

Analysis of Links among E-books in Undergraduates' E-Book Logs

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Abstract: The purpose of this study is to investigate the relationship between academic achievement and learning patterns of students using e-book logs. Specifically, we examined how students who maintain good academic achievement *link* among knowledge of different e-books. We hypothesized that good achievers might access e-books sequentially those were used in the same class session and/or consecutive class sessions, for systematically linking among the different knowledge of related e-books. Logs were collected from first-year students in an information science course at Kyushu University. The present study revealed that the good achievers more frequently linked e-books which were used in the same class sessions than the poor achievers. This result suggests that the good achievers more frequently linked knowledge of e-books which deeply related each other.

Keywords: E-book, log, link, learning pattern

1. Introduction

“The race to replace traditional textbooks with electronic versions is on” (Daniel & Willingham, 2012, p. 1570). As of the year of 2010, Amazon.com sold more e-books than print books (Bounie, Eang, Sirbu, & Waelbroeck, 2012). E-book sales show strong and steady growth (Reynolds, 2011). In recent years, many countries (e.g., Japan, South Korea, and Singapore) have implemented and begun the assessment of information and communication technology (ICT)-based education and learning materials in schools, especially of electronic textbooks, called *e-books* (Nakajima, Shinohara, & Tamura, 2013). For example, in Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) compiled a “Vision for ICT in Education,” a comprehensive policy to promote the utilization of ICT in education in 2011 (MEXT, 2011). In Korea, the research on e-books in learning started in 1997 and, in 2007, an e-book usage plan was announced by the Korean Education and Research Information Service (KERIS) (Shin, 2012).

Previous e-book research has mainly focused directly on the effectiveness of e-books for students (e.g., Chen & Chen, 2014; Daniel & Woody, 2013; Eden & Eshet-Alkalai, 2013; Huang, Liang, Su, & Chen, 2012; Ihmeideh, 2014; Korat & Shamir, 2008; Morineau, Blanche, Tobin, & Guéguen, 2005). For example, Ihmeideh (2014) investigated learning effectiveness of e-books and paper books on preschool children. The pre- and post-test data was collected on several literacy skills (i.e., print awareness, vocabulary, alphabetic knowledge and phonological awareness). After the pre-test, the children in the experimental groups were exposed to e-books, whilst the children in the control groups were exposed to printed books. In the results, children in the experimental group achieved better improvement in the areas of print awareness and vocabulary. On the other hand, Ogata and his colleagues carried out a series of studies in which they focused on e-book logs¹ as a research tool to investigate students' learning patterns and their relationship with academic achievements (e.g., Ogata, Oi, Okubo, Shimada, Yin, Kojima, & Yamada, in press; Okubo, Shimada, Yin, & Ogata, in press; Oi, Okubo, Shimada, Yin, & Ogata, in press; Shimada, Okubo, Yin, Kojima, Yamada, & Ogata, 2015; Yamada, Yin, Shimada, Kojima, Okubo, & Ogata, 2015; Yin, Okubo, Shimada, Hirokawa, Ogata, & Oi, in press). Their e-book log was a Cloud-based system for e-book usage

¹ More information (in Japanese) can be found at <http://www.kccs.co.jp/ict/cloud-booklooper/>.

monitoring. It provides a detailed of which student used which e-book when and for how long, and which pages they looked at.

Oi et al. (in press) examined patterns of students' e-book logs before and after the main content learning in class (that is, 'Preview' and 'Review'), using e-book logs as an objective measure. Logs were collected from first-year students in an information science course at Kyushu University. To measure preview and review learning, we analyzed data using three types of measurement: Change indicates how many times a student changed e-books over the course of one hour. Duration indicates how many seconds a student access a given e-book for during one Change (i.e., one turn). Page flip indicates how many pages of a given e-book a student flipped through during one Change. To analyze the relationship between academic achievement and preview/review, the students were categorized into six groups according to their scores on midterm and final (term-end) examinations. For preview, students who had consistent good achievement showed higher values for Change and Page flip than students who showed poor achievement. In contrast, for review, none of the three measurements showed differences among the six groups. These results suggest that preview is more deeply relevant to academic achievement and assessment than review. Furthermore, they reported the frequent Changes and Page flips in good achievers. These frequent Changes and Page flips suggest that students who maintain good academic achievement using e-books actively link (Hartman, 1995; Strømsø & Bråten, 2002) different texts not only within an e-book but also among different e-books, and understand content more deeply as a result. In Oi et al. (in press), the details of link among different e-books were not reported. To clarify how students, especially good achievers, linked knowledge of different e-books, the present study examined the details of the links among different e-books. We hypothesized that good achievers might access e-books sequentially those were used in the same class and/or consecutive classes, for systematically linking among the different knowledge of related e-books.

