ShaReader: Sharing Annotations within Digital Reading Environment

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ABSTRACT
Existing research has confirmed that social annotations can contribute to a better understanding of book content. We designed ShaReader to support users sharing annotations within reading environment based on the analysis of existing product (KReader) and a formative study. A factorial within-subject study was conducted to evaluate the usability and usefulness of ShaReader with comparison of KReader. Results show that the users can perform tasks faster on ShaReader than KReader and find it less distractive to reading and easier to use.

Author Keywords
Social annotations, eReaders, collaborative reading, design.

ACM Classification Keywords
Human-centered computing: Interactive systems and tools.

INTRODUCTION

Exchanging thoughts and sharing annotations about a book is an important experience for many readers. Existing research has confirmed that social annotations can contribute to a better understanding of book content [3]. Typically, participating in reading groups and reading books with existing annotations are two general ways for people to share their annotations and comments [6, 9]. With the increasing popularity of digital reading, social annotations should be better supported by some collaboration tools. However, the need for social annotations has not been sufficiently satisfied in the digital reading environment: 1) the existing book review sharing platforms, such as Goodreads, only support comment sharing at the book level rather than a highly granular level at which particular book sections are also taken into account; and 2) in most cases, readers need to leave the immersive reading environment in order to share their comments.

A possible solution to supporting effective social annotating is to design an e-reader application that enables users to share annotations seamlessly while they are reading, without distracting them from the immersive reading environment. We examined a commercial e-reader, whose interface is referred to as KReader in following sections, which allows users to share their annotations with their facebook friends within the reading environment. We discovered that its interface and functions are not well designed to encourage participation in social annotations. Therefore, we developed the ShaReader, an e-reader application prototype for tablets based on a formative study. We then evaluated and compared it with the KReader interface through controlled experiments. The effects of social annotations on readers in digital reading environment as well as users' needs for social annotations are also investigated in our study.

We begin with the review of existing research on social annotations and a quick examination of current industrial products. This is followed by the formative study, in which we describe our findings in the preliminary study that informs our design of ShaReader. We then explain our design rationale for ShaReader. Finally, we present our evaluation process and the results of the evaluation as well as future directions.

RELATED WORK

Collaborative Reading

There has been a lot research on collaborative reading in paper-based reading settings [6, 9]. For example, by creating a chance for students to share their views of the books within groups, collaborative reading is found to be helpful for students to understand the book content better [6]. However, most of the current research on collaborative reading only focuses on the traditional paper-based reading environment in spite of a growing demand for digital content. Existing literature suggests that digital reading is

an experience that is very different from traditional paper-based reading experience in many ways, such as reading depth and sustained attention [2, 5]. Although existing literature on collaborative reading does indicate a certain value in its own regard, how does collaborative reading affect readers' behaviors and performance in the context of the digital reading is still relatively new in literature. In one study, the authors have started the investigation into digital collaborative reading [7], but they only focused on a co-located-synchronous channel. What we are interested in is to create a universal application that supports both synchronous and asynchronous channels and can be used by distributed users rather than concentrate only on one collaborative channel.

Social Annotations

One important aspect of digital reading collaboration is the sharing of annotations. The sharing of annotations is an important process for people to get better understanding of the book [3]. The practice of social annotations has existed since the medieval period, which was originally a less technical annotation sharing process: scholars used the margins and spaces between lines of manuscripts to engage in dialogue with others. The same physical copy of a manuscript was passed around a community, and selected annotations (often including comments of readers on the remarks made by other readers) were customarily retained when scribes made new copies [10, 11]. Although human technology has greatly improved today, the need for social annotations has not yet been fully satisfied in the digital reading environment. Most of the existing digital reading applications only support comment sharing at the book level rather than a highly granular level at which particular book sections are also taken into account.

