Ergonomically design e-book to improve comprehension and retention

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Abstract

***Abstract*— E-book has become a widely used tool by schools and universities to complement printed books. Previous studies conclude that the ability of e-books to convey knowledge is not as effective as with the printed books. The performance of e-books in terms of student's reading comprehension and retention is not satisfactory as compared to printed books The paper intends to a assess the current design of e-books and develop an appropriate design to enhance its acceptability over printed book which will further improve student's reading comprehension and retention. The design focuses on user preferences and features in accordance with the Guidelines of Designing an Electronic Book and Golden Rules of User Interface from Human Computer Interaction (HCI) Concepts.**

Keywords
E-book, HCI, Comprehension, Retention

1. Introduction
With an emerging trend in technology, printed books are now being replaced by e-Books. Some publishing companies like Newsweek and Britannica Encyclopedia has stopped printing and opted to adapt digital publishing. The fame of e-Books has expanded that even the educational sector was influenced with this technology.
According to Yoon Tecnam, most experts agree that E-books will be the wave of the future education considering the fact that younger generations are becoming more proficient in using computers at very early age. Also, the rate of internet users increased at an astounding rate of over two million each month which means that interests in E-book readings had been elevated. (Tecnam, 2012). However, in the study conducted by Jeong, students who read printed books are better in reading comprehension, performed better on quizzes, and suffered less eye fatigue (Jeong 2012). In Princeton University's Amazon Kindle Pilot Study, it was concluded that retention of information was decreased when using a Kindle e-reader due to its lack of flipping and skimming functionality, the screen size of e-readers, poor zoom capabilities, difficulty to read graphics, and the use of continuous scrolling to navigate texts (particularly in PDF format). The current E-book cannot easily make use of text features and cognitive mapping to retain information. Text features (such as chapter and section headings, captions, illustrations, charts, tables, and graphs) help readers comprehend and remember what they've read. (Fisher and Frey, 2008; Morrison and Nunnery, 2011; Yang, Chen and Li, 2011). "Cognitive mapping" is a technique in which readers use text features and physical cues such as the location of information on the page and the position in the book to go back and find a section of text or even to help retain and recall the information they had read. Cognitive mapping is more difficult with e-texts. (Hickey, 2011).

2. Methodology
To come up with an ergonomically design e-book, the authors conducted a survey to university students to determine users preferences, assess the technical specifications to be prioritized in the design using Quality Function Deployment (QFD) and develop an E-book prototype based on users requirements and Human Computer Interaction (HCI) concepts.

2.1 Determine the students' preference for the e-book presentation

The Survey Questionnaire was created based on the Guidelines and Golden Rules from Designing an Electronic Book and Human Computer Interaction Concepts of User Interface. Questions were focused on features and functionalities of E-book that the users want to be included in the design and they are grouped into 22 characteristics such as; (a) E-book Cover- attractive, colourful, with logo and title, (b) Table of Contents – chronological sequence of topics, inclusion of subtopics and hyperlinks, (c) Index – inclusion of hyperlinks to keywords, (d) Individual User Learning Style- inclusion of links to other sources like video, dictionary etc. , (e) Typographical Design – simple and clean, enough space, uncluttered appearance, (f) Short Pages – minimize page scrolling, (g) Orientation Clues – page numbers, chapter and section headings, navigation bars to reflect the progress of reading the e-Book, easy navigation bar to jump page to page , (h) Non-Text Items- includes pictures, diagrams, (i) Other Functions –easy bookmarking, highlighting tools, note taking/ (j) Multimedia and Interactive Elements –inclusion of links and videos, short quizzes in between topics(k) Customization – zoom in and zoom out functionality, (l) Mode and Change Focus –save customizations, remove icons and other bars in reading mode, (m) Display of Messages and Feedbacks – system messages, labels on icons and buttons should be easy to understand , (n) Immediate and Reversible Actions – undo command/ icons in wrong highlighting and note taking , (o) Meaningful Paths and Exits – easy navigation moving upward, downward, forward and backward, provide command using mouse or keyboard, (p) Relieve Short Term Memory – undo, redo, cut, copy and paste, (q) Recognition not Recall – provide context sensitive help, (r) Interface Shortcuts – provide system shortcuts , (s) Object Commands and Consistent Interface – provide save and copy command in object/picture, (t) Search tools – search engine, (u) Consistent Interface – minimize/ maximize open tabs, consistent icons and (v) Style and scannibility – use colours and can include short paragraphs .

