

Creating Personal Notes in Electronic Textbooks on Touch-based Tablet PC

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Abstract

Tablets and smart devices became a big surprise in education field over past years. Schools that brought tablets into the classroom showed that the tablets can be a great learning device. Tablet and mobile devices have strong power to change education paradigm. Specifically, many people believe that electronic textbooks will take the place of the next paradigm shift in education. However, just providing students with smart devices and electronic textbooks is not sufficient. Students are supposed to write and communicate with each other in mobile education, not just to read textbooks. Moreover, students want to pile their own knowledge as their private assets. In this paper, we propose a user interface that helps users to create a note in electronic textbooks along with user's touch gestures and to organize their own personal notebook. We focus on solving inaccuracy of touch gesture to create a note on a target object on touch screen device. We present then the evaluation and it indicates that our proposing interface is more accurate with small time cost.

Keywords: *Note-taking, Electronic Textbooks, Smart Education, Annotation, Tablets, Touch Gesture*

1. Introduction

Tablets have created a new market for electronic textbooks in education. They provide students affordable options for their essential study materials. Electronic textbooks are a new paradigm across tablet platforms now. The market for electronic textbooks is yet small but growing fast. It's increased 44.3% from 2011, according to publishing industry research information.

US government is pushing a new initiative to move from standard printed textbooks to electronic textbooks within the next five years. The major hardware manufacturer, KNO is now focusing on its textbook delivery and annotation software. The company is already working with publishers, including Cengage Learning, McGraw Hill, and Pearson and Wiley, to publish its electronic textbooks content.

Moreover, Apple announced iBooks 2 [1] providing full screen textbooks with interactive animations, diagrams, photos, videos and navigation. Leading publishers, just mentioned above, are delivering their educational titles on the store. Apple also provides an authoring tool for Publishers of small and private presses to create textbooks (Figure 1).

In South Korea, a promotion strategy for "Smart Education", focusing on customized learning and teaching has been designed as shown in Figure 2. By 2015, South Korea's

classrooms will be switched to electronic textbooks. The classroom will be able to deliver all its curriculum materials in electronic textbooks from through tablets [2].

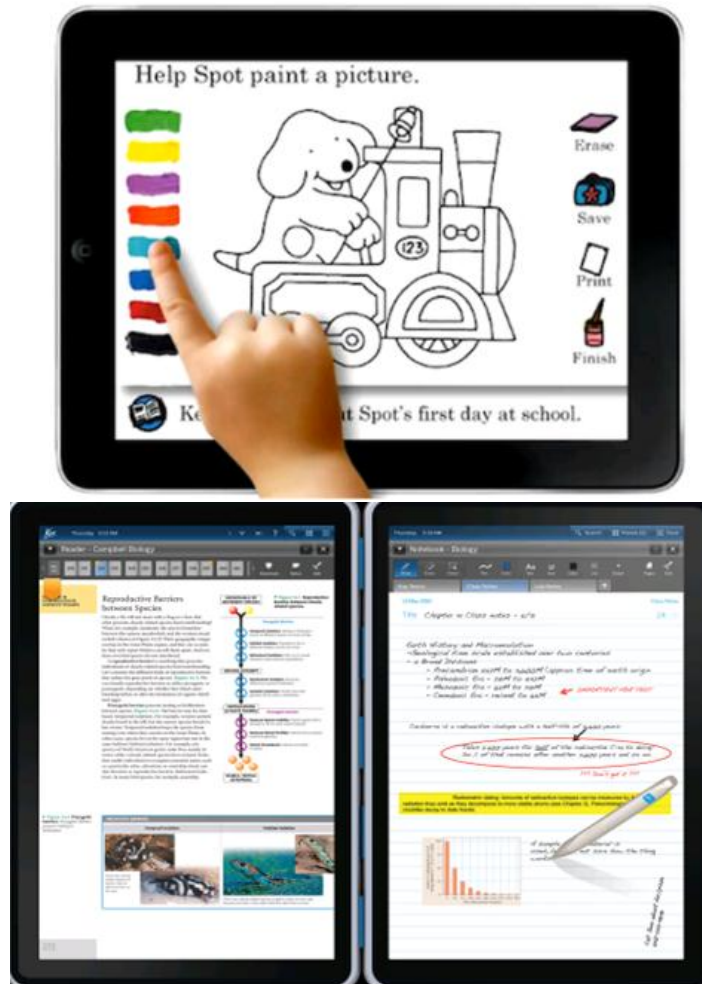


Figure 1. An Example of Touch-based Educational Content on iPad(left) and KNO(right)

Applications and technologies related to electronic textbooks are actively being developed [3, 4, 5]. For example, The Inking feature in electronic textbooks allows students to interact with the text, and other content. The learners can digitally highlight text and create notes, in the same they would with a pen in paper textbooks, but then those notes can be shared with other class members [6].