2. Methods

2.1 Participants and data collection

Logs for this analysis were collected from 98 first-year students in an information science course taken in the second semester of the 2014/2015 school year at Kyushu University in Fukuoka, Japan, via BookLooper (Kyocera Maruzen Systems Integration Co., Ltd.). Figure 1 shows samples of logs. The data from 15 students who did not take the midterm or the final (term-end) examination for the course were discarded from further analysis.

Devices	User ID	e-book ID	Title (e-book)	Operation	Page	Status	Marker	Start	Marker End	Date	Time	Duration
AIR	xxxxxxxxxx	00000000NKFS	A-10-通信路架	OPEN	50	0	0	0		2014-11-12	08:54:35	3
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	OPEN	0	0	0	0		2014-11-12	08:54:42	0
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	PORTRAIT	1	1	0	0		2014-11-12	08:54:46	2
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	NEXT	2	1	0	0		2014-11-12	08:54:48	1
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	NEXT	3	1	0	0		2014-11-12	08:54:49	6
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	CLOSE	3	0	0	0		2014-11-12	08:54:55	68
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	OPEN	3	0	0	0		2014-11-12	08:56:03	5
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	NEXT	4	1	0	0		2014-11-12	08:56:08	1
AIR	xxxxxxxxxx	00000000NKG	A-11-暗号	NEXT	5	1	0	0		2014-11-12	08:56:09	8

Figure 1. Samples of e-book logs.

2.2 E-Books

Nineteen e-books were used in the course which had 15 class sessions. Table 1 shows the date when each e-book was used in a class session.

Table 1: Number of pages of each e-book.

Shortened titles of e-books										
	A-01	A-0678	A-09	A-10	A-11	B-01	B-04	B-05	B-06	B-07
Date	10/08	10/15	10/22	10/29	11/12	11/12	11/19	11/19	11/26	11/26

Shortened titles of e-books									
	B-08	B-09	B-10	B-11	C-01	C-02	C-03	C-04	C-05
Date	12/10	12/10	12/17	12/17	01/07	01/07	01/14	01/14	01/14

2.3 Data analyses

2.3.1 Link between e-books

To identify the links among the e-books, we investigated which e-book was accessed before and after a given e-book from e-book logs for each participant. After identification of before and after e-books, we categorized those links according to an interval between e-books, to clarify relationship between e-books. For example, e-book “B-04” and “B-05” were used as textbooks in the same class session, then if “B-04” was accessed after “B-05”, the link between “B-04” and “B-05” was categorized as 0. And if “B-06” was accessed after “B-05” which was used in a class session after one week of “B-05” was used, the link between “B-04” and “B-05” was categorized as + 1 week. The maximum value of the interval is +14 and minimum value is -14.

2.3.2 Categorization of academic achievement

First, we coded quartiles of students’ midterm and term-end examination scores (first quartile: A, second quartile: B, etc.). Then, the students were categorized into six groups according to a combination of midterm and term-end coded scores. Figure 2 shows the six groups and the number of students in each. Students who received the same scores on their midterm and term-end examinations were subcategorized into A (A-A), B (B-B). Since C-C and D-D students were too few as groups, they were combined into a group CD. Students who improved their scores were categorized into two groups: Students in group U1 got a B, C, or D on the midterm examination and an A on the term-end examination, while students in group U2 got a better score on the term-end examination than on the midterm examination, but not an A (thus, a B or C). The last group, L, got worse scores on the term-end than on the midterm examination.

Midterm	Term-end			
	A	B	C	D
A	10	6	4	6
B	9	11	6	4
C	3	10	1	7
D	-	-	2	4

Figure 2. The six groups and the numbers of students of each group. Yellow: A, Green: B, Blue: CD, Red: U1, Pink: U2, Gray: L

