

Effectiveness and Usability of Stylized Notes for Electronic Textbooks in Tablet PC

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Abstract

The rise of smartphones and computer tablets has been shifting computer tasks to mobile applications. Educational environments are changing quickly as a generation of learners grows up with technologies such as tablets, smartphones and other smart devices. With the success of mobile textbook market, tablets are replacing paper textbooks to digital. Especially, one of the most important features of electronic textbooks application is creating and reading annotations. Most electronic book readers support this fundamental functionality. However, when an application moves from desktop pc to mobile device, its feature should be redefined to fit on a mobile device. Therefore, we propose a user interface which supports visualized annotation on touch-based tablets. It enables a user to gain additional information from annotation style and guide to navigate on useful resources. This interface is developed on a tablet device to evaluate it in a classroom study to prove its effectiveness. As a result, the proposing approach encouraged students to use the electronic textbooks and annotation feature in an efficient way.

Keywords: *Electronic Textbooks, Note Visualization, Note-taking*

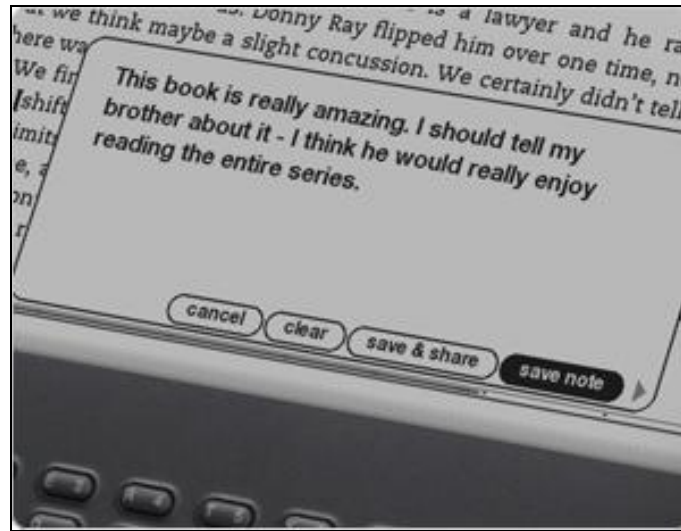
1. Introduction

Smartphones and tablet PC are the new communication tools that have revolutionized the social network. Users are now able to write a text message, read a book and take a photo whenever they want. Tablets and some smartphones such as Galaxy Note provide richer interface users with an annotation feature. These devices enable users to annotate by handwriting or drawing a shape. This interface can be especially useful in education. Annotation is a natural and beneficial activity for users because it assists them in reading, writing, sense-making, indexing and retrieving. Annotation has proven to increase germane cognitive load and enthruses the student from a passive reading routine to active learning practice [1].

At the same period of time, the electronic textbooks market has grown largely, and major publishers such as Pearson, John Wiley and so on, offer 90 percent of electronic textbooks used at North American universities [2, 3]. The use of electronics textbooks on the touch-based devices such as Amazon Kindle [4], iPad [5, 6] and Galaxy Tab is more likely to replace paper-based reading rather than reading that was done on the desktop environment (Figure 1). Electronic Textbooks offer various interactive functions, and provide the student

with a combination of textbooks, references books, dictionaries, and multimedia contents such as movie clips and animations. Electronic Textbooks are based on various interaction functions and are designed to fit students' personal attributes and experiences.

However, Amazon found that a considerable number of the users had quit using the Kindle DX for reading due to issues like its lack of support for note-taking and problems with looking up references, which was easier to do on the computer. In addition, the Kindle DX had negatively affected a study technique called cognitive mapping, which helps readers use physical cues they have seen on the pages to remember where to find a specific section of text. Also, most of students used paper to take notes as they read [7, 8]. Therefore, a usability of electronic textbook has become more important with new touch-based devices than desktop PC.



(a) Amazon Kindle



(b) iPad iBooks

Figure 1. An Example of Touch-Based Educational Content

Meanwhile, traditional textbooks will disappear in South Korea elementary schools by 2015[9]. Students don't need to bring their heavy backpacks to schools. They will be getting ready for classes by using a tablet or desktop PC equipped with electronic textbooks. Electronic textbooks will allow students to perform realistic but virtual experiments while sitting in the classroom as shown in Figure 2.