Many researchers [7, 8] believe the pen or sketch-like input metaphor makes the tablet computer more user friendly and easy to learn.

However, the studies in various cases and learner's responses since electronic textbook launching in 2008 shows that no significant effectiveness in using electronic textbook than traditional textbook.

The main reason is the usability of the tablet device because the usability effects on user experience and learning effect. Inappropriate design in usability may cause a negative cognitive process in learning, therefore it is very important in elementary school education [9,

10, 11]. According to our research, it is shown that the following two factors should be considered to enhance the usability of educational contents in touch-based device.



Figure 2. Smart Device-oriented Education in Korea

First, a user, especially a learner, has strong urge to create own personalized content. Therefore, easy input methods such as sketch, dragging, or pasting, are preferred than formal keyboard input. This can be represented as note-taking behavior. Second, 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. A learner has high interest in other member's problem solving style. Therefore, we propose an annotation-based smart user interface for electronic textbooks for the educational purpose.

In this paper, we propose annotation-based smart user interface in Section 2 and evaluate it in Section 3. Then, we conclude in Section 4.

2. Related Works

Annotation functionality has been studied in many research papers and implemented in various tools in desktop operating systems. However, touch-based devices such as tablets have different user input method and applications. Since the history of touch tablets is not so long, few studies on annotation techniques in tablets have been done compared to the desktop system.

The most common book reader is iBooks 2, developed by Apple. It supports basic annotation features such as note, highlight and bookmark as shown in Figure 3. It also synchronize user bookmark in a book purchased by the same account between the apple devices. A reader selects a word or paragraph by touch input, and resizes the area by using a built-in magnifier. The operating system highlights the target text in a sky blue rectangle. The reader can move small blue spots on its edges, so the selection can be adjusted. Therefore, it may require a delicate and accurate touch action to select an exact text area.

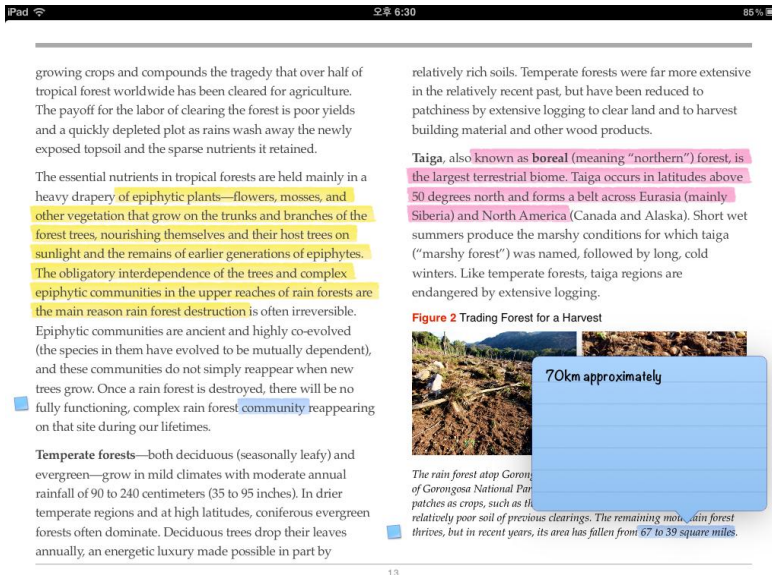


Figure 3. Annotation Example of iBooks

Another annotation tool is PDF annotator that allows a user to read and annotate PDF documents on iPad as shown in Figure 4. It allows the user to highlight text, add sticky notes, free hand-drawing and photos to a PDF document. The tool has been related to social networking service and commonly used websites. It enables user to share the annotated PDF on Facebook, Twitter, Google Docs, and so on.

