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Influence of Individual Differences on Learning with Digital Textbooks

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Abstract: Digital textbooks have many affordances to facilitate deeper learning through active interaction with multimedia contents and learning tools. This study aimed to investigate how digital skills, epistemological beliefs, and attitude of secondary school students influenced situational interest and cognitive engagement as well as perceived learning outcomes in learning with digital textbooks. A total of 131 students participated in this study as part of their coursework in science class. They used a tablet computer including a digital textbook application. Students used digital textbooks for studying multimedia resources, information search, personalized learning, and recording inquiry-based learning activities. The results showed that there was no significant influence of digital skills on learning with digital textbooks. On the other hand, this study found that students' epistemological beliefs and attitude toward digital learning significantly influenced situational interest and cognitive engagement, which in turn influenced perceived learning outcomes. This finding implies that a teacher should pay more attention to student beliefs and attitude, which might be developed through socio-cultural interaction at home and school, when using digital textbooks.

Keywords: Digital textbook, individual difference, epistemological belief, tablet computer

1. Introduction

An increasing number of studies have paid attention to the usefulness of e-books, which have many strengths when compared to printed books (Huang, Liang, Su, & Chen, 2012; Korat, 2010). In South Korea, the government has supported developing and using a digital textbook, which is a kind of e-book, in elementary and middle schools. The digital textbook has many affordances to encourage motivation and deeper learning through interactive learning materials, multimedia resources, and an online learning community (Sung et al., 2017). Digital textbooks can be beneficial particularly for digital natives who have grown up with information and communication technologies like computers, smart phones, and tablet computers. However, all students do not have sufficient knowledge and skills to use digital textbooks for meaningful learning. It is plausible that some students can learn better with digital textbooks than others because of a digital divide among students (Kennedy et al., 2008). The purpose of this study is to investigate what individual differences influence learning with digital textbooks. The findings of this study will be helpful in providing personalized support for learning with digital textbooks in school.

2. Individual Differences in Digital Learning

Prensky (2001) argued that students, as digital natives who have spent a lot of time with new digital technologies, think and learn differently from older people. However, it is controversial to assume that all students are digital natives. Many students are not familiar with using digital technologies for meaningful learning, although they frequently use smart phones, computers, and the Internet for social interaction and entertainment (Suk, Cho, & Jeong, 2017; Ng, 2012). Eynon and Malmberg (2011) found that 31% of young people showed the peripheral profile, low-level use of the Internet in communication, information seeking, entertainment, participation, and creativity. In addition, students in rural and migrant schools tend to have fewer opportunities to develop their digital skills

than those in urban schools (Li & Ranieri, 2013). Teachers may not use smart devices for teaching and learning if students do not have previous experience of using the technologies at home. The differences in digital skills can influence how students use digital technologies in school, which may lead to differences in learning outcomes (Pagani et al., 2016).

In addition to digital skills, students' beliefs and attitudes can influence how they use technologies in school. Literature showed that epistemological beliefs played an important role in online learning (Cho & Huang, 2014; Yang & Chang, 2009). Epistemological beliefs are defined as "individuals' beliefs about the nature of knowledge and the process of knowing" (Hofer & Pintrich, 1997, p. 117). Cho and Jonassen (2011) found that students were more actively engaged in online interaction and acquired more knowledge when task types (collaborative summary vs. collaborative argumentation) were well matched with students' epistemological beliefs (low- vs. high-level epistemological beliefs). In addition, students' attitude can influence the quality of learning with digital technologies. According to the theory of planned behavior (Ajzen, 1991), attitude is a key factor to predict people's intention of a behavior like using new technology. It is a legitimate concern that students with negative attitude toward digital textbooks may not effectively use them for constructive and interactive learning.