Several researchers have put effort in developing tools to support social annotation. Chen & Chen [1] develop a reading annotation and interactive discussion scaffold (CRAS-RAIDS) for improving reading performance in collaborative digital reading environments. They confirm a positive interest in learning and a high satisfaction rate among CRAS-RAIDS users. Similarly, Su et. al [8] and Yang et. al [12] conduct a series of research on the appliance of social annotation in computer supported cooperative learning (CSCL). They develop a tool to support knowledge sharing through annotation. Their experimental result demonstrates that their tool can facilitate knowledge sharing and improve participating students' reading comprehension. Moreover, Johson et al [3] develop the Social Annotation Model-Learning System (SAM-LS), which combines various instructional strategies, team-based learning, and a social annotation computer-supported collaborative learning tool, HyLighter, to increase students' engagement with selected essays and with classmates. Their study finds that the SAM-LS stimulates students to actively monitor their thoughts and compare their thoughts to both peers and the instructor (or domain experts). Moreover, Kopak and Chiang [4] design a prototype called the Open Journal Systems Reading Tools, which is an interactive reading environment for online scholarly journals. The tool aims to enhance the online reading experience and improve the level of critical engagement with the content of the journal articles published within the system by allowing users to create annotation and link components within or across resources. Readers can choose to publish their links and annotations with the reading tool, which makes this intellectual work visible to other readers.

Despite a number of studies on the improvement of learning performance through interactive reading tools, their focuses are mainly on the implementation of interaction functions rather than the improvement of reading experience. In all, the potential improvement of reading experience and other outcomes through the availability of social annotation have not been given enough attention in literature.

Current Industrial Products

Two popular digital reading devices Amazon Kindle and Kobo have been examined for their ability to support the sharing of user-generated annotations and comments. Below we will briefly discuss the existing functions on these two devices.

Social Function

Both Kindle and Kobo allow readers to share their notes/annotations to popular social media, e.g. Facebook and Twitter.

In Kobo, the generated sharing link simply takes viewers to the introduction page of that specific book; the comments will be shown in the Facebook timeline of the person who has shared it. By contrast, the link generated by Kindle will lead others to an automatically created webpage which contains an introduction of the book, as well as the shared notes.

We argue that the sharing functions mentioned above fail to facilitate the communication of ideas among readers mainly for two reasons: 1) Other people cannot clearly see which part of the book is related to the shared notes. Since the notes could be very specific, the lack of context makes it hard for other readers to recall their thoughts about the same book content. As a result, it is less likely for those people to initiate a discussion on that annotation. 2) Sharing annotations to external social media requires the readers to leave the immersive reading environment, which may distract the users from the reading task.

Public Comments

The public comments in Kobo may be the most relevant feature compared to what we proposed here. It allows readers to see the comments made by other readers when they are reading the same book. It uses bubble icons to indicate annotations made to each paragraph. As a result, if other users have marked annotations to a specific sentence or a word, these annotations will be counted as annotations

of the paragraph to which that specific sentence or word belongs. Moreover, a user needs to click on the annotations to see the text content that the annotations are made to. This is contradictory to the way readers used to view annotations: first see the highlighted text, and then view the annotations. It may also distract users from the reading task, as it doesn't afford smooth switch between reading and annotation viewing. Therefore, seamless switch between different tasks on e-readers yet has a lot of room for improvement.

FORMATIVE STUDY

After analyzing the problems of the current eReaders that support socia annotations, we conducted a formative study to learn users' annotating behaviors and thoughts on social annotations. We conducted semi-structured interviews with 6 individuals at the participants' convenience, with each interview lasts between 15 minutes to 35 minutes. The 6 participants (2 female) are aged between 21 and 30, and all of them have some experience with e-readers. In the formative study, we are particularly interested in their motivations for sharing annotations, the effects of social annotations on their reading and annotating behavior, and their function requirements of social annotations.

Motivations for using social annotations

Four out of the six participants showed their desire to use social annotations in digital reading environment when reading materials of different genres. Their motivations can be categorized into three major themes, which are 1) purely enjoying the sharing experience; 2) gaining deeper understanding of the book content; and 3) interacting with other readers who share the same interest.

Purely enjoying the sharing experience

Two participants mentioned that the strongest motivation for them to use social annotations is the pure enjoyment of sharing interesting thoughts with other people. They often feel an impulse to share their thoughts on the details of the book. For example, one participant talked about how he wished to share his experience of conducting an experiment on whether bananas float after reading the book Life of Pi in which there is a scene describing a chimpanzee sailing on a raft of bananas.