Annotating method is similar to that of iBooks. In addition, it supports free hand-drawing to write text or drawing shapes by touch gesture. This tool is specifically designed to annotate on PDF document. However, most electronic textbooks are now follow HTML5 or ePub standard. Thus, annotation features should support web document standard for compatibility and reuse issue.

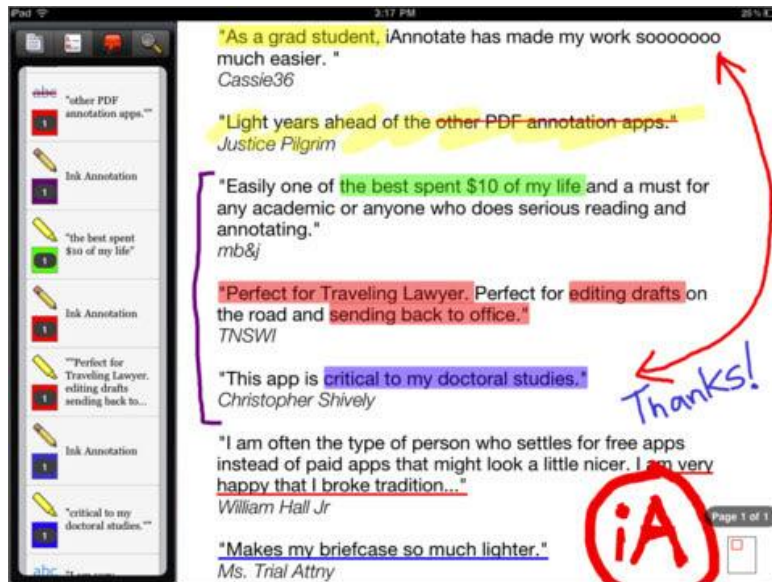


Figure 4. PDF Annotator

Other annotation tools for tablets can be easily found in app markets such as iAnnotate, Notability, DocAs and so on. Most of them have similar annotation interface to iBooks or PDF Annotator.

Touch input is more convenient but less accurate than mouse input. It might be hard to select small text area to highlight or add a note. Fundamental functionality of annotation is already provided by various tools, but this touch input problem has not been considered for creating annotation. Therefore, we propose smart user interface for creating annotation at the following section.

2. Smart User Interface for Creating Notes

2.1. Creating a Note

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.

Here, we defined the three types of touch gestures. The first is holding down by one finger on a specific location of a web page. A user can move around the finger to select a target area until the target is selected as shown in Figure 5. This gesture can be used for selecting a simple target such as an image, video, or a paragraph of text.

The second gesture is holding down by two fingers, and moving them to adjust the size of selecting area. This is useful when a user tries to select multiple objects or a part of text.

The third gesture is holding down one finger on the left-top side of the screen for one second, and drawing a freeform area using another finger. This is useful for selecting a complex layout such as irregularly shaped table or a combination of layers (*i.e.*, tables, images and text), which is hard to select using a square shaped area.



(a) Selecting an object by a finger

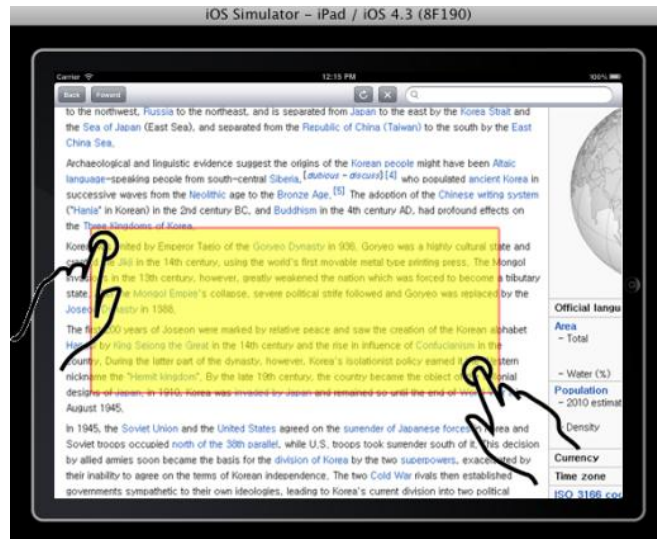


(b) corrected area by proposed algorithm

Figure 5. Selecting Object on a Website by the First Type of Touch Gesture: Initial Input (a) and Corrected Result (b)

