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Analysis on Students' Usage of Highlighters on E-textbooks in Classroom

Yuta TANIGUCHI[a*], Fumiya OKUBO[b], Atsushi SHIMADA[c] & Shin'ichi KONOMI[b]
[a]*Research Institute for Information Technology, Kyushu University, Japan*
[b]*Faculty of Arts and Science, Kyushu University, Japan*
[c]*Information Science and Electrical Engineering, Kyushu University, Japan*
*yuta.taniguchi.y.t@gmail.com

Abstract: E-book has been gradually getting popularity in educational contexts. Reading textbooks on computers or hand-held devices enables us to track the learning activities of students regardless of situations. In our university, several courses for first year students employs our e-book system, and we have been collecting its usage logs. From the logs, it seems that the highlighter function of the e-book reader plays an important role in learning because it is used most by the students. Though many researches studied the effectiveness of e-textbooks, only limited studies addressed how students utilize highlighters and how marking activity affects their learning. In this paper, we focus on highlighted portions of e-textbooks, and analyze how students use highlighters in their learning. We also attempt to provide recommendations to students for highlighting based on the highlighter usage in other classes.

Keywords: E-book, highlighter, usage pattern, suggestion of highlighting

1. Introduction

E-book has been gradually accepted by people, and it has been also introduced to educational contexts as an alternative form of the traditional textbooks (Brown, 2013). Compared to traditional textbooks, course materials in e-book form enable us to track their usage regardless of situations. Thus, it is crucial to develop analysis methods which leads to improvement of learning by a data-driven manner.

In our university, several computer science courses use our own online e-book system in combination with the learning management system Moodle. Most classes of those courses use slides as primary teaching materials. Among the functions of our e-book reader application, highlighter feature is used most. Therefore, it is considered that the feature plays an important role in learning, and the event logs of highlighter have potential to describe the learning process of students.

The effectiveness of e-books in educational context has been studied over the years. Maynard and Cheyne (2005) studied e-textbooks in education of children, Rockinson-Szapkiw, Courduff, Carter, and Bennett (2013) made comparative study on traditional textbooks and e-textbooks, and Al-Mashaqbeh and Al Shurman (2015) studied the adoption of tablet and e-textbooks. However, how students utilize highlighter feature in their learning has not been studied well. In this paper, we investigate the usage of highlighters and discuss how such an activity affects the quiz scores.

2. Method

In this paper, we focus on the course "Primary Course of Cybersecurity" in our university. The course provides primary matters include basic technologies, laws and morals about computer security. The course is one of the mandatory courses for all first-year students. There are 15 classes for the course, and 10 teachers give lecture for around 200 students on average using the same textbooks provided through our e-book system. We chose two classes out of those classes, in which the same teacher gave lecture, as targets of highlighting suggestion. We call them "Class A" and "Class B", for convenience.

On the left hand side of Figure 1, we show an example screen of e-book system with a material for the cybersecurity course. In the figure, a red rectangle and a yellow one are shown; students are

instructed to use red color for a portion of a page where they consider important, and yellow one for an incomprehensible part of a page. The e-book viewer records such highlightings as event logs in our database.

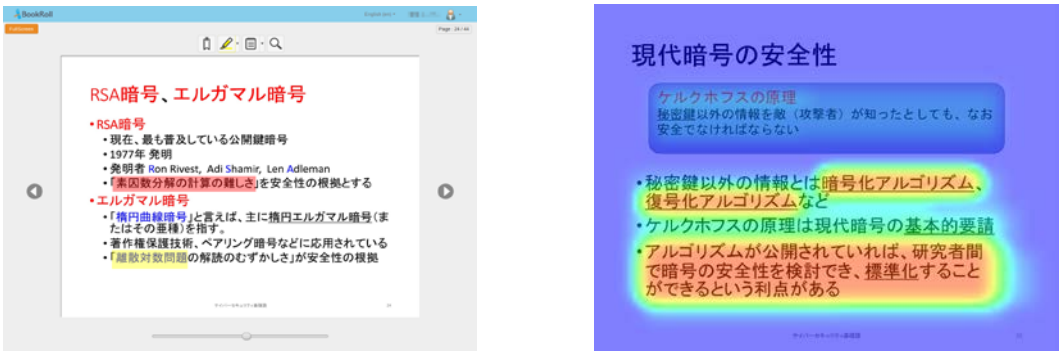

Figure 1. An example screen of e-book system showing a material for "Primary Course of Cybersecurity" (left hand side) and an example heat map of aggregated highlightings (right hand side).