Gaining deeper understanding of book content.

Two participants thought that using social annotations could help them get better understanding of the content. They mentioned that they could learn different perspectives of the same issue by viewing the other people's annotations, and they can also ask questions to the particular part of the book instantly when they read it and get answers from other readers. For example, one of the participants is a PhD student in history. She does a lot of reading on history everyday and often has questions when she reads. However, there is no effective way for her to note down which part of the book her questions are related to. It is usually the case that she forgets about what her questions are or which part of the book that triggers her question. She thinks by marking down and sharing her questions while reading, she can partly solve her problems.

Interacting with other readers who share the same interest

Several participants expressed their desire to find and interact with people who share same interests in books with them, and their difficulty in looking for such people currently. Even though there are some platforms for readers to share book reviews, the common situation is that when readers share their reviews after read a book, their enthusiasm and desire of interacting with other readers will sharply diminish. Several participants mentioned that they would prefer to share their thoughts and interact with other readers while reading the book, with their clear memory of and easy reference to the book content.

Effects of social annotations

In addition to the motivations of using social annotations, we are also interested in the effects of sharing annotations on users' reading and annotating behaviors. The possible effects mentioned by the users are described as 1) putting extra effort to make annotations understandable to others, 2) slowing reading process, and 3) motivating more reading.

Putting extra effort to make annotations understandable to others

Some participants thought sharing annotations would require them to put extra effort to make what they share understandable to other people. When annotations are private, they often use self-recognizable abbreviations to make fast annotations. However, these annotations may not make any sense to other readers. As mentioned by a participant, one reason for her to share annotations is to get replies from other people. It is not likely for others to reply the annotations if they couldn't even understand the annotations. Making annotations understandable for others requires extra effort than simply keeping the annotations for self, which includes both more mental and more physical effort in crafting the annotations.

Slowing Reading Process

Several participants also pointed out that viewing the other people's annotations and sharing their own annotations may also slow their reading process. It is a concern for many participants that the availability of too many annotations may be distractive and overwhelming. What's more, as explained by one participant, when being aware of the existence of annotations shared by others, he may have difficulty deciding how many annotations should he read until he goes back to the book content.

Motivating more reading

Even though social annotations may slow the reading process of the readers, some participants also believe it can motivate them to read more. Some participants thought the frequent interactions between readers during the reading

process can motivate them to read more books. What's more, they mentioned that they would be more willing to accept the recommendations of the readers who share common interest of the same part of a book with them, than that of the readers who like the same book with them in general.

Function Requirements for Social Annotations

In addition to the motivations and possible effects of social annotations, we also investigated into users' needs when they use social annotations. Participants were asked to describe the important functions that should be included in the e-reader that supports social annotations, and explained their reasons for such inclusion.

A "clean" Reading Environment

Many participants mentioned that they don't want to be distracted by the social annotation functions when they want to focus on the book content itself. And it is of vital importance for them to have a "clean" reading interface that encourages them to read immersively.

Indication of the Book Content that a Particular Comment Refers to

It is important for many participants to know which part of the book that the annotations are made to. Several users mentioned that when they have questions of a particular part of the book, such as a word or a sentence, they would want to see the annotations on those particular parts. Therefore, being able to link the book content with the annotations is a very important feature

Easy Control over the Shareability of the Annotations

Almost all the participants mentioned that they don't want to share all of their annotations and they want to have a choice over what to share. Several participants mentioned their needs of having easy control over the shareability of their annotations when using the e-reader application. Because sharing annotations with others is still a novel experience for most users, some participants were worried that they might share their private annotations to the public by mistake. Thus clear indications of the shareability of the annotations should be included in the final product. And it should be easy for users to choose whether to share a certain annotation or not.

Sharing and Replying Anonymously

Sharing and replying anonymously are important features that have been identified by many participants. They have various reasons for hoping to be anonymous, the most salient reasons are that they don't want to be attacked by other readers when expressing sensitive ideas, or they don't want the other people know they read this book. Because the desire for sharing or replying annotations anonymously varies across each particular piece of annotation or reply, users should be supported to change the anonymous setting conveniently every time they publish thoughts.