We provide three ways to clip an area on a webpage. Due to the touch device characteristic, finger touch input is very convenient and fast, but less accurate than a mouse or keyboard. For accuracy enhancement, our correction process using a semantic HTML structure should be applied to the selected area. For instance, the correction module analyzes the HTML elements that lie inside the coordinates of the area. If any element is found within the area, the selecting area will be extending to include element and displaying on the screen.

Figure 6 shows the result of an area correction when a user uses the first gesture type on an image element. The system reads the touch point coordinate and traces the corresponding target element. For the first type input, system reads the point and extends its selecting area into exact size of single element.



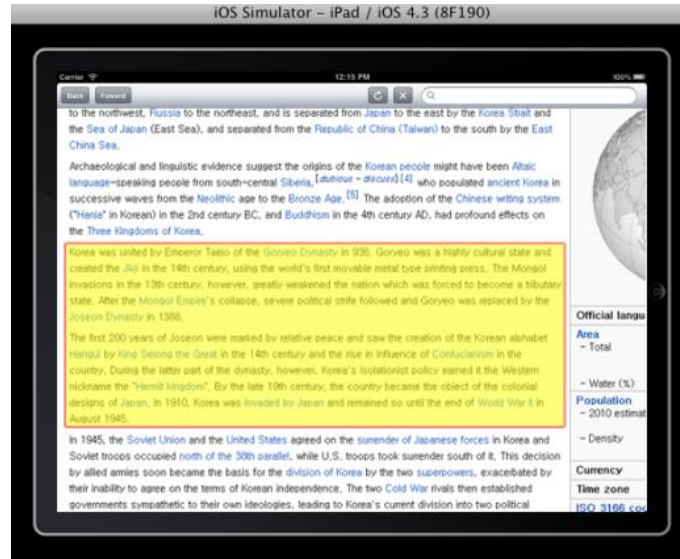


Figure 6. Selecting Text by the Second Type of Touch Gesture

The second touch type can select multiple objects by moving two fingers for resizing the selection area. User can select not only a part of paragraph, but also multiple paragraphs. For the better usability, our correction process will select whole paragraph when the selected text size is larger than a certain threshold size of paragraph.

Figure 7(a) shows the text area selected by a user and selected area exceeds 90% of two paragraphs. Then, the correction module expands the region to select two paragraphs as shown in Figure 7(b). The module assumes that the user intends to refer the whole two paragraphs, but is not be able to select them exactly due to the inaccurate input type of touch interface.

The following HTML code described in Figure 7 is an example of the underlying text structure

```
... by the Joseon Dynasty in 1388.</p><p> Korea was united
by Emperor Taejo of the Goryeo Dynasty in 936. G ... omit ...
so until the end of World War II in August 1945.</p>
```

(a) Partially selected paragraph

```
... by the Joseon Dynasty in 1388.</p><p> Korea was united
by Emperor Taejo of the Goryeo Dynasty in 936. G ... omit ...
so until the end of World War II in August 1945.</p>
```

(b) Area corrected to the complete paragraph

Figure 7. The Underlying HTML Text Structure

The threshold value may depend on the number of words in targeted paragraph. According to our analysis of user behavior observation in touch input selection, user tends to select more

accurate on short paragraph than long or multiple. Therefore, the high threshold value should be applied for short paragraph and low for long or multiple paragraphs.



(a) Manual Area Correction Interface



(b) Note collecting interface

Figure 8. Slider Menu (a) and Note Collecting Interface (b)

Once a correction process is completed, the selected area will be displayed with a slider menu interface on the screen. This enables the user to manually manipulate the selecting area as shown in Figure 8(a).

The slider expands or collapses the area by navigating the target HTML tree nodes (Figure 9). Moving it to right side makes a selected node going up to its parent node and this means expanding the area to cover all sibling nodes which might be related original selection and vice versa.