3. Results and Discussion

To examine whether link patterns differed among the six groups of students, the average frequency of interval of the links were calculated for each student. Then, averages of interval of the links for each group were calculated across the 19 e-books. Figure 3 shows these averages. Two-way analysis of variances (ANOVA) with group (6) as a between-participant factor and interval (29) as a within-participant factor was conducted on the average of the frequency of the links of before and after. Results revealed for both of before and after links, significant main effects of group, before: $F(5, 76) = 2.656, p = .029, \eta_p^2 = 0.149$; after: $F(5, 76) = 2.624, p = .030, \eta_p^2 = 0.147$, and interval, before: $F(28, 2128) = 131.121, p < .001, \eta_p^2 = 0.633$; after: $F(28, 2128) = 130.985, p < .001, \eta_p^2 = 0.633$, and interaction, before: $F(140, 2128) = 3.023, p < .001, \eta_p^2 = 0.166$; after: $F(140, 2128) = 3.014, p < .001, \eta_p^2 = 0.165$. In multiple comparisons with Bonferroni adjustment ($p < .05$), the group A who maintained good academic achievement revealed that compared to the groups CD, L, and U2 who showed poor academic achievement, significantly higher values for 0 week. In other words, the group A more frequently linked e-books which were used in the same class sessions. These results suggest that compared to other groups, the good achievers more frequently linked knowledge of e-books which deeply related each other.

A: Before

Group	Interval																												
	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	0	0	0	0	0	0	0.6	0.2	0.4	0.6	0.8	2.3	5	14	62	8.7	3	0.9	0.6	0.5	0.5	0.2	0.6	0.2	0	0	0.3	0.2	0
B	0	0	0.2	0	0	0	0.2	0.1	0.2	1	1.7	2.4	6.1	9.4	39	4.7	3.7	0.9	1.8	0.3	0.1	0.3	0.4	0.2	0	0.1	0	0.1	0
CD	0	0	0	0	0	0	0	0.2	0.4	0.4	0.8	1.2	2.8	5.2	22	3.2	1.6	0.8	1	0.6	0.2	0	0.2	0	0	0	0	0	0
U1	0	0	0.1	0	0	0	0.2	0.2	0.4	0.7	1.2	1.7	4.4	9.6	37	5.2	2.6	0.6	1.1	0.6	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.1
U2	0	0.1	0.1	0	0.1	0	0.1	0.3	0.1	0.3	0.8	1.8	3.6	7.9	29	3.6	1.4	0.7	0.9	0.5	0.1	0.3	0.2	0.3	0.1	0.2	0	0.1	0.1
L	0	0	0	0	0	0.1	0.1	0.1	0.3	0.7	0.9	1.8	4.8	9.1	31	3.9	2.8	0.5	1.2	1	0.6	0.1	0.2	0.1	0	0	0	0.1	0.1

B: Next

Group	Interval																												
	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	0	0.2	0.3	0	0	0.2	0.6	0.2	0.3	0.5	0.6	0.9	3	8.7	62	15	5	2.3	0.8	0.6	0.5	0.2	0.6	0	0	0	0	0	0
B	0	0.1	0	0.1	0	0.2	0.4	0.3	0.1	0.3	1.8	0.9	3.7	4.7	39	9.7	6.2	2.4	1.8	1	0.2	0.1	0.2	0	0	0	0.2	0	0
CD	0	0	0	0	0	0	0.2	0	0.2	0.4	1	0.8	1.6	3.2	22	5.2	2.8	1.2	0.8	0.4	0.4	0.2	0	0	0	0	0	0	0
U1	0	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.5	1.1	0.6	2.5	5.2	37	10	4.5	1.7	1.2	0.8	0.4	0.2	0.2	0	0	0	0.1	0	0
U2	0	0.1	0	0.2	0.1	0.3	0.2	0.3	0	0.4	0.9	0.7	1.4	3.6	29	8.6	3.6	1.8	1.2	0.3	0.1	0.3	0.1	0	0.1	0	0.1	0.1	0
L	0	0.1	0	0	0	0.1	0.2	0.1	0.3	0.9	1.2	0.5	2.8	3.8	31	9.4	4.9	1.8	0.9	0.9	0.3	0.2	0.1	0.1	0	0	0	0	0

Figure 3. Average of frequency of interval between e-books. Figure 3A shows which e-book was accessed before the given e-book, and figure 3B shows which e-book was accessed after the given e-book. More red means higher value.

4. Conclusion

The present study investigated how students, especially good achievers, linked knowledge of different e-books. Our hypothesis is that good achievers might access e-books sequentially those were used in the same class and/or consecutive classes which relate each other, for systematically linking among the different knowledge of e-books. The results partially support our hypothesis. The present study revealed that the good achievers more frequently linked e-books which were used in the same class sessions than the poor achievers. This result suggests that the good achievers more frequently linked knowledge of e-books which deeply related each other.

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