The previous studies indicate that individual differences in digital skills, attitude toward digital learning, and epistemological beliefs can affect learning with digital textbooks. This study intends to explore the influences of the individual differences on situational interest and cognitive engagement, which are influential in learning achievements (e.g. Chi, & Wylie, 2014; Magner, Schwonke, Aleven, Popescu, & Renkl, 2014). Situational interest refers to a focused and affective reaction generated instantly by the environmental factor, which may or may not last long (Hidi & Renninger, 2006). Cognitive engagement includes a degree of cognitive strategy use (Greene, 2015). Deep strategy use refers to an active use of prior knowledge and creation of complex knowledge structure through integrating new information with prior knowledge. By contrast, shallow strategy use refers to a rote and mechanical processing such as rehearsal and memorization strategies. This study predicted that the individual differences would influence situational interest and cognitive engagement, which in turn would influence perceived learning outcomes.

3. Methods

3.1 Participants

In the current study, 131 students (58 males, 73 females) in the 7th grade participated as part of their science coursework at a middle school located in South Korea. Their age ranged from 13 to 14 years old. Students who did not complete a survey were excluded, and 99 students' data were used for analysis.

3.2 Procedure

Students participated in nine sessions (100 mins for each session) of the science class using a tablet computer, which included a digital textbook application, for nine weeks. They studied the composition of the geosphere, which included the types of rocks, the features in the geosphere, circulation of the geosphere, and a seismic wave. Students were engaged in student-centered learning activities like modeling, inquiry, experiments, and reflection. The digital textbook was used for studying multimedia resources, information search, personalized learning, and the recording of an experiment (see Figure 1). The teacher acted as a guide through monitoring and facilitating students' learning activities. Students took a survey right after nine-week science class.

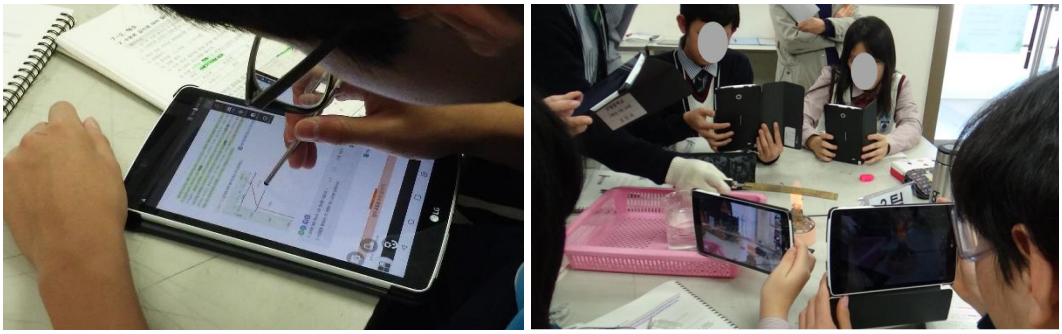

Figure 1. Personalized learning (Left) and recording of an experiment (Right) with a tablet computer

3.3 Data Collection and Analysis

The survey included digital skills of using a tablet computer for learning, attitude toward digital learning (positive/negative), epistemological beliefs, situational interest, cognitive engagement (deep/shallow strategy), and perceived learning outcomes. To investigate individual differences, surveys of digital skills, attitude, and epistemological beliefs were used. The survey items of digital skills (e.g., I can search for information about an interesting topic with a tablet computer) and attitude (e.g., A tablet computer is helpful for understanding learning contents) were modified from the study of Suk et al. (2017). The reliabilities (Cronbach's alpha) of digital skills and positive/negative attitudes toward digital learning ranged from .87 to 90. The epistemological belief survey (Bak & Chung, 2012) included 16 items about beliefs of stability (e.g., Useful scientific knowledge also needs to be evaluated when new scientific phenomena are discovered), structure (e.g., New scientific knowledge should be understood through connecting it with existing scientific knowledge), and source of knowledge (e.g., People can create new scientific knowledge through scientific inquiry about natural phenomena), and justification of knowing (e.g., People should judge whether a content is right or wrong even if it is in a science textbook). The reliabilities of the survey items ranged from .73 to .89. For examining learning process, this study used surveys of cognitive engagement (Greene, 2015) and situational interest (Rotgans & Schmidt, 2009). 4 items (e.g., I am fully focused in today's topic) of situational interest are included. The cognitive engagement survey included 4 items of deep strategy use (e.g., When learning new material, I summarized it in my own words) and 4 items of shallow strategy use (e.g., I copied down main ideas exactly as they were stated in my readings). The reliabilities of cognitive engagement and situational interest surveys ranged from .72 to .86. To explore perceived learning outcomes, 3 items (e.g., I deeply understood the learning topic) were modified from the study of Cho et al. (2015). The reliability of the survey items was .82. All survey items were with a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Multiple regression analyses were carried out to examine the influences of digital skills, attitude, and epistemological beliefs on students' situational interest and cognitive engagement in learning with digital textbooks. In addition, a hierarchical regression analysis was conducted to examine the effects of individual differences (i.e., digital skills, attitude, and epistemological beliefs), situational interest, and cognitive engagement on perceived learning outcomes.