Each item was rated through Likert Scale from 1 to 5, with 5 being the Very Important and 1 as Not Important. The result with an average rating of 3.5 and above are considered in the design of the proposed comprehensive and retentive e-book presentation.

2.2 Technical Specifications using Quality Function Deployment (QFD), a customer analysis tool

The user preferences were grouped into twelve technical specifications for e-book design as follows:

A. Organized Typographical Design

Describes the placement of page numbers, chapter headings, simple and clean design of the E-book presentation, plenty of spaces, uncluttered appearance, and words are left justified for clear reading and inclusion of table of contents for chronological sequence of topics and subtopics.

B. Handy Navigation

Showcases the ability of the program to be navigated easily. Functions deployed to fasten the navigation inside and out of the program itself. The functions include: minimized page scrolling, navigation bars to reflect the progress of reading the e-book, easy navigation bar to jump from page to page, ability to move downward, forward, upward and backward, easy navigation to get into parts easily and where to go next.

C. Engaging Aesthetic Design

Represents the whole appearance of the e-book presentation focusing mainly on the use of colours within the program. The inclusion of colours to the e-book adds enjoyment to the reading experience and gives the program a sense of recognition for future reading. Attractive e-book cover design, title and logo in e-book cover, inclusion of pictures and diagrams are some of the features added in the design.

D. Customizable to User Learning Style

With this specification, users may modify the presentation accordingly, the way he wants it to be. The features embedded are: button to switch off links to other sources, easy bookmarking, highlighting features, note taking, ability to change background colours, ability to customize according to individual preference, ability to save customization, ability to remove icons and other bars in Reading mode and fully functional tools in customizing the e-book presentation.

E. Adjustable Functions

The users get to adjust the physical appearance of the e-book reader. It describes the ability of the program to modify the e-book itself and the reader. The functions include: ability zoom in and zoom out the e-book, remove icons and other bars in Reading mode, minimize and maximize the open tabs and e-reader tab.

F Flexible Commands

The group of flexible commands designed specifically to the requirements of the students. The commands under this specification are: ability to save customization, undo commands/icons in wrong highlighting and note taking,

ability to cut, copy and paste, ability to undo and redo, provision for "save and copy" commands in objects/pictures and commands using mouse and keyboard.

G. Consistent Icon Selections

The display icons are consistently used throughout the program for recognition and ease of understanding. The features are: consistent icons for closing and opening commands, labels on icons and buttons that are easy to understand and undo commands/icons in wrong highlighting and note taking.

H. Cognitional Tools

These are tools that help readers to expound, elaborate and remember the topics discussed in the e-book. The functions are: easy bookmarking, highlighting feature and note taking.

I. Linkable to Relevant Sources

This is a utility where hyperlinks are used in different parts of the e-book presentation to link directly to parts relevant to the topics discussed. Not only within the confinements of the e-book presentation but also outside the program especially in media and the internet. The hyperlinks are: inclusion of hyperlinks in the table of contents directly to the topics, inclusion of links to other sources like dictionaries and the likes, inclusion of hyperlinks to keywords directing to other relevant topics in the e-book and hyperlinks to videos and audios that illustrates the topic being taught.

J. Search and Scan

A function of the e-book presentation to search keywords within the entire e-book. It serves an easy navigation as well in searching for a certain word, phrase or topic. The specifications under this function are: provision for search engine, ability to search the entire e-book and context-sensitive help.