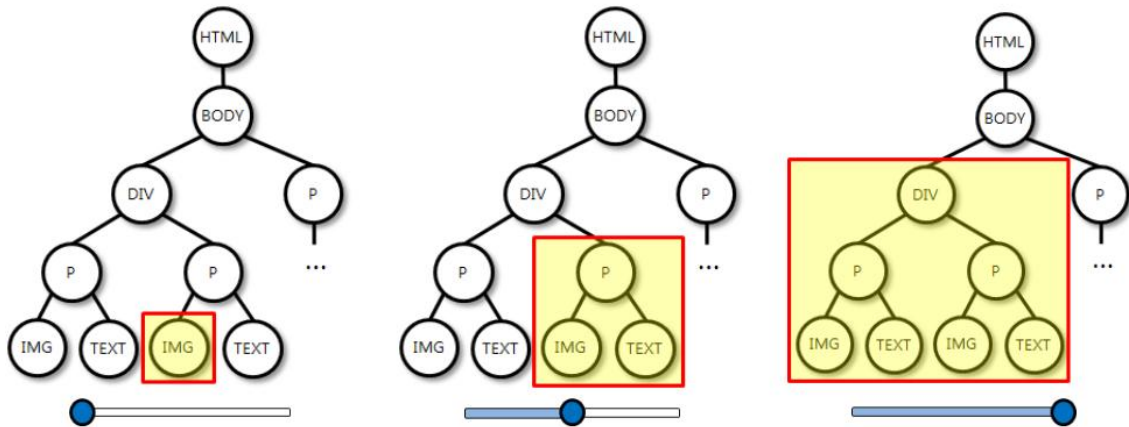
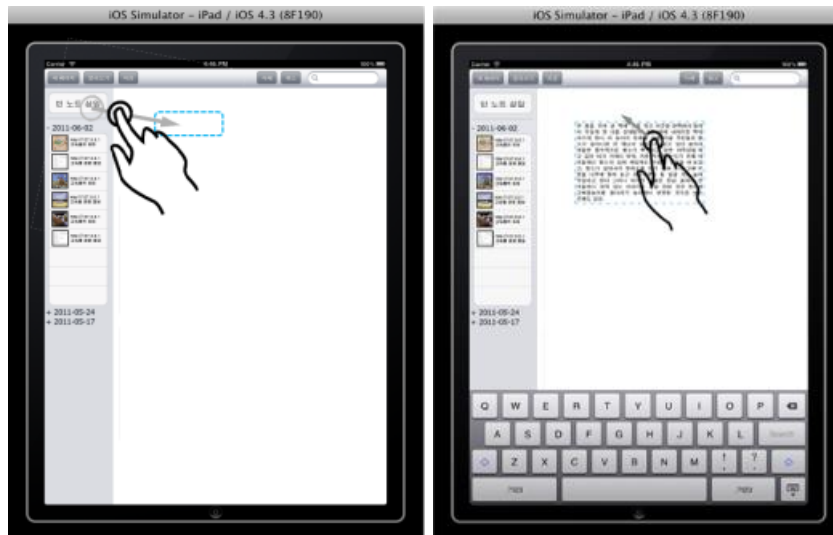


Figure 9. Navigating the Target HTML Tree Nodes

After finalizing the area, an empty slot will be appeared on the right side of the screen. A user can drag and drop the selected object into the slot to store it in the note collection as shown in Figure 8(b).

2.2 Organizing and Sharing a Notebook

The proposing application has another view called a notebook canvas where a user can create a personal notebook by inserting notes from the collection. The collected notes are listed as thumbnails on the left side of the screen ordered by date or source web URL. A user can drag and drop the thumbnail on the empty canvas, and also insert a blank note as a new note. It also provides basic touch gestures to manipulate a note clip such as translation, rescaling, and rotation as shown in Figure 10.