Sharing within Groups

The participants' desire of sharing within certain groups is very strong. Some participants mentioned that they are only willing to share their annotations when they are aware of whom they are sharing with. And sometimes they are only willing to view the annotations made by the people they know. To meet the users' needs, the final product should support users creating groups and easily select the audience they want to share with.

Knowing the Role of the other Annotators

It has also been suggested by some participants that knowing the role (profession) of the annotator in the product would be helpful for them to decide whose annotations to view. For example, a participant would be very interested in the annotations made by professors or field experts. Such function is especially useful when there are a large amount of public annotations.

Getting Notifications

As mentioned above, one of the motivations of readers to share their annotations is to get replies and interact with other readers who share the same interest. Therefore, several participants thought that getting notified when the other people reply their annotations is an important function.

The findings we found in the formative study shed lights on our design of ShaReader.

DESIGN RATIONALE

We designed ShaReader based on our understanding of the potential users gained through the formative study. ShaReader is a vertical prototype which supports viewing annotations and replying annotations within the reading context. The reason for not implementing the function of making annotations is that there is no significant change in the process of making annotations in our design. Key considerations on the design of ShaReader are illustrated as follows.

Creating Immersive Reading Environment

As mentioned in the formative study, a clean interface that encourages immersive reading is of great importance. Thus in ShaReader, we put all the indicators and buttons in the margin area, and use modest colors to be less distractive. Moreover, all the functions, including viewing and replying annotations, can be seamlessly completed within ShaReader, without jumping to external applications. Furthermore, users could also easily go back to the reading environment wherever they are in the application.

Indicating Annotations

One of the biggest design challenge for us is to indicate the existence of the annotations without distracting the users from reading. What's more, the amount of annotations and the related book content of the annotations should also be indicated clearly, because such information could be useful

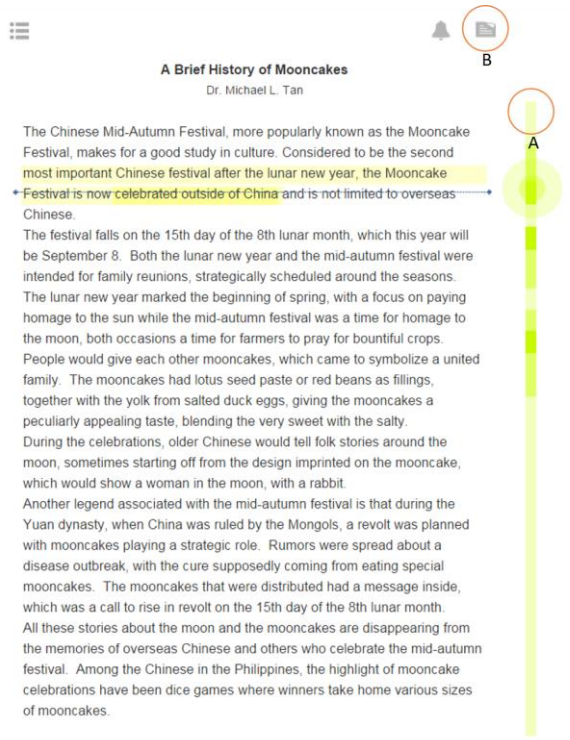

Figure 1 Reading View of ShaReader

A: Annotation Indication Bar B: Comment Box

to suggest the key parts of the page. After eliminating several sketches, we designed an Annotation Indicator Bar to indicate annotations on the reading screen. As shown in figure 1, the Annotation Indicator Bar is on the right edge of the screen with modest green color. The depth of the color suggests the amount of annotations made to the line of content on the bar's left; the deeper the color is, the more annotations there are on that line.

Viewing Annotations

ShaReader supports mainly two ways of viewing annotations within reading environment. The first way is to view annotations related to a specific line in the page by using the Annotation Indicator Bar. This way of viewing annotations is important because many participants in our formative study mentioned that it is important for them to view the annotations related to particular words or sentences. We design a new interface to support viewing annotations made to specific content in ShaReader. When the users move their finger along the Annotation Indicator Bar vertically, the three lines with annotations on the fingers' left will be highlighted accordingly. There is also a horizontal line that suggests which line of the book content the user is selecting. When the users release the finger, a window will pop up on the reading page to show the annotations related to this particular line. The window will be either below the selected line when the line is on the upper area, or above the selected line when the selected line is at the bottom area of the screen. In both situations, the readers could view the annotations and the original line of text at the same time. When clicking on a particular piece of annotation, the annotated text will be highlighted deeper.

