Assessment of the Usability of e-books for Aged and Young Readers

Haruo ISONO, Yusuke TAKIGUCHI and Chihiko YAMADA*
Nippon Institute of Technology
4-1 Gakuendai Miyashiro-Machi, Minami-Saitama-Gun,Saitama-Ken345-8501,Japan
Phone: +81-480-33-7487 Fax: +81-480-33-7461 , E-mail: isono@nit.ac.jp

Abstract

We evaluated the usability of two kinds types of recently commercialized e-books through an analysis of their protocols, compared the time required to read an e-book with that for a paper book, and compared text display sizes that were easy to read for aged and young readers, under identical conditions. This showed clear problems with the usability of e-books for aged and young readers. It was found that it took longer for aged readers to read text in an e-book than for young readers, and that the size of text that aged readers found easy to read was different than for young readers.

1. Introduction

Recently, e-books specially designed for reading documents using such new display devices as LCDs with memory functionality and electronic paper have become available for sale. It is predicted that in the future, it will be normal to read using e-books. In order for reading via e-books to be widely accepted by general users, however, it is vital for e-books to not only focus on performance and functionality at the hardware level, but also on human engineering – the design of e-books from the users' perspective.

One point thought to be especially vital is the usability of e-books. E-books, however, are a recent appearance, and because of this research on their usability is scant. In particular, there have been no reports comparing usability when e-books were read by aged versus younger readers. This paper evaluates the usability of two kinds types of recently commercialized e-books through an analysis of their protocols, compares the time required to read an e-book with that for a paper book, and compares text display sizes that were easy to read for aged and young readers, under identical conditions.

2. Evaluation of usability through protocol analysis

Protocol analysis is one of the more common methods for evaluating the usability of a human interface. Using this methodology, test subjects are given tasks to perform, and their verbal protocol and behavior are recorded on video during the performance of the tasks; the video is then analyzed, and issues for the usability of the item being evaluated are identified. Fig. 1 illustrates the experimental layout of the protocol analysis.

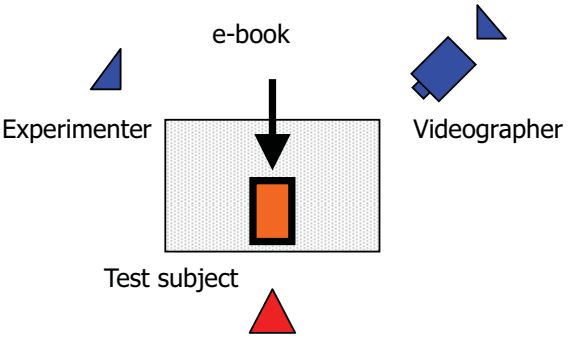

Figure 1. Experimental layout of the protocol analysis

2.1 Method

In the present research, two types of e-book were the subject of the experiment: they were a Sony e-book using E-Ink electronic paper (a micro-capsule electrophoresis system), and a Panasonic e-book using memory-type LCDs. For the e-book usability test, a protocol analysis was conducted. Subjects were assigned the tasks in Table 3. They were made to manipulate the e-book with no prior instruction, during which time they

were instructed to freely verbalize their thoughts and feelings. Although a time limit of 30 minutes was set for the tasks, the experiment was ended once a subject had completed the tasks assigned to him or her. The test subjects consisted of a group of 13 young readers (average age 21), and a group of 6 older readers (average age 66). During reading,500 lx of vertical illumination was applied.

Table 1 . Specification of Sony e-Book

e-Book Reader	: EBR-1000EP (SONY)
Display Panel	: E-Ink electronic paper
Resolution	: SVGA(800 x 600 dots)
Display Size	: 6-inch (diagonal)
Display Color	: Black & White
Tone reproduction	: 2 bit grayscale
Contrast Ratio	: 9: 1
Reflectance	: about 36% (white)
Viewing Angle	: near 180 degree
Weight	: 190 g

Table 2 . Specification of Panasonic e-Book

e-Book Reader	: BKE-AW-N7 (Panasonic)
Display Panel	: Coresticc LCD
Resolution	: VGA(1024 x 768 dots)
Display Size	: 7.2-inch (diagonal)
Display Color	: Blue & White
Tone reproduction	: 4 bit grayscale
Contrast Ratio	: 3: 1
Weight	: 520 g