The Korean Ministry of Education and Human Resources Development announced that it will develop the electronic textbooks as a study aid tool, which uses multimedia contents, to overcome the limitations of traditional paper textbooks. The electronic textbooks' available content can be published on the fly without the need to wait for yearly revisions. The government tested the system with the help of 300 elementary school students from four South Korean schools. According to the study, students, especially those whose school records were in the middle or lower achievement brackets, showed marked improvement. The Korean Ministry of Education intends to deploy the digital textbook program for all fifth and sixth grade students in elementary, three unspecified middle school grades, and two unspecified high school grades. They intend for the new system to be adopted in 112 targeted pilot testing elementary schools [12].

Publishers are now building up electronic textbooks for the 'Smart Classrooms', and various interactive contents are being developed. The question still remains: how will they support the essential annotation function such as taking a note or creating a bookmark?

Tablet computer is a good way of note-taking on web resources. The main characteristic of this method is the high quality of its labeling. The touch input makes the tablet computer more user friendly and easy to learn. The main reason is the usability of the tablet device because many studies mentioned that the usability effects [10, 11] on user experience and learning effect. Inappropriate design in usability may cause a negative result in learning, therefore it is very important in education purpose, and a note added to course materials is mainly used for knowledge in learning. When group members share this knowledge, it plays a great roll in learning effect [12-14].



Figure 2. "Smart Classroom" in Korea

We propose an approach which assists users with visualized note-taking interface. Thus, we encourage users to use the digital textbook more, and guide to navigate on useful information. This approach is implemented on touch-based device and we evaluated it in a classroom study to prove our hypothesis.

In this paper, we propose research design and implementation in Section 2 and evaluate it in Section 3. Then, we conclude in Section 4.

2. Related Works

Most electronic book readers on tablets and smartphones support annotation functionality. For example, textbooks on iBooks offer interactive diagrams, photos, and videos. Students can look at an image with interactive captions, rotate a 3D object, or have the answer spring to life in a chapter review. They can flip through a book by simply sliding a finger along the bottom of the screen. It also supports highlighting text, taking notes, searching for content, and finding definitions in the glossary as shown in Figure 3. A user selects a word or paragraph by touch input, and resizes the area by using a built-in magnifier. The application highlights the target text in a sky blue rectangle. A user can move small blue spots on its edges, so the selection can be adjusted. A user can also select different colors for annotations. However, the color of annotation is only selected by a user which means that the color is meaningful to a specific user in a private way.

In biology or chemistry area, visualized annotation is frequently used to describe information about complex objects such as molecule structures. Each part of molecules is attached by annotations in different colors, so that a user could easily scan rough information about the whole structure from the colored annotations as shown in Figure 4.