The other way of viewing annotations is to see all the annotations that has been made on a page within one window by clicking on the "comment box" icon on the top right corner of the screen. Even though none of our participants mentioned similar needs, yet we decided to include this feature to supplement with the Annotation Indicator Bar as we believe this function can be very useful when users want to have a general idea of what the other people are talking about this page of content, or looking for particular person's annotations on this page.

In both ways of viewing annotations, the users could archive or favorite a specific annotation by clicking on the star icon for later reference and 'like' the annotations by clicking on the thumb icon. What's more, the annotations windows of the two ways are consistent with each other.

Replying to Annotations

Replying to annotations is the major way for users to interact with other readers of the same book. Thus a successful design should support users replying annotations easily and in the way they want. Since the annotations are closely related to the original book content, it would be easier for the readers to reply the others' annotations when they can have easy refer to the original text of the book. Therefore we included a scrollable preview area on the top of the reply window to show the annotated text and its surrounding text (see figure 2). The users don't need to go back and forth between the reading screen and the reply window anymore if they need to refer to the original text. In addition, there is an obvious toggle button that allows users to reply anonymously.

Notifications

Being notified when users get replies can facilitate the active interactions among users. Thus we include a notification icon on the top of the reading screen. The risk of including the notification icon in the reading screen is the potential disturbance to the users when they intend to read immersively. Thus customization of the notification, and the automatic mute of notification when there are too many should be included in ShaReader to support the notification function.

Sharing annotations

Even though we didn't realize the function of sharing annotations in the final prototype, we elaborate our idea of sharing annotations in our low fidelity prototype. Based on our formative study, ShaReader allows users to share annotations anonymously and share within certain groups.

USER EVALUATION

Study Design

To evaluate the usability and usefulness of ShaReader, we conducted a comparison study for ShaReader and another

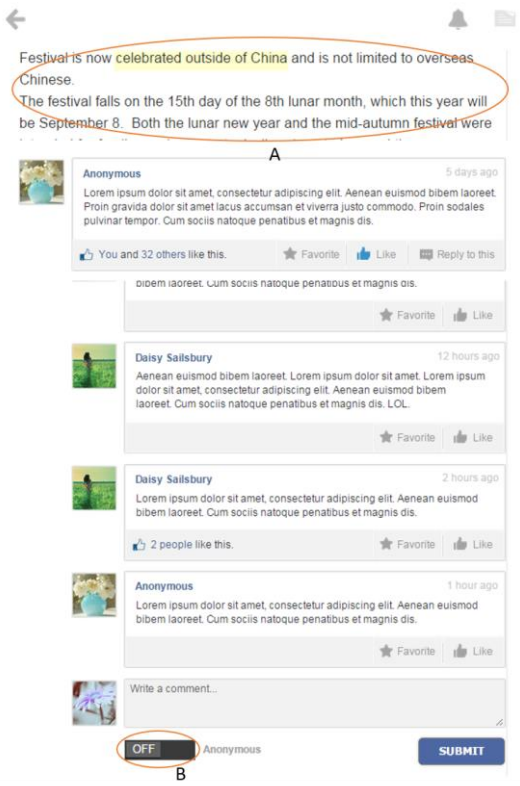

Figure 2 Reply View of ShaReader

A: Scrollable Preview Area B: Anonymous Reply Toggle

prototype that simulates a current commercial e-reader application that also supports social annotations, which will be referred to as Kreader in the following evaluations. Participants were asked to perform tasks that are same in nature on both ShaReader and Kreader. User performance and satisfaction on both prototypes are evaluated and compared. The order of using the two prototypes was also randomized among the participants.