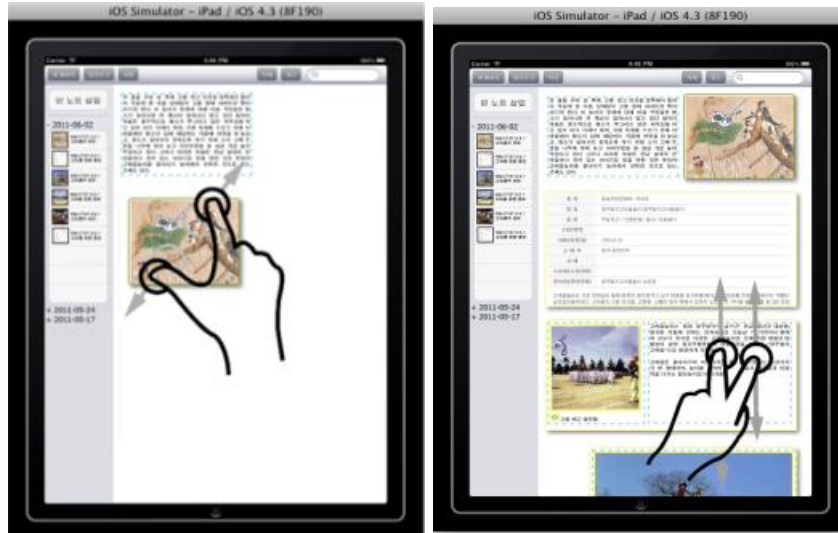


Figure 10. Notebook Editing Interface

When a user stores a created notebook on the cloud server, it can be accessible at any location. In addition, a notebook can be shared to other group members for their information. Touching the ‘publish’ button on the top of the screen sets one of note-books open to the public. Thus, other group members can read public notebooks and import them into their workspace as well.

In educational institutes, it is shown that many students tend to refer a well-noted notebook of a top student or a teacher. They also often tend to discuss about their notes. These educational behaviors are the motivation of this interface.

3. Evaluation

In this paper, the proposing interface is evaluated using quantitative and qualitative methods. Both the proposing and a comparative interface are explained for 30 minutes to 40 elementary students (i.e., 21 male and 19 female, the 6th grade student) as evaluators. We have them familiar with the interface before the test. The overall system structure used in the test is shown is Figure 11.

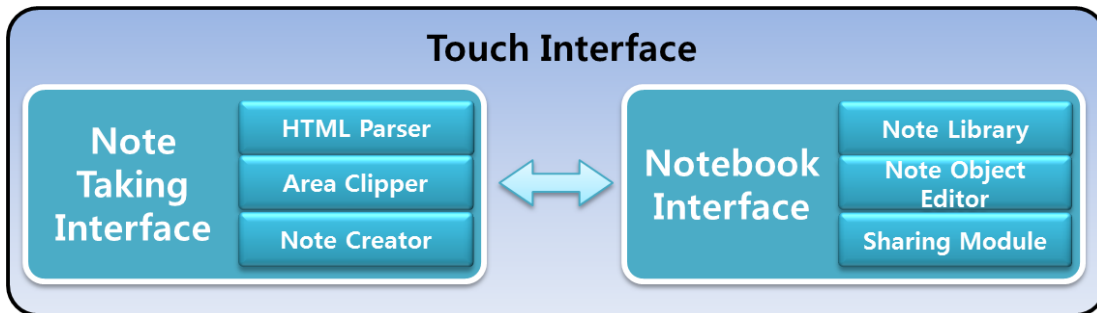


Figure 11. Overall Structure of the Proposed System

3.1 Experiment 1

In experiment 1, the time consumption to complete the task and accuracy are measured. For the experiment, 10 sheets of paper, printed educational websites, marked with total 40 annotations are given to the participants first where each page has 3 to 5 annotations. They were divided into experimental group (*i.e.*, EG) and control groups (*i.e.*, CG). Each group is asked to create the note, exactly same as given sheets, from the webpages. EG used the proposing interface and CG used a multi-gesture enabled iPad device with Safari web browser.

We evaluate the time needed to complete the task and accuracy of selected areas compared to the area of marks on the given sheets. The entire outcome of two groups is shown in the Figure 12. Paired-t test was used to analyze the result. CG takes more time to complete the task and overall accuracy is significantly lower ($p = .01$). EG is able to undertake highly accurate work with less time ($p = .03$).