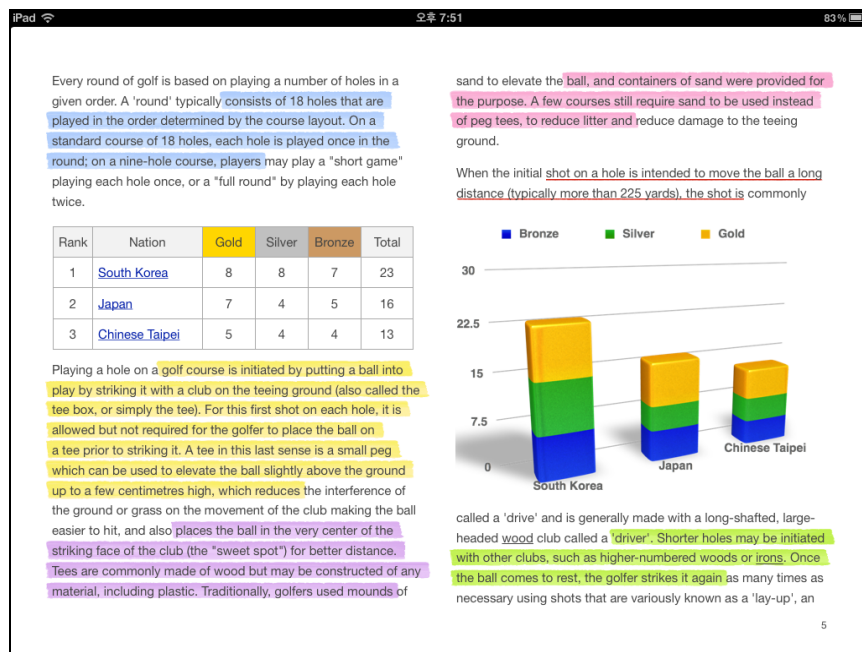


Figure 3. iBooks 2 Colored Annotations

Annotation color can give user additional information on resource even though a user has not read text in annotation yet. In this paper, we use this visual information to represent users' activity on annotation. Scanning annotations in electronic textbooks, a user is able to collect information such as which annotation is most hit, which annotation has many comments on it, which annotation is my private note and so on.

This approach is especially useful on touch tablets, because tablets' screen size is relatively smaller than desktop PC's. A tablet PC user is likely to scan pages quickly by swiping fingers, and see what he or she thinks important. Moreover, opening a text note by touching annotation and closing it again by touching annotation could be laborious work. Therefore, annotation needs to represent as much as information as it has.

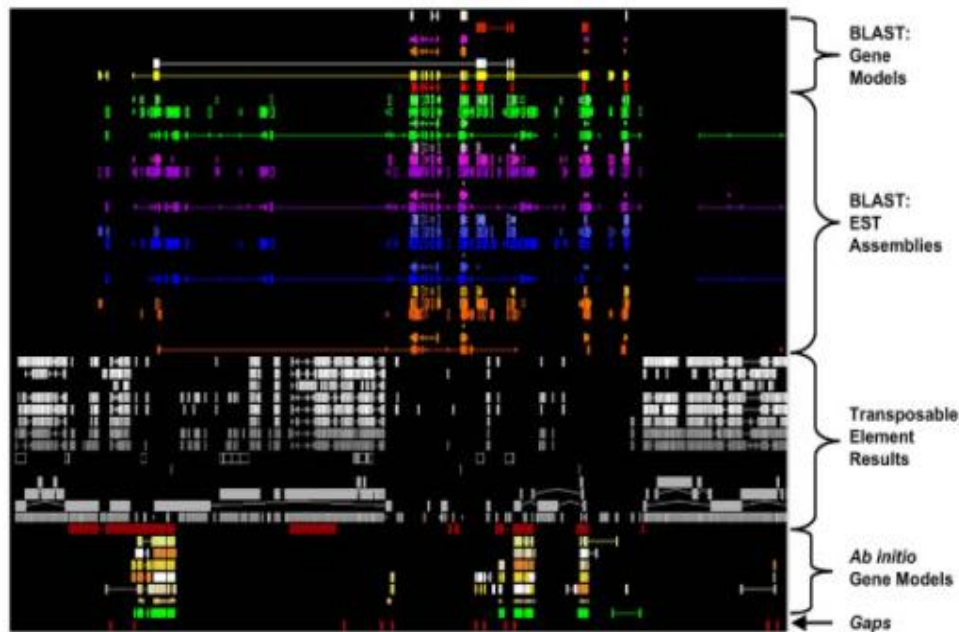


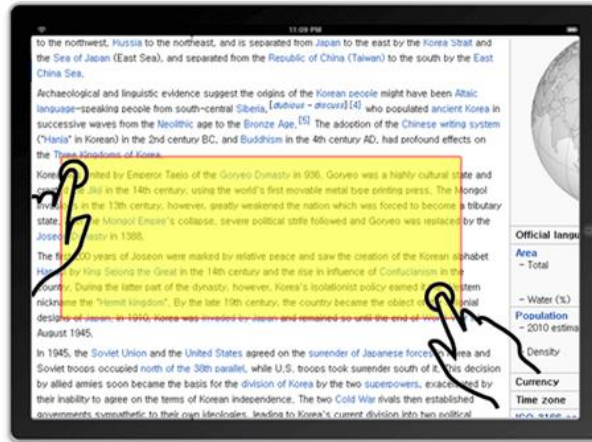
Figure 4. Visualized Annotation in Genome

2. Note Visualization for Digital Textbooks

The proposed interface is designed for the note of textbooks in digital textbooks on tablet pc. The interface allows users to mark spatial regions in textbook pages and use them for bookmarking, commenting, and sharing opinions with class members.

