Reconstructing the contextual cues (space) of a textbook for building a study guide on the e-book-based SQ3R method

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Abstract: Most e-books support functions of highlighting, taking notes, and adding bookmarks for students to read the material, and these functions suffice for reading. However, when they want to review content, they are required to drag the scrollbar to revisit information, though the speed of turning pages varies, and they may frequently navigate unrelated chapters. Using contextual cues to help people revisit information is useful. According to our previous study, chapter names and the visualization of each page are critical for readers revisiting information. However, these cues are used depending on the reading habits of users. This study thus employs an SQ3R reading strategy to enable users to utilize more cues, and consequently presents a design of an e-book system with integrated contextual cues (space) and the SQ3R method. The results of the experiment shows that the proposed e-book system can help students enhance their learning and reviewing performances, and reduce the time to revisit information compared to a typical e-book.

Keywords: E-books, Electronic books, Contextual cues, Revisit information, Review content, E-books design, SQ3R method

1. Introduction

The e-book market with the most potential is the university campus, and the most prospective groups are students. Three common cases are present when students use e-books for learning on campus: (1) they take the e-book to attend courses; (2) they use it to study on their own; and (3) they review textbooks to enhance their memory of the content and prepare for exams. Most e-books provide functions of highlighting, taking notes, and adding bookmarks, and these functions can meet student needs when they attend classes or study on their own. However, because students have already read the content before the reviewing stage, they have constructed a mental representation of the location of the textual information [9,14,4]. Jason Alexander's study shows that revisiting information is a common activity that is worthy of functional support [1]. When students review the content in paper books, they can find the information or cross-reference between chapters by flipping through the pages freely, based on their mental representation.

By contrast, e-book scrollbars are a common type of widget for readers to navigate digital documents, though they can only provide a rough idea of the approximate position in a document, and thus have weak efficacy for helping users form a mental model of the material during their readings [10]. When scrolling to find information, the speed of page turning is dependent on the number of pages; students therefore commonly navigate to an

unrelated chapter and check a large number of unrelated data, Erol Ozcelik indicated that to enhance learning, unnecessary searches for irrelevant information should be minimized [13].

Using contextual cues to revisit objects is a useful skill. Dr. Marvin Chun defines contextual cueing as the manner in which the human brain gathers information from visual elements and their surroundings [6]. When memorizing a visual object, people can naturally associate the context of the object to the object. When searching for an object, they can locate the object by recalling the related contextual cues. Contextual cues can be the objects around target objects, the spatial layout of target objects, or the trajectories of the target objects. Books provide certain contextual cues for readers to recall from memory and search for information [12]. Readers can perceive the thickness of a book by using their senses of sight and touch, and can realize the approximate location of information regarding the text as a whole [7]. Another example of employing contextual cues is the use of bookmarks to separate a book into different sections, facilitating the search for information. In contrast, the digital properties of an e-book erase all traces of tangibility, which consequently erases the spatial and temporal performance of a tactile object (such as paper) [11]. Therefore, certain contextual cues that are used when reading physical books disappear. In our previous study, chapter names and the visualization of each page are significant when readers revisit information because they can perceive location with ease and find information quickly [17].

However, contextual cues supported in e-books are used depending on the reading habits of individual readers; if they are passive during reading, contextual cues are used less compared to readers who have a few contextual cues to help them review content and find information quickly in the review stage. All reading strategies are for the purpose of rendering reading more active, and the SQ3R reading strategy is common and easy[18]. When readers utilize SQ3R to read their textbooks, they are required to write down all the chapter names hierarchically on paper, and use 5W1H (why, what, when, who, where, and how) to transform chapter names to questions, and focus on finding the answer to the questions when they read the content. Writing down all the chapters and questions on a sheet of paper can provide readers with an overview of content, though a connection between questions and content is lacking. However, if readers write the questions next to the chapters in textbooks, they lose the overview of the content. When they want to find a question and related content, they must check the table of contents or flip through the pages. Therefore, this study designed an e-book system with integrated contextual cues and the SQ3R reading strategy, in addition to an overview and connection property.

