

Relationship between Learning Achievement and Learning Strategies in the use of Digital Textbook Reading Logs

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Abstract. Much research has used questionnaires to examine the effectiveness of preview/review strategies; however, it is difficult to find evidence of whether the students have actually done a preview/review or not, since the collection of questionnaire data is subjective. Through collecting learning log data, it is possible to gain objective data that provide evidence of preview/review. In this paper, we investigate the relationship between learning achievement and preview/review learning strategies through the use of the learning log data of digital textbooks. We found that the students' learning outcomes are affected by preview and review learning strategies.

Introduction

With the development of e-publishing technologies and standards, more and more traditional textbooks are being replaced with digital textbooks [1]. Compared with traditional textbooks, digital textbooks have many benefits in that: 1) they help to save money, 2) they are quicker to obtain by internet, 3) instead of a bulky library, they take up less space, 4) they are more portable, and 5) they have multimedia functions [2, 3].

Many countries plan to use digital textbooks in school [4]. For example, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan is scheduled to change all the textbooks for elementary, middle, and high schools into digital textbooks in Japan by 2020 [5, 6]. The Korean Education and Research Information Service announced a digital textbook usage plan in 2007 [7].

In the past 10 years, much research has focused on the effectiveness of digital textbooks for students' learning [2, 8, 9], some of which has specifically examined their functional features [3]. However, there is little research that has focused on the reading log data of digital textbooks. In this paper, we investigate the relationship between learning achievement and preview/review learning strategies through the use of digital textbook log data.

For the current purposes, preview is defined as a learning behavior that students preview the lesson's content before the class, and the review is defined as a behavior that students go back to learn the same content what they have learned in the class [10, 11].

Lecture review

Previous Studies of Data Collection. Collecting data is the first step of behavior analysis [12, 13]. Based on their data sources, previous studies could be classified into three categories: Questionnaire-based Data Collection (QDC), Manual Data Collection (MDC), and Automatic Data Collection (ADC). For categories QDC and MDC, the data are purposefully collected. For category ADC, the data are objectively collected. A digital textbook system was used for the current research, in which students' learning behavior log data are continuously recorded while they read digital textbooks, such as "turning to the next/previous page," "writing a memo on a page," "jumping to another page," "zooming in/out on a page," and "adding a marker on a page" (Table 1). Therefore, the current work falls under the category of ADC.

Table 1 Digital Textbook Reading Logs

User ID	Action name	Document	Page Number	Action time
User A	Next	Lesson1	8	2016/10/22 10:40:55
User B	Prev	Lesson2	7	2016/10/22 10:42:15
User C	Marker	Lesson3	7	2016/10/22 10:42:16
User D	Memo	Lesson4	8	2016/10/22 10:42:18

Preview and Review. Many previous studies have focused on preview and review strategies. These studies fall within the QDC category, which required students to answer a questionnaire to examine the effectiveness of preview and review strategies [10, 11]. However, there is no evidence that students actually did any preview or review.

In this study, digital book reading logs were used as subjective measurements to evidence learning. Oi et al. focused on using digital book reading logs to objectively measure the preview and review strategies. They analyzed data using three types of measurement: Change, Page flip, and Duration. They found that preview is more deeply relevant to academic achievement and assessment than review [3].

In the current paper, different measurements were used to analyze the relationship between learning achievement and preview/review strategies. The results showed that the strategies of preview and review are effective for the students to improve on their achievements.

Methodology and Analysis Results

As mentioned above, through the use of learning logs, two kinds of learning strategies are analyzed in this paper: preview and review. They are explained as follows:

- **Preview:** By using reading logs, we can determine how long the students read the book. If a student has learning behavior logs (such as “go to next page” or “go to previous page”) that have been recorded before the class and a total reading time of over 5 minutes, then we consider the student to have previewed the lesson. In this study, Preview Times (PT) are used to measure the preview strategy. PT means how many times that student has previewed the lessons.
- **Review:** By using reading logs, we found that students go back to the previous page frequently, and they try to confirm their understanding or review the meaning in light of the learning content. This learning behavior is defined as review in the current research. Such action can be linked to a review learning strategy, which allots time to commit information to long-term memory [14], as well as to a reflection learning strategy, which involves linking current knowledge to previous knowledge [15].

In order to investigate the relationship between learning achievement and preview strategy, we divided students into two groups: Preview Group (PG) and No Preview Group (NPG). We calculated how many times students prepared for the lesson in a course. PG is the group in which students previewed the lesson more than one time ($PT \geq 1$). NPG is the group in which students never previewed the lesson ($PT < 1$).

Table 2 Mean comparison between PG and NPG results using a paired-sample t test

	Preparation Times (PT)	N	Mean	S.D.	T
PG	$PT \geq 1$	51	87.84	12.21	4.11
NPG	$PT < 1$	49	71.79	24.92	

$p < .05$

Table 2 presents the t-test results of the learning achievements of the students who previewed the lessons. It is noticeable that the score is 87.84 for PG and 71.79 for NPG. According to the t-test results, the preview learning strategy ($t=4.41$, $p = 0.001 < 0.05$) shows a significant difference

between the two groups. Hence, the preview learning strategy is an effective learning strategy for students to improve on their achievements.

In order to investigate the relationship between learning achievement and the review strategy, we divided students into two groups using students' learning achievements. As most students' learning achievements constituted more than 60 %, they were divided into two groups from 80%.

The frequency rate (FR) of "going back to previous page" is used to measure the review strategy. The FR is calculated by action times of "go to the next page (NEXT)" and "go back to the PREVIOUS PAGE (PREV)."

$$FR = \text{Times of PREV} / \text{Times of NEXT}$$

We analyzed the differences between Group A and Group B of the FR. Table 3 presents the t-test results of the FR of "going back to previous page." It is noticeable that the FR is 0.37 for Group A and 0.32 for Group B. According to the t-test result, it is found that the FR ($t=2.3$, $p = 0.048 < 0.05$) shows a significant difference between the two groups. This means that Group A does more review than Group B. Hence, the review strategy is an effective learning strategy for students to improve their learning achievements.

Table 3 T-test results of the FR

	N	Mean	S.D.	t
Group A (Learning Achievement \geq 80%)	69	0.37	0.14	2.3
Group B (Learning Achievement < 80%)	31	0.32	0.20	

$p < .05$

Conclusion

The study collected learning log data through the use of digital textbooks in order to analyze what kinds of learning strategies students used and which of these could improve their learning achievements. We analyzed two kinds of learning strategies: the preview strategy and the review strategy (which involved returning to the previous page to confirm understanding many times).

The analysis results showed that the students' learning outcomes are affected by these two learning strategies.

- The preview strategy has a correlation with the students' learning achievements: the more times students previewed their lessons before class, the better their learning achievements.
- The review strategy has a correlation with the students' learning achievements: the more they went back to the previous pages, the better their learning achievements.

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