2.1. Note-taking Interface

We use the iPad1 on iOS 5.0 to implement our proposing interface. The interface accepts the touch input and is designed to automatically recognize the selecting area by touch gestures. Since it traces underlying HTML objects, the note object could be determined by the HTML structure in selected area shown as Figure 5.



(a) Selecting text area by two finger touch



(b) Selected text for note area

Figure 5. Selecting Text by Touch Gesture

To add a new note, the user touches and moves the one or two fingers to create a rectangle of the desired size on the page image or text and then releases the fingers. A small popup menu then confirms the creation of the note at the designated location and allows adding the first comment in this location. A student can draw the rectangle anywhere on the page, regardless of existing notes. If the note from another student already exists in the desired area, the current student may choose to add a comment to the existing note.

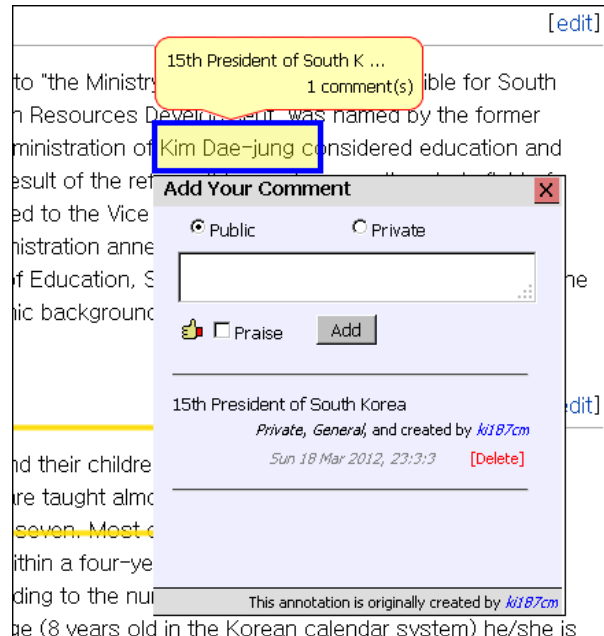


Figure 6. Adding a Comment to a Note Space

After creation of a note, there are two ways to add comments. First, as mentioned before, the popup menu will be shown when finished drawing the square and the student can then type some related text. Touching the 'create' button will add the comment to the note. A square can also be created without adding a comment if the student just wants to mark the specific area with this graphical object.

The second method is by touching on an existing area of the annotated webpage. The same popup menu will appear and this allows browsing of other's comments, as well as the ability to add comments, and to delete the note or comment itself (Figure 6). Thus, a note can have 0 to n students' notes on it.

The interface also offers students the ability to make their notes public or private as regards visibility of the note, and to choose type of note, such as praise or general, and authorship. We added these options to motivate students to share their feedback with their classmates. Inside the popup menu frame, students can view public notes they or others have previously written. The options are designed to encourage the students to express themselves through note, since the benefits are clearer to them. We expect to see strong correlations between an increase in the number of annotated pages and the students' navigation behavior; as well as showing a higher usage of the system, since it is easier for students to find relevant information. We further hypothesize that the ability to specify types for notes will encourage higher usage of the note system, since its benefits are clearer.

2.2. Note Visualization

In this technique, visualization of notes is supported through different visual features such as notes style and color