K. Error Proof

A feature of the e-book presentation wherein error is prevented to happen with the use of system messages and prompt messages to ensure commands. The specifications of this function are: system message should be easy to understand and inclusion of prompt messages to ensure commands.

L.Interactive Medium

This function deploys better comprehension and retention of the materials being read by the user and helps the students to be engaged with the topics being discussed. The functions under this specification are: inclusion of links to videos that illustrates the topic being taught and inclusion of video and audio to strengthen engagement of topics.

3.Proposed e-book design

The design of the e-Book relative to the technical qualities are as follows:

A. Flexible Commands

The commands should be able to save customization, undo commands/icons in wrong highlighting and note taking, cut, copy and paste, undo and redo, provision for "save and copy" commands in objects/pictures and send commands using mouse and keyboard. Refer to Figure 2.

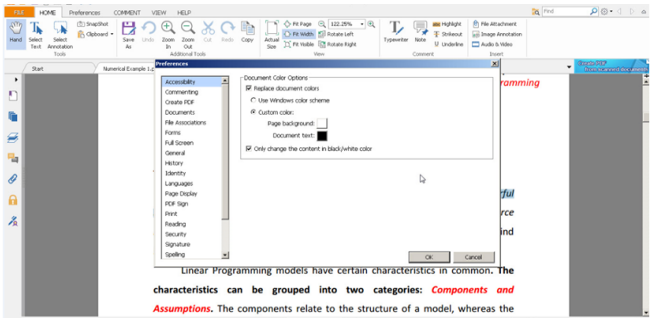

Figure 2 Screenshot of Flexible command

B. Organized Typographical Design

The design includes placing of page numbers, chapter headings, simple and clean design of the e-book presentation, significant spacing, uncluttered appearance, left justification for clear reading and inclusion of table of contents for chronological sequence of topics and subtopics. Refer to Figure 3.

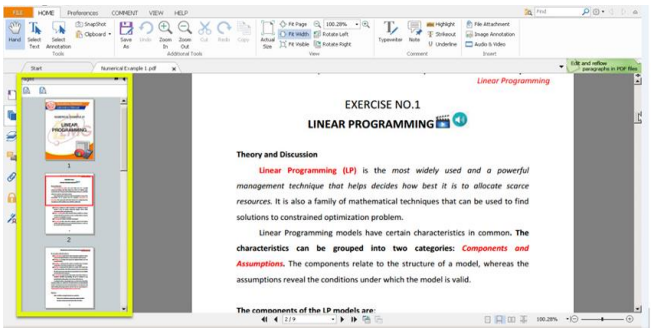

Figure 3 Screenshot of Typographical Design

C. Cognition Tools

These are tools that help readers to expound, elaborate and remember the topics discussed in the e-book. The functionalities are: easy bookmarking, highlighting feature and note taking. Refer to Figure 4.

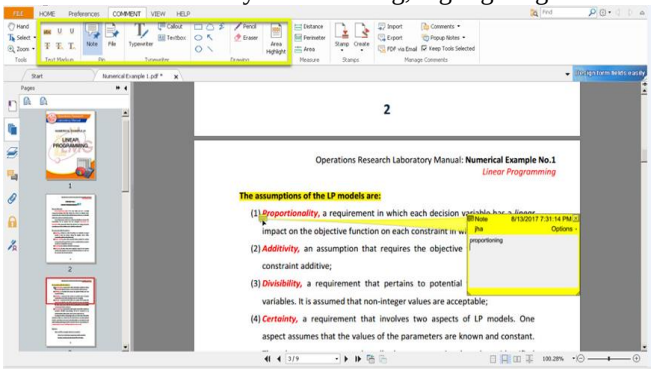

Figure 4 Screenshot of Cognition Tools

D. Customizable to Learning Style

The design provides user's comfortability through the following funtionalities: button to switch off links to other sources, easy bookmarking, highlighting features, note taking, change background colours, customize according to individual preference, save customization, remove icons and other bars in Reading Mode and fully functional tools in customizing the e-book presentation. Refer to Figure 5.

