learning effects. Motivated by the results, we suggest that studies on how the learners' emotions regarding classes mediate the relationship between individual characteristics and academic performance are necessary.

In conclusion, it is necessary to increase the student's intrinsic motivation and self-regulated learning level in order to raise the positive emotions toward digital textbooks while also encouraging the use of computers for daily learning and entertainment. In order to lower negative emotions, it is important to improve the individuals' efficacy of digital textbook use through pre-training while lowering the level of addiction to computers. The most important factor to raising the perceived effectiveness of digital textbooks is maximizing the positive and minimizing the negative emotions that students' have toward using digital textbooks. The results from this study shows that the individual characteristics and computer usage affect the students' emotions and, consequently, their perception of the learning effects. This may be tested through path analysis in following studies. In addition, it is necessary to further explore other factors that affect the students' emotions of using digital textbooks, such as teacher and instructional characteristics.

The study had two major limitations. The current analysis focused on the emotional response of students in digital textbook classes. The students' emotions were categorized as either positive or negative measured based on the students' self-report. Specifically, positive emotions were measured by the enjoyment and anticipation of digital textbook classes, while negative emotions were measured by annoyance, anxiety, and boredom. However, this places a limitation by simplifying

the spectrum of emotional responses into a few discrete criteria. In further studies, an in-depth analysis of the students' emotions should be given by using a validated academic emotions measurement scheme (Pekrun et al., 2005) that could more appropriately measure the various states of emotions. In particular, more research to develop and validate tools that measure learners' emotions specialized to technology-based learning environments are necessary. Another limitation of this study lay in the method of measuring the students' learning performances. Since the students' academic achievement data was difficult to access, their learning performances were measured based on self-report. However, there is a possibility that self-reported learning performances may lower the reliability of the data. Further studies will need to find a better way to measure learning performances while not relying on self-report.

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