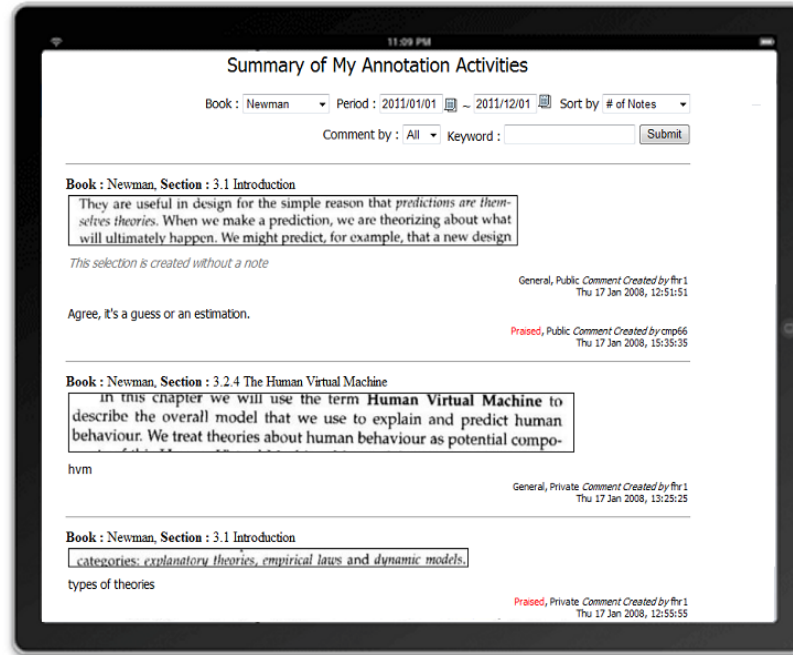


Figure 8. Summary of My Note Activities

The summary page provides filtering and searching functionalities that allow the students to quickly find relevant notes. Filtering can be executed based on type of textbook, time period of the activity, praised, number of notes, and authorship of the note. Notes can be also searched by keywords. Returned result can be sorted by time of the activity.

3. Evaluation

3.1. The Study Design

In this section, we focus on the application of note feature. The system has been used for 2 semesters. Digital textbook without note function was used in the first semester(S1), and the note system was used for the second semester(S2).

The studies were done in a course in a graduate school. The system was introduced to the students at the beginning of the semester, and there was no obligation to use it for any homework or test. Thus, students were free to use it anytime and anywhere during two semesters.

In S2 group, there were total 29 students in the class and 25 students used the system. The students made 89 notes on pages. The number of notes is ranged from 1 to 8 over pages. The total pages in the books are around 490, and 46 pages are annotated. During the semester, all students' activities were logged for data analysis.

3.2. The Hypotheses

In this evaluation, we pursued to validate our following hypotheses:

(1) Users tend to annotate most valuable pages in the corpus. The number of notes made for a page reflects the importance of this page for the group

(2) Visualized note encourage the students' navigational decisions: noted pages are visited more frequently.

(3) The proposed system will improve learner's knowledge by helping them to access important resources.

3.3. Important Pages and User Notes

We provide the digital textbook in the 2011 spring semester, and applied the proposed system in the 2011 fall semester. During this second semester, students are more likely to use the system and access the resources. Unlike the previous semester, students could annotate pages and even more notes are accumulated on the important pages as shown in Figure 9 where S1 represents the page hits without note system, and S2 represents the second semester with proposed method. Therefore, significantly large number of page hit is made on these annotated pages. The significant difference is found between S1 and S2 ($p=.00$). Note that the pages with the high number of notes were also considerably hit in the S1. We can assume that these pages contain already important information of the course.

The first and second hypothesis reflects our belief that the community note process. It is able to identify the pages in the corpus, which are most valuable to the users. More specifically, we expect that the more valuable a page is, the higher chance is has to be annotated. Our expectation is proven that note-based interface support, which shows the presence of notes, will provide a good way to identify valuable pages and help students to find them.

Since in a free navigation environment, the number of visits to a specific page provides a good measure of page importance. We can assume that these pages contain important information, and the note on the pages encouraged students to visit them. Note functionality helps learner to find useful information easily. Therefore, our hypotheses are validated.