We chose other two classes, from which we computed a set of highlightings to recommend. These classes went ahead of the aforementioned classes by one week, and thus it was able to collect event logs in advance. We aggregated the event logs from the students of the classes, and computed the two-dimensional histograms for each page. Figure 1 shows an example heat map of accumulated highlightings on the right hand side. We extracted bounding boxes of the most notably highlighted areas that gained supports from more than 20 percent of students using highlighters at least once.

We presented obtained bounding boxes to students as highlighted areas colored blue. We provided such recommendations to Class A in the fourth week and to Class B in the fifth week. Those recommendations are limited to the course materials used in the particular weeks. We conducted quizzes at the end of every class. In the rest of the paper, we discuss the differences of the patterns of usage and acceptance of recommendations, and the difference of the scores of quizzes between these classes.

3. Results & Discussion

3.1 Usage Pattern of Highlighters

After providing recommendations in classes, we investigated the event logs of highlighters to see how students responded to the recommendations. Figure 2 shows a heat map table of event frequencies for Class A in the fourth week, and Figure 3 shows the same for Class B in the fifth week. Since the tables are very wide, they are split into two lines. Columns correspond to students, and rows correspond to the types of highlighted regions: the numbers of remaining suggested highlightings (first row), the numbers of added highlightings (second row), and the numbers of deleted highlightings (third row). Every cell is colored according to its count value, where the highest value corresponds to red and the lowest value corresponds to green.

Figure 2. A heat map table of counts of highlighter-related events for Class A.

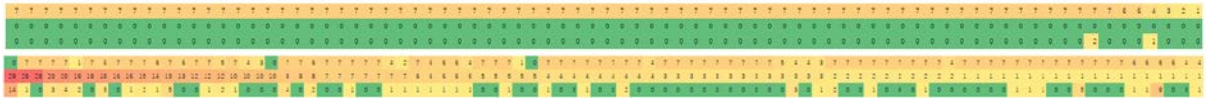

Figure 3. A heat map table of counts of highlighter-related events for Class B.

The upper matrices shows counts especially for students who did not use any highlighters, and the lower matrices shows the counts especially for students who used some highlighters. From the upper matrices of the both figures, we can see that most of the students did not care about the suggested highlightings. In contrast to that, from the lower matrices, more students made reaction to the suggested highligtings in addition to their own highlightings. We can say that whether a student is concerned about highlighters or not is strongly related to whether the student care about the suggestion or not.

3.2 Highilghting Suggestions and Scores of Quizzes

Table 1 shows the average scores of quizzes for each class on fourth and fifth weeks. Asterisks beside numbers represent that students are given highlighting suggestions. From the result, we cannot say that suggesting highlightings does or does not improve the quiz scores.

Table 1: Average scores of quizzes.

	Class A	Class B
4th Week	6.21*	6.35
5th Week	6.10	7.94*

However, compared to the fourth week, the average score of students of Class B in fifth week is relatively high. We further investigated whether suggested highlightings are related to the content of quizzes or not, and we found that suggestions given to Class B in the fifth week is related to quizzes more than those given to Class B in the fourth week. Therefore, we can conclude that just suggesting the most popular areas does not necessarily improve scores although there is some possibility that considering the content of highlighted area could give a good influence to students.

4. Conclusion

We showed a preliminary result of analysis on the usage of highlighters for e-books. We discussed how our recommendation of highlighters affect students' learning. There were almost the same numbers of students who uses highlighters and who do not use them, and their responses to the recommendations are somewhat different. Although we could not find any evidence that suggestions themselves improve students' quiz scores, it was indicated that we may be able to see some improvement in quiz scores if we examine the contents under the highlightings in addition to the popularity of the areas.

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