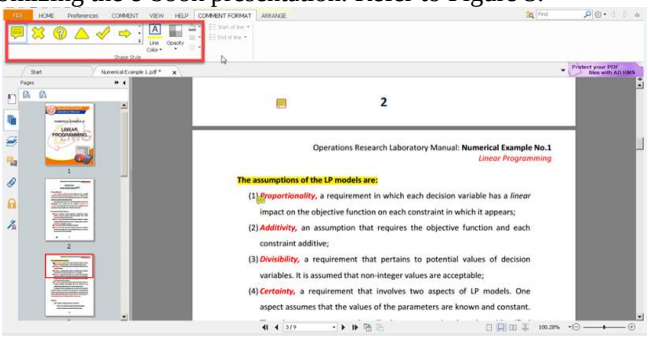

Figure 5 Screenshot of Customizable Learning Style

E. Interactive Medium

This design stipulates better comprehension and retention to the users as it helps the students to engage with the topics being discussed. Inclusion of interactive tools such as multimedia elements (audio and video) are the significant part of the specifications.. The functions under this specification are: inclusion of links to videos that illustrates the topic being taught and inclusion of video and audio to strengthen engagement of topics. Refer to Figure 6.

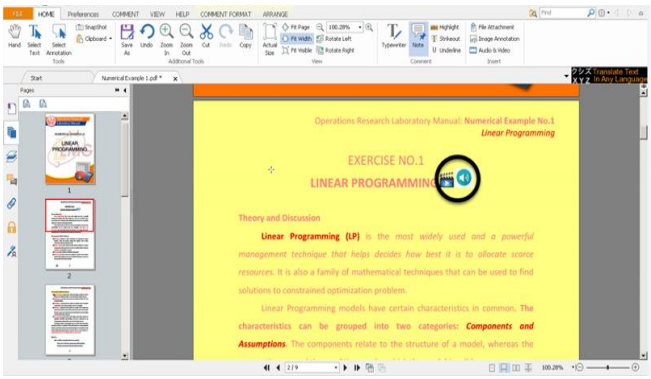

Figure 6 Screenshot of Interactive Medium

4. Evaluation of the proposed e-book design

In order to assess if the proposed e-book is effective, the researchers conducted hands-on activity using the printed materials, current e-Book and the proposed e-Book. Comprehension test was done by using set of questions being rated by the respondents using Likert Scale (refer to Table 4). After a week, the comprehension test was made retention test was conducted. The results show that the proposed e-book is more effective. Then, test for significant differences was made in order to determine which e-book format is more comprehensive and retentive according to the performance of the respondents through series of tests.

Table 4 Summary of Average Comprehension

Material	Average Comprehension Score
Printed	15.53
Current e-Book	14.25
Improved e-Book	16.64

Table 5 Summary of Average Retention

Material	Average Retention Score
Printed	3.97
Current e-Book	3.54
Improved e-Book	4.79

With this data on hand, the researchers were able to determine the significant differences among the formats used.

Table 6 Summary of Significant Differences

Average Score	Improved	Current e-Book	P-Value	SD
Comprehension	16.64	14.25	0.0000000013	There is a significant Difference
Retention	4.79	3.54	0.0000000016	There is a significant Difference

Since P-Value is less than the alpha of 0.10 therefore significant differences are realized. Hence, the improved e-book presentation is more comprehensive and retentive compared to the current format

Conclusion

The significant differences in the analysis of t-test prove that the proposed e-book presentation is most likely helpful and innovated towards the impending future of education. It will likely improve student comprehension and retention.

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Biographies

Grace Lorraine Intal is a full time faculty member in Mapua University. She is teaching systems related courses both in the School of Industrial Engineering and School of Information Technology. She obtained a BS degree in Management and Industrial Engineering from Mapua Institute of Technology, Master in Business Administration from Pamantasan ng Lungsod ng Maynila and Master in Information Systems from Asia Pacific College respectively. She is also an independent Management Consultant.

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