Table 3. Assigned e-book tasks

- ◆Turn on power of e-book
- ◆Select specified book
- ◆Read specified book from beginning
- ◆Read while turning pages
- ◆Turn off power of e-book

2.2. Results

Fig. 2 shows the average time taken by the subjects to complete the tasks. For both types of e-book, it took longer for the older subjects to complete the tasks than the younger ones; only about 50% of the older subjects were able to complete the tasks within the time limit (30 min.). Most of the subjects who failed to complete the tasks were not accustomed to operating machinery in their day-to-day lives. A common feature of these subjects was that after performing an action incorrectly, they would repeat the same error again, and be unable to progress to the next task. Additionally, many of the subjects mistook the e-books' display screens for touch panels, or were unable to find where the power switch was.

Tables 4 and 5 show the main problems shown by the protocol analysis for the Sony and Panasonic e-books. The figures in the table are the proportions of respondents to total subjects.

For the Sony e-book, "Don't know where the power switch is" was an issue common to both older and younger subjects. For the Panasonic e-book, "Screen is hard to see," "Can't understand on-screen instructions," and "Too heavy" were common issues. In addition to these, common issues for the older subjects were as follows: for the Sony e-book, "Buttons size," "Method for turning pages," and "Use of jog dial"; for the Panasonic e-book, they were "Text is too small" and "Mistook it for touch panel. A common issue for the younger readers was "Response too slow," which was common to both types of e-book.

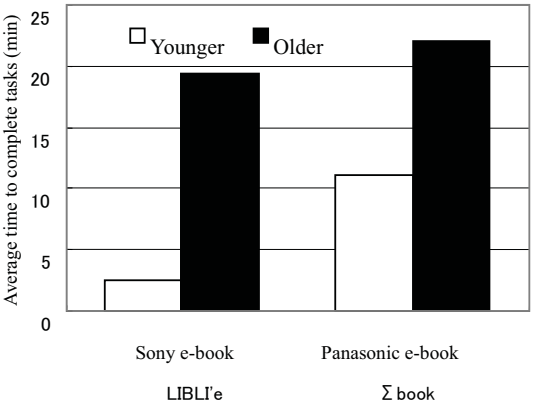

Figure 2. Average time to complete e-book tasks

Table 4. Issues with Sony e-book

Issue	Younger	Older
Button size	23%	83%**
Page-turning method	8%	67%*
Response too slow	46%*	0%
Jog-dial operation	15%	50%*
Method to turn off power	15%	50%*
Mistook for touch panel	23%	50%*
Location of power switch	46%*	100%**

Table 5 Issues with Panasonic e-book

Issue	Younger	Older
Text size	15%	100%**
Can't understand on-screen instructions	77%*	100%**
Mistook for touch panel	8%	83%**
Response too slow	77%*	17%
Screen is hard to see	69%*	83%**
Contents function hard to use	15%	100%**
Too heavy	31%	33%

3. Time required to read e-book

3.1 Method

We compared the time it took older and younger subjects to read 40 pages of text (about 25,000 Japanese characters) using e-books and paper books. The test subjects consisted of a group of 20 young readers (average age 21), and a group of 20 older readers (average age 68). 500 lx of vertical illumination with a distance of 40 cm was used. Table 6 shows the font sizes of the text used for the e-books and paper books.

Table 6. Font sizes for e-books and paper books

Sony e-book ..... 9.5 pt
Paper book ..... 9.5 pt
Panasonic e-book ..... 8.0 pt
Paper book ..... 10.5 pt

3.2 Results

It was found that it took longer for the older subjects to read both e-books and paper books than the younger subjects. Fig. 3 shows the results of the experiment with the Sony e-book; Fig. 4 shows the results of the experiment with the Panasonic e-book. A t-test ($p < 0.01$) was conducted on the results of the experiments to test for statistical significance. It showed no significance for the amount of time required for younger and older subjects to read paper books and the Sony e-book.

Meanwhile, it took longer for both younger and older subjects to read the Panasonic e-book than paper books, and this was found to be statistically significant. One reason for this may be that the text in the Panasonic e-book was blue, and had low contrast with the background, making it difficult to see. Alternatively, since an LCD is used it may be because the screen is more susceptible to ambient lighting conditions.