2. Related work

2.1 Scrollbar with cues

Scrollbars are a common type of widget for readers to navigate digital documents, though they can only indicate a rough approximate position in a document, and have weak efficacy for helping users form a mental model of the material during their reading [10]. Numerous studies have improved the interaction and exhibition of scrollbars. Donald Byrd inputted the results of different keyword searches into the scrollbar by using colored marks [3]. Laakso et al. designed a bookmark scrollbar that has a bookmark area next to the scrollbar [10]. Footprint scrollbars use colored marks overlaid with numbers and situated in the scrollbar to provide spatial cues to previously visited areas [1]. Content-Aware scrolling changes the scrolling direction based on the order of content. Context-aware scrollbars are useful when reading multi-column documents [8].

2.2 SQ3R reading strategy

Reading ability is important for students, because it not only influences their scores of courses, but also influences their achievements in society [5]. Taraban et al. found that college students with higher scores use more reading strategy during their learning [16]. The SQ3R method is a common reading strategy and widely used for reading [18]. SQ3R was introduced by Francis Pleasant Robinson in his 1946 book Effective Study [15], and SQ3R stands for Survey, Question, Read, Recite, and Review.

In Survey stage, learners only have to skim over the title, headings, graphs, charts, introductory and summary. In Question stage, learners can ask many questions by using 5W1H(what, why, where, when, who, and how)to transfer the headings or title into question, for instance: heading name "Virtual machine", and learners can ask "What is virtual machine?". In Read stage, learners need to read one section at a time in order to seek the answers to questions asked by themselves. In Recite stage, learners should recite the content after reading, and answer the questions by using their own words. In Review stage, learners can test themselves by questions which they ask in order to know whether them understand or remember the content or not.

Reading strategy can enhance learner comprehension of content, though for learners to become familiar with the reading strategy in a short period is difficult, due to less training or time consumption [2]. Guozhen Zhang et al. designed a distance-learning support system based on the SQ3R reading strategy, and they support a large number of useful tools to assist students to execute SQ3R, including a material map, query tool, memo tool, maker tool, glossary tool, search tool, quiz tool, and progress-confirming tool [18]; however, they are not useful for guiding students to execute SQ3R, and the reading strategy has been less commonly used in applications of e-book design in recent studies.

3. System description

According to previous studies, the concept of the proposed design is as follows:
1. Reconstruct contextual cues (space) of a textbook to enable students to navigate intuitively and operate similarly to physical books.
2. Integrate the SQ3R method and contextual cues into e-books.
In physical books, individual pages are perceived by using the senses of sight and touch, though in e-books readers perceive objects by using their sense of sight. Therefore, the visualization of each page is necessary, and readers can navigate any page.

3.1 Hardware

This study used a touch-screen notebook (screen size: 1366x768) as the hardware for the simulation of the e-books, and the reader can hold it in both hands to read the content (Fig 1 and Fig 2).
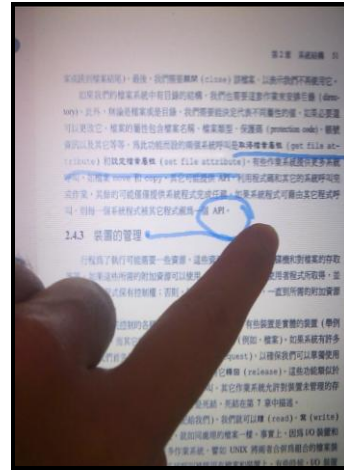
Fig. 1 Hardware