4. Results

4.1 Descriptive Statistics and Correlation Analysis

Descriptive statistics of the variables are presented in Table 1. Students tended to have high means in digital skills, positive attitude, epistemological beliefs (i.e., stability, structure, source, justification) but a low mean of negative attitude. They were likely to have high situational interest in learning with digital textbooks. Students tended to use deep strategy moderately, but they were less likely to

use shallow strategy. The mean of perceived learning outcomes was high. The results of the correlation analysis are shown in Table 1.

Table 1

Means (Standard Deviations) and Pearson's Correlation Coefficients of Variables

Variables	M(SD)	1	2	3	4	5	6	7	8	9	10	11
1. Digital skills	4.26(.58)	-	.48**	-.12	.08	.35**	.28**	.23*	.09	.22*	.11	.18
2. Positive attitude	4.22(.83)		-	-.26*	.15	.24*	.16	.14	.33**	.30**	.04	.24*
3. Negative attitude	2.57(1.05)			-	.10	.15	.08	.18	.08	-.01	.22*	.09
4. Stability of knowledge	4.45(.55)	-			-	.50**	.44**	.55**	.39	.22*	-.19	.43**
5. Structure of knowledge	4.21(.66)					-	.56**	.57**	.33**	.33**	.14	.37**
6. Source of knowledge	4.28(.62)						-	.59**	.28**	.19	.08	.30**
7. Justification of knowing	4.4(.68)							-	.27**	.15	.01	.35**
8. Situational interest	4.08(.66)								-	.64**	.03	.69**
9. Deep strategy	3.79(.76)									-	.17	.64**
10. Shallow strategy	2.91(.83)										-	.12
11. Perceived learning outcomes	4.31(.62)											-

* p < .05. ** p < .01. *** p < .001.

4.2. Influences of Individual Differences on Situational Interest and Cognitive Engagement

Multiple regression analyses were carried out to examine the influences of digital skills, attitude, and epistemological beliefs on situational interest and cognitive engagement. As a result, digital skills, attitude, and epistemological beliefs significantly predicted students' situational interest, $F(7, 90) = 4.95$, $p < .001$, $R^2 = .28$. As shown in Table 2, students with more positive attitude toward digital learning, $\beta = .36$, $t = 3.44$, $p = .001$, and with more advanced beliefs about the stability of knowledge, $\beta = .28$, $t = 2.51$, $p = .014$, had higher situational interest in learning with digital textbooks.

Table 2

Standard Coefficients of Digital Skills, Attitude, and Epistemological Beliefs on Situational Interest and Cognitive Engagement

	Digital skills	Attitude toward digital learning		Epistemological beliefs				Model Significance
		Positive attitude	Negative attitude	Stability of knowledge	Structure of knowledge	Source of knowledge	Justification of knowing	
Situational interest	-.19	.36**	.10	.28*	.13	.08	-.03	$F(7, 90) = 4.95$, $p < .001$
Deep strategy use	-.04	.23*	.03	.09	.27*	.05	-.15	$F(7, 90) = 2.73$, $p = .013$
Shallow strategy use	.10	.06	.26*	-.37**	.20	.12	-.06	$F(7, 90) = 2.81$, $p = .011$

* $p < .05$. ** $p < .01$. *** $p < .001$.