As the ability to complete tasks may differ greatly between individuals, we decided to adopt a factorial within-subject design for our comparison study. There are XX reasons for us to adopt a factorial within-subject design; first of all, participants' performance on the products largely depends on their experience with digital products, especially touch screen tablets. A factorial within-subject design can help to mitigate the effect of the digital product experience on their performance, and identify the effect of the factors that we are interested in; second, eReaders that supports social annotations are relatively new to most people. Participants may tend to accept the way of design when it supports new functions that they are not familiar with. Merely using one prototype may be hard for participants to suggest alternative ways to realize new functions. Instead, using two different prototypes may encourage them to think broader and deeper about the product design; third, there is minor carry-on effect in our study, which supports the within-subject study.

We prepared two sets of articles and similar tasks for the participants to perform on the two prototypes. They only need to do tasks related to one article on each prototype. To mitigate the effect of the articles on the users' performance, we chose two articles about the culture of Chinese traditional food, with one about Jiaozi (Chinese dumplings) and the other one about moon cakes. The articles are of the same difficulty level, and are both of two pages. Participants were randomly assigned of which one of the articles to read on each prototype. And they were not told which prototype was designed by us and which one was the controlled prototype. There was also a sample article to be used when introducing the prototypes.

In addition to the independent factor of the prototype, we also use number of annotations as an independent factor. On the first page of the two articles, there are 10 annotations whereas on the second page there are only 3 annotations. The participants were asked to perform tasks that are same in nature on the two pages for each article in page order.

There are four tasks for each participant to perform on one page of each article, and there are 16 tasks to perform on the two prototypes in total. The four tasks are:

1) View the annotation made by a particular person.
2) View the annotation made on a specific sentence.
3) View the annotation made on a specific word.
4) Reply a question in an annotation with the correct answer found in the surrounding text of the annotated text.

To mitigate the order of the tasks and considerations on the task' characteristics, we randomized the order of task 1 and task 2.

In sum, we designed a within-subject study with independent variables of prototype (2), number of annotations (2), and tasks (4). We measure the participants performance and satisfaction in different situations.

Introduction of KReader

KReader is the prototype we designed with Axure to simulate a commercial eReader that supports social annotations. The screenshot of KReader is shown in figure 3. KReader is different from ShaReader in indicating annotations, viewing annotations and replying annotations.

Indicating annotations. KReader displays a bubble on the left of the paragraph if there are annotations made to that paragraph. There is also a number under the bubble indicates how many annotations are made to that paragraph.

Viewing annotations. To view annotations, the users need to click on the bubble. And the users can only know the related text of the annotation after click on a specific annotation into its detail screen.

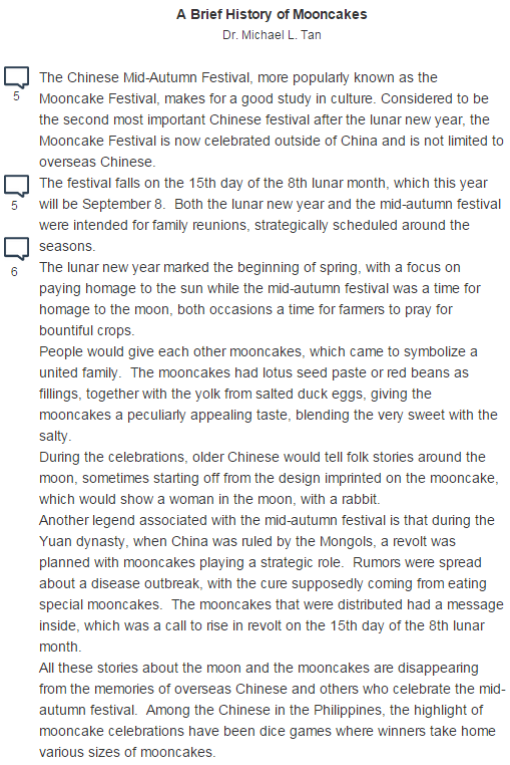

Figure 3 Main View of KReader

Replying. The users can reply to the annotations when they click on a specific annotation and get into the detailed page. Only the annotated text is shown on the screen, without the surrounding text. If the users need to refer to the surrounding text when replying, they need to go back to the reading screen.