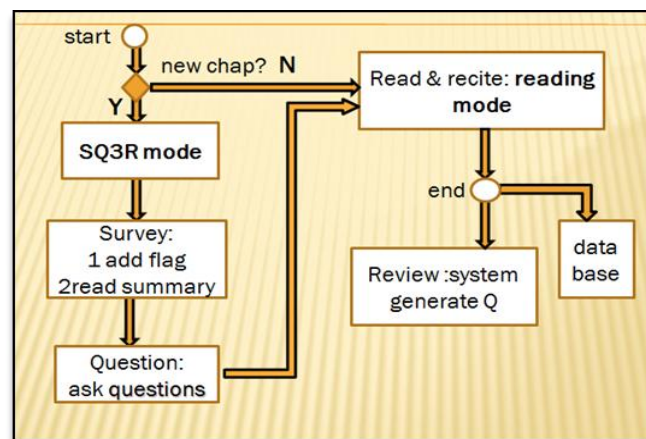Fig. 2 Highlight by using hand

3.2 Software

Fig. 3 System Model

Two modes are present in the proposed e-book system: SQ3R mode and Reading mode (Fig. 3). In the beginning, readers can choose any chapter that they wish to read by clicking the side of the book (Fig. 4, lower right corner). If the selected chapter has not been read before, the system enters SQ3R mode. According to the SQ3R method, in the Survey Stage learners only skim each subchapter or title and read a summary or introduction. Therefore, the system guide learner finds a page of each subchapter, and adding a green flag to each page. When learners survey the proposed system, they are provided with each subchapter name and the general idea of the location of each subchapter in a chapter. After adding a flag to each subchapter, the system informs the reader to find the summary page and adding a red flag to that page. In the Question Stage, the system asks the learner to search for each subchapter. Thereafter, the system automatically presents a question form to remind them to ask questions for each subchapter. Upon completing the Survey and Question stage, the system enters reading mode. In reading mode, the system supports the functions of highlighting, note taking, and bookmarking for readers to read the content. In the Read Stage and Recite Stage, they can read the content to find the answers to the questions that they asked in the question stage, enabling them to retrieve the questions easily.

Upon finishing reading, the system compiles all the questions into a document, and enables them to recall the content from memory and answer the questions without referring to the textbook.
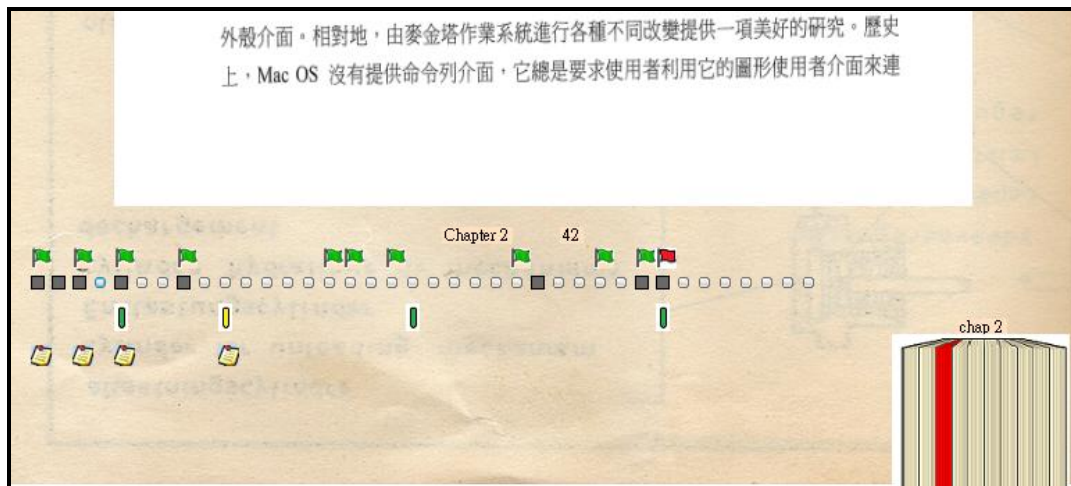
Fig. 4 System Interface

In Figure 4, the flag icons represent the beginning of each subchapter. Each dot represents a page in the chapter. The dark dots represent a page that has been read for a long time period in the chapter. The reader can add a bookmark or note icons below each dot to remind readers of contextual cues. These contextual cues can be landmarks related to a single page in space.