Digital skills, attitude, and epistemological beliefs significantly predicted students' deep strategy use, $F(7, 90) = 2.73$, $p = .013$, $R^2 = .18$, and shallow strategy use, $F(7, 90) = 2.81$, $p = .011$, $R^2 = .18$. Students with more positive attitude toward digital learning, $\beta = .23$, $t = 2.05$, $p = .044$, and with more advanced beliefs about the structure of knowledge, $\beta = .27$, $t = 2.02$, $p = .046$, used more deep strategy while learning with digital textbooks. On the other hand, participants with more negative attitude toward digital learning, $\beta = .26$, $t = 2.48$, $p = .015$, and with more naïve beliefs about the stability of knowledge, $\beta = -.37$, $t = -3.09$, $p = .003$, used more shallow strategy.

4.3. Influences of Individual differences, Situational Interest, and Cognitive Engagement on Perceived Learning Outcomes

A hierarchical regression analysis was conducted to investigate whether individual differences, situational interest, and cognitive engagement influenced perceived learning outcomes. In Step 1, digital skills, attitude, and epistemological beliefs significantly predicted perceived learning outcomes, $F(7, 90) = 4.22$, $p < .001$, $R^2 = .25$. In Step 2, individual differences, situational interest, and cognitive engagement significantly predicted perceived learning outcomes, $F(10, 87) = 12.87$, $p < .001$, $R^2 = .60$. As presented in Table 3, after controlling the effects of individual differences, situational interest, $\beta = .43$, $p < .001$, and deep strategy use, $\beta = .31$, $p = .002$, significantly predicted perceived learning outcomes. Situational interest and cognitive engagement explained 35% of the variance in perceived learning outcomes.

Table 3

Hierarchical Regression Analysis for Perceived Learning Outcomes

Variables	Step 1		Step 2	
	β	*SE*	*β*	*SE*
Digital skills	-.01	.12	.05	.09
Positive attitude toward digital learning	.18	.08	-.05	.07
Negative attitude toward digital learning	.08	.06	.01	.05
Stability of knowledge	-.28*	.13	.17	.11
Structure of knowledge	.12	.12	-.03	.09
Source of knowledge	.06	.12	.00	.09
Justification of knowing	.05	.12	.11	.09
Situational interest			.43***	.10
Deep strategy use			.31**	.08
Shallow strategy use			.07	.06

* $p < .05$, ** $p < .01$, *** $p < .001$.

5. Discussion

This study found that epistemological beliefs and attitude toward digital learning were influential in students' situational interest and cognitive engagement, which in turn influenced perceived learning outcomes in learning with digital textbooks. This finding is consistent with previous studies that found important roles of epistemological beliefs and attitude in digital learning (e.g., Cho & Huang, 2014; Yang & Chang, 2009; Soffer & Yaron, 2017). When using digital textbooks in class, teachers should consider students' epistemological beliefs and attitude. To enhance learning with digital textbooks, a teacher can provide students, who have less advanced beliefs or negative attitude, videos that conflict with their beliefs or attitude and support critical reflection on the videos (Cho & Huang, 2014).

This study did not find a significant influence of digital skills on learning with digital textbooks. This study had limitations in measuring digital skills because students self-reported their digital skills, which might be different from their actual skills. On the other hand, students might not need high-level digital skills in learning with digital textbooks, which were easy to use. Although digital skills were not influential in this study, teachers should monitor students' learning with digital textbooks and provide personalized supports to students who lack digital skills.

In addition, the hierarchical regression results showed that situational interest and deep strategy use affected students' perceived learning outcomes, controlling the individual difference effects. This result is consistent with the previous study that the types of learning behaviors using

e-books can influence their learning outcomes (Yin, et al., 2015). The result implies that teachers should design learning activities promoting students' situational interest and deep strategy use, which will contribute to overcoming individual differences in learning with digital textbooks.

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