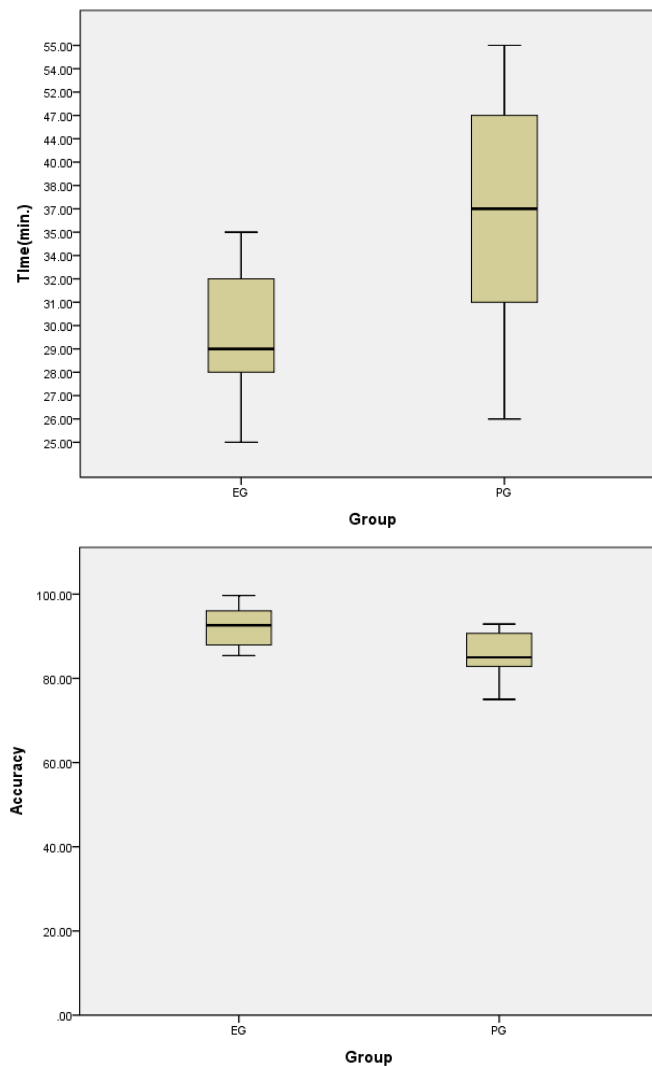


Figure 12. Test Results of Both Groups: Working Time (top) and Accuracy (bottom)

3.2 Experiment 2

To evaluate an effectiveness of the proposing notebook to students, we designed a 2 hours course for the participants. The participants freely create their personal note-books and share them with other group members. Without any sharing requirement, they could share each other's notebook by using the application. The other group can also freely access to the course material and take a note on a paper.

A pre/post-test was taken to measure the effectiveness of the proposing interface. To verify objectivity of the test, the participants are given a quiz to distinguish problem solving ability between two groups. EG and CG scored average of 69.1 and 68.3, standard deviation of 16.76 and 17.49 respectively. We can see that the difference of test results between EG and CG is not significant ($p = .06$) as shown Table 1. This ensures that those two groups have a similar level of basic knowledge on the testing material.

One hour is given for each group to study the assigned material. As shown in Table 2, the score of experimental group is higher than that of control group. Significant difference is found($p = .009$).

Table 1. A Comparison between the Pre-test of Two Groups

	N	Avg.	SD	df	t	p
EG	20	69.17	16.76	22.00	.119	.637
CG	20	68.33	17.49	21.96		

Thus, it is shown that our proposing notebook application in touch device, we can see that use of the proposed notebook application on a touch device have on positive effect on the problem solving skills.

Table 2. A Comparison between the Post-test of Two Groups

	N	Avg.	SD	df	t	p
EG	20	87.23	8.63	22.87	1.057	.009
CG	20	73.26	13.13	14.89		

4. Conclusions

We proposed the note-taking smart user interface for electronic textbook and measure its functionality and effectiveness. Our results show that the user is satisfied with the demand of creating the own content through the note-taking interface, which minimizing costs by the improved accuracy and reduced time. Furthermore, a personalized notebook created and shared by the interface significantly improves the learner's knowledge.

In the future work, we will build the cloud-based database, which stores pedagogical information such as learner's profile, scores, learning behaviors, and etc. Using the database, a recommendation system can be combined with notebook interface in order for the learners to gather more related and proper information.

Currently the application only runs on iOS. However, we will work on the cross platform compatibility for Android OS and even desktop OS. Thus, a learner can manage notes on the electronic textbook anywhere at any time via the cloud service.

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