4. Methods

4.1 Participants

26 undergraduates from the department of computer science in NCU were recruited, and pretests were conducted to distribute students fairly into the experimental group and control group (13 participants in both groups). Participants of the experimental group were requested to use the proposed e-book system to study material for their operating system course that they were enrolled in that semester. The approach to operating each step of SQ3R in the proposed e-books was shown. Participants of the control group were asked to use Acrobat Reader to read the same material (because functions of Acrobat Reader are similar to functions of most e-book reading software) and they were not permitted to use full-text search because we wanted to observe their navigation behavior.

4.2 Procedure

Task 1: Subjects are requested to use their assigned e-books to read material in 75 m before taking a test. A week after finishing Task 1, they are asked to complete Task 2 and Task 3.
Task 2: Several paragraphs were extracted from the material before subjects were asked to find the page of the assigned paragraph and write down the page number.
Task 3: Subjects were asked to use their assigned e-books to review the content in 10 m before taking a test.
Subjects were observed via webcam to record the duration and reading behavior, and for finding the assigned paragraph and recording post-task interviews and questionnaire (using the five-point Likert scale).

5. Results

For Task 1, the average score of the experimental group was 75.9, and this was higher than the average score of the control group (69.3). For Task 2, the average time for finding information in the experimental group was 8 minutes and 45 seconds, which was much faster than the average time of the control group (14 minutes and 20 seconds). For Task 3, the average reviewing score of the experimental group was 74.5, and this was higher than the average reviewing score in the control group (62.7).

5.1 The SQ3R method

Questionnaire:

	Point
It is easy for you to conduct the SQ3R method when using this e-book system.	4.15
In the Survey Stage, adding flags can help you have general ideas of the location of each subchapter in a chapter.	4.69
In the Question Stage, presenting a question form automatically can help you ask questions.	4.23
In the Read Stage, perceiving the functions of highlighting, taking notes and adding bookmarks are sufficient for reading.	4.23
In the Recite Stage, it is easy for you to retrieve the questions.	4.31
In the Review Stage, collecting questions into a document can help you review content.	4.38
You would like to apply the SQ3R method to guide your learning.	4.23
You could form the habit of conducting the SQ3R method.	4.38

Subjects stated that they did not know the SQ3R method beforehand. They could still conduct SQ3R easily by following the system's guide. Furthermore, most subjects liked being guided to conduct the SQ3R method during their own learning because they thought their learning would be efficient if they spent a little more time. In addition, they suggested that in the review stage, the system's automatic collection of all the questions was good, though if the system can provide author or peer questions, this would be an improvement because they can have the opportunity to learn material with different perspectives.

5.2 About contextual cues

Questionnaire:

	Point
Contextual cues in this system can help you revisit information quickly.	4.62
Contextual cues in this system can help you review content.	4.54
Contextual cues in this system can help you grasp the structure of the content.	4
You would like to use this e-book system for reviewing content.	4.46
You would like to take this e-book system to attend classes.	4.15
You would like to use this e-book system for learning.	4.23

Subjects thought that contextual cues in the proposed e-book could help them grasp the structure of the content and facilitate revisiting information. They could know the location of each subchapter in a chapter and the number of pages of each subchapter via visualization of each page and flag. Therefore, they can plan the time reading any given subchapter. Due

to the notes, bookmarks, and dark dots of the contextual cues, they thought that they could perceive which content is significant or difficult, and which content they are unfamiliar with. Subjects thought that the contextual cues of support are useful for revisiting notes or bookmarks, and have chapter overviews, which was superior compared to the support of physical books.

6. Conclusion

The proposed e-book system with integrated contextual cues and the SQ3R method can help learners enhance their learning and reviewing performance by enabling effective and efficient information revisiting compared to general e-books. Contextual cues are useful for learners to grasp content structure, and to review and revisit information. Furthermore, other contextual cues could be investigated in depth to support learning, for example, images or content charts.

Applying a study guide to e-books for learning is practicable, and students want to enhance learning performance, despite having to invest a little more time. The SQ3R method in the proposed e-book provides us with the opportunity to support collaborative learning, and we could add more support functions, for example, peer's notes or questions, PowerPoint files of lectures, and links to teacher notes into the proposed e-book system.

Acknowledgements

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