Participants

Ten participants participated in the study (4 female). All of the participants are students in UBC with highest education level achieved varies from Bachelor to Ph.D. with different majors. Their ages are between 22 to 29. Even though the participants were not randomly selected, they were chosen to represent the potential users of eReaders that supports social annotations. All the participants have experience of digital reading, and many of them have experience of sharing comments of books online.

Apparatus

The study was conducted in an individual laboratory room. All the tasks were performed on the same iPad Mini, which had installed Shareader and Kreader. Both Shareader and Kreader were developed with Axure, and were turned into two individual iPad apps on the iPad Mini used for the study. The response speed of both of the prototypes depended on the internet speed. An 11 inch MacBook Air was used to collect users' answers to the questionnaires.

Procedure

The study was conducted in 10 participants individually. The participants were introduced with the goals of the study and the study procedures, and we asked their consent for being videotaped in the study. They were told to interact with two prototypes of eReader that supports social annotations. After they interacting with each prototype, they was asked to fill a questionnaire solely based on their experience with that particular prototype. After all the tasks with both the two prototypes, there was a questionnaire about their overall feelings about social annotations and a short interview. For each prototype, we showed it to the participants with a sample article, and asked them to play with the prototype and discover as many functions and as fast as possible. They were also told to ask us questions if they had. Their interactions with the prototypes were observed by two researchers. For the ShaReader, if they hadn't found the Annotation Indicator Bar within three minutes, one researcher would give him/her hints about the bar. After playing with the prototype, the participant would be introduced of the functions of the prototype and be taught how to use those functions. Then the participants were given a piece of paper with the descriptions of tasks. They were asked to finish the tasks independently as fast and accurate as possible. They were also asked to read the task description aloud before performing each task and inform us when they thought they finished each task. Their time of finishing each task were recorded by the observers.

Dependent Measures

We evaluate both the participants' performance and satisfaction with the prototypes. For the performance, we use time to perform each task to measure. In order to avoid users being frustrated, we asked the participants to move on to the next task if a task hasn't been completed within 4 minutes, and the completion time for this tasks will be recorded as 240s. The longest successful completion time of the tasks is 123s.

For the satisfaction, we measured 1) usefulness, 2) product's ease of use, 3) task completion easiness, 4) learnability, and 5) non-distractiveness. A Likert scale was used to collect data for each product.

Results

Performance

We conducted ANOVA to compare users' task performance on ShaReader and KReader by comparing the time used to finish each task. Task types and annotation number are controlled in the comparison. The result showed that the performance on ShaReader is overall better than KReader ($F=27.755$, $p<0.05$; ShaReader mean = 14.71, St.d = 14.14; KReader mean = 37.24, St.d = 49.214). When controlled annotation number, ShaReader is faster than KReader in every task (as shown in figure 4). When there are few comments, performance on both prototypes of task 1,2 and 3 are close, but it takes a very long time to find annotations made to a specific sentence on KReader (as shown in figure 5). When controlled task type, ShaReader is also faster than KReader in both many annotations condition and few annotations condition. When there are a