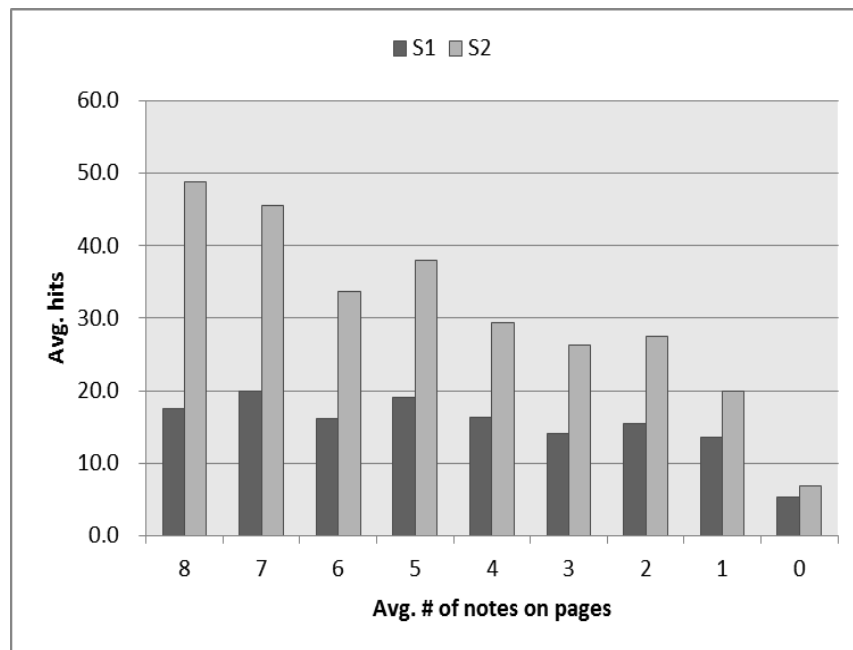


Figure 9. Average Number of Hits on Pages both S1 and S2

3.4. Improving Learner's Knowledge

As was shown in previous sections, the community note-taking process helps to reveal important pages, while note visualization support successfully guides the users to these pages. Thus, note-taking increases students' chances to discover and read most valuable pages in the textbook material. In turn, by helping students to attend to most valuable pages, it has a chance to increase students' knowledge of the subject. If this is true, we have a chance to register this effect of SNS on student knowledge by comparing student classroom quiz scores between S1 and S2, when a considerable volume of notes was accumulated at the end of the course. Multiple-choice quizzes were administered in the classroom at the end of semester to check the quality of student reading.

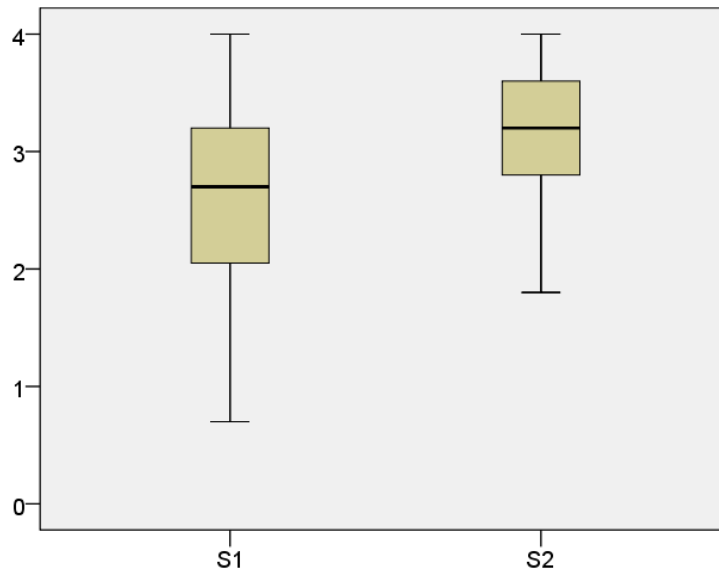


Figure 10. The Average Quiz Score of S1 and S2

The average scores and other data for the quizzes are shown in Figure 10 and Table 1. As the data shows, the average scores increased significantly between semesters (independent t-test, $p = .00$). This result supports our third hypothesis: the proposed system does help students to access resources, which are important for their learning. Looking at the data closer, we can observe that the highest score stayed the same in both semester, but lowest score increased from 0.7 to 1.8.

Table 1. Descriptive Statistics of Quizzes in S1 and S2

Semester	Minimum	Maximum	Mean	Std. Deviation
S1	.70	4.00	2.63	.73
S2	1.80	4.00	3.19	.52

In addition, the standard deviation decreased by almost one third. It hints that the increase of the average score was mostly achieved by increasing the scores of weaker students. Therefore, we can hypothesize that stronger students are able to discover most valuable pages on their own.

However, for students who have lower scores, note visualization provides valuable support bringing their knowledge closer to that of strong students. In this context, the combination of visual style and note-taking functionality provides a mechanism for transfer of discovered knowledge between students making the class as a whole to benefit significantly.

3.5. Subjective Data Analysis

As mentioned before, we ran an optional questionnaire at the end of each semester to collect more explicit feedback from students about aspects of the system. A subjective data analysis through questionnaire was done to evaluate satisfaction on visualized annotation interface. In a class, the questionnaires designed to measure users' satisfaction on creating and viewing annotation functionality and usefulness of summarizing page. Students were asked to answer a number of questions about the usefulness of the annotation functionality of the system. As shown in Figure 11, average 80% of students in all cases appreciated the annotation functionality.