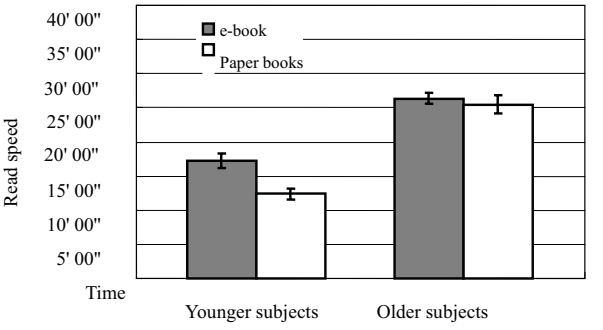

Figure 3. Comparison of time required to read Sony e-books and paper books

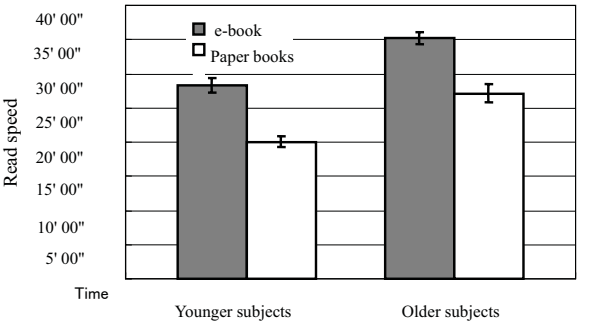

Figure 4. Comparison of time required to read Panasonic e-books and paper books

4. Text sizes that are easy to read for e-books

4.1 Method

When reading text in an e-book, the size of the text that is displayed is vital for our easy it is to read. The Sony e-book used in the present experiment (6" screen) has a function to change the text size in 5 steps, from 9.5 to 19 pt (see Table 7). We conducted a subjective-assessment experiment to clarify which text size was easiest to read for older and younger subjects. In the experiment, two Sony e-books were used, and the

parameters were set up to create every combination of two text sizes among the five text sizes available. The ease of reading each of the text sizes was evaluated by comparing each of the five size categories against the other on the two e-books, using these combinations. The test subjects consisted of a group of 10 young readers (average age 22), and a group of 20 older readers (average age 68). 500 lx of vertical illumination with a distance of 40 cm was used.

Table 7. Text sizes of Sony e-book

Text size	*Num. characters displayed on screen*
9.5 pt	***320***
12 pt	***184***
14 pt	***150***
17 pt	***101***
19 pt	***69***

4.2 Results

It was shown that on the Sony e-book (6" screen), 12 pt text was easiest for the younger subjects to read, and 17 pt text was easiest for the older subjects to read (Fig. 5). Thus, the text sizes that were easiest to read differed among younger and older subjects. For this reason, a function to change the display text size should be particularly effective for older readers.

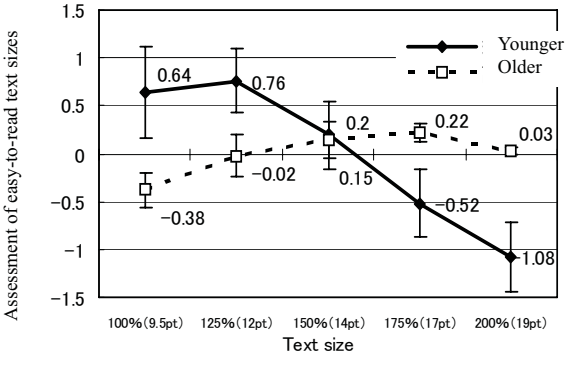

Figure 5. Easy-to-read text display sizes

5. Conclusion

The usability of e-books for older and younger readers was assessed using protocol analysis. The analysis showed problems with the usability of e-books for older and younger subjects. Usability is an issue for e-books today; there are many aspects of e-books currently being commercialized that make use difficult for both older and younger readers. There is a need for e-books to be designed for usability.

It was also found that there are differences between older and younger readers in the amount of time it takes to read documents on e-books, and the text sizes that each group found easiest to read on e-books. The capability of e-books to change the text display size is an advantage that paper books do not have, and is effective for older readers whose eyesight has deteriorated.

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