To evaluate student opinion about if '(a) creating annotation, (b) reading annotation, (c) border thickness, (d) annotation color, (e) summary page, (f) search functionality' was useful. Most students were glad with the proposed annotation features.

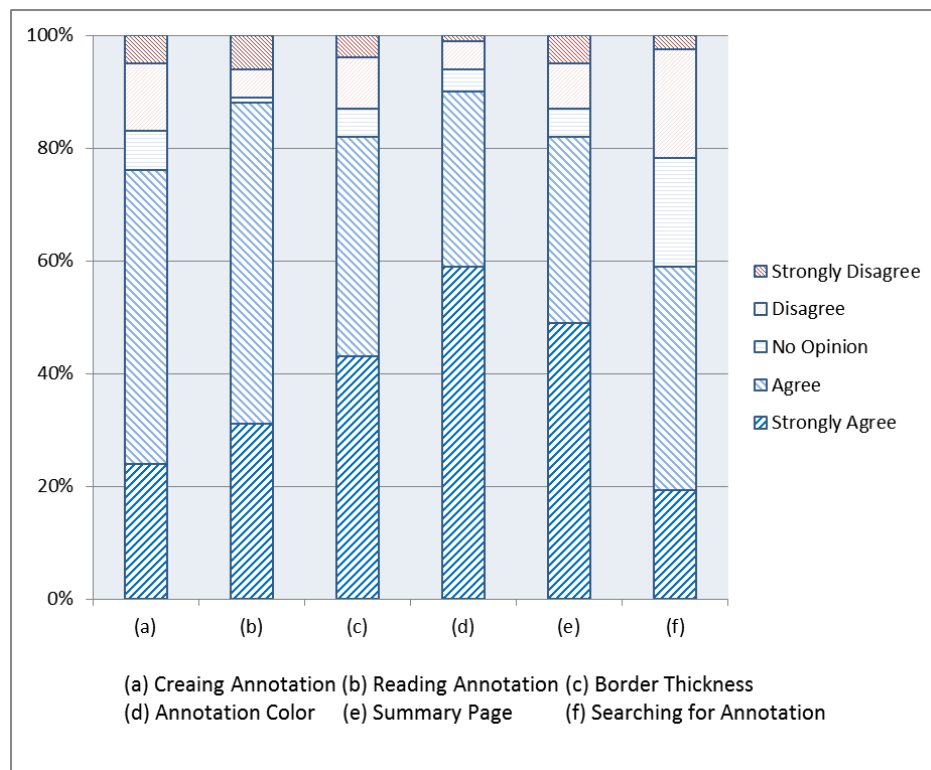


Figure 11. Satisfaction of the Proposed Annotation Features

We also collected student feedback. Many students appreciate the functionality of annotations and they would like to draw and read graphical object on the textbooks. Some students mentioned that the color of annotation is not familiar to them and it might cause cognitive loads. Also, multiple annotations on a page could hide the background text and might decrease the readability. The system provided a help page to explain about the annotation color, and the on/off button on each page to hide annotations though. It seems like that more intuitive way to represent the icon and annotation is required for the students who have little experience with annotation functionality.

4. Conclusion

The proposed annotation interface for electronic textbooks on tablet PC has been developed in this paper. We focused on visualized features to convey annotation information to students.

The interface enables students to create annotation in electronic textbooks as a bookmark or personal note. Annotation is used not only for reserving a place to take a note, but also for exchanging ideas with other class members. We measured the effect of proposed interface over two semesters in an elementary school. As a result, annotated pages significantly were read by students more frequently than non-annotated pages. Moreover, pages with multiple annotations were appeared to have important information for students. The proposed visualized feature has attracted more students to access annotations than single colored annotation. We also took pre- and post-test, and the test scores showed that students' knowledge was improved when they used the proposed interface. The results showed that annotation provided a better guide to students to find useful resources. The subjective data analysis also shows a highly positive result for the visualized note features.

In future work, we would like to extend our system to other smart operating system such as Android OS and Windows Phone 8. We would like to explore the use of the technique to various platforms as case studies

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