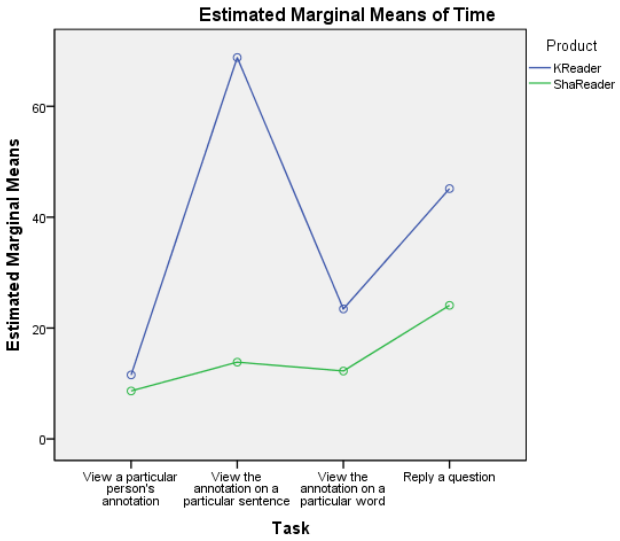

Figure 4 Performances on Each Task

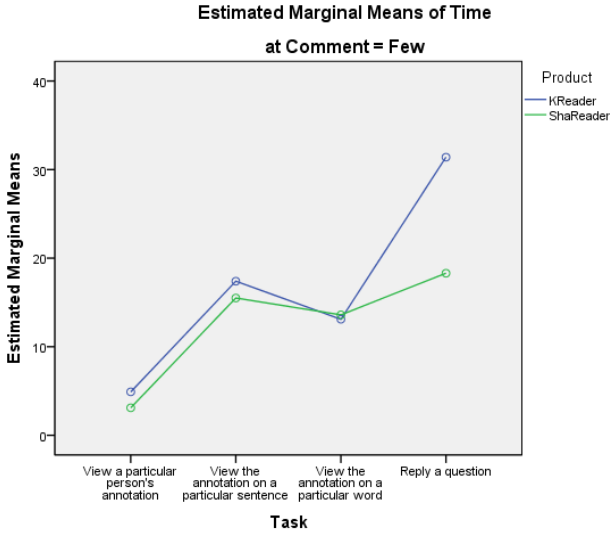

Figure 5 Performance on Each Task when having few comments

lot of annotations, it takes much longer to perform tasks on KReader than on ShaReader (as Shown in Figure 6).

Satisfaction

For the satisfaction analysis, a paired two sample t test conducted on questionnaires revealed that ShaReader is significantly better than the KReader, in usefulness ($P<0.01$, M1= 4.08 M2= 3.33) and task completion easiness ($p<0.01$, M1= 4.35 M2= 3.3). And ShaReader is marginally better than KReader in ease to use ($p< 0.1$, M1=4.2,M2=3.8). The difference in learnability ($p=0.26$) and non-distractive ($p=0.3$) is not significant. The result of learnability corresponds with our findings from the interview. Several participants mentioned that the Annotation Indicator Bar in ShaReader is not quite intuitive, but it is very easy to use when they are taught how to use it. However, the questionnaire analysis result of the non-distractiveness is contradictory to the findings in the

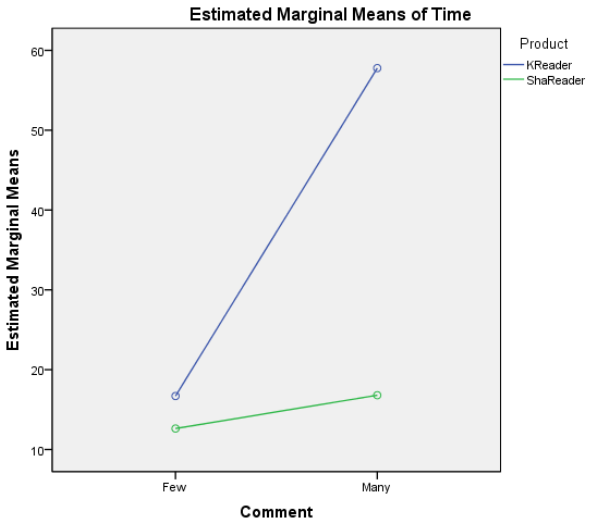

Figure 6 Performances when having Few and Many comments

interview. Several participants mentioned that the bubble icon that indicates the annotations distract them from immersive reading, because they feel that they are suggesting that they should click on them.

Interview

We conducted a short interview with each participant at the end of study. The interview was supplements to the questionnaires. The participants were asked to talk about what they liked and disliked about ShaReader and KReader. Even though all the participants clearly expressed their preference of ShaReader, both the strengths and weaknesses of ShaReader were identified by the participants.

Strengths of ShaReader

Less distractive. It is reported by 4 users that ShaReader is less distractive than KReader. The main reason for it is that the bubble icon used in KReader is hard to be ignored when reading, whereas the Annotation Indicator Bar in ShaReader is on the margin of screen and can be easily ignored.

"(ShaReader) is less distracting. When I am trying to read the whole document, I keep seeing those bubbles (in KReader). And It was like 'Oh someone is talking!', because they are talking bubbles. Whereas here (in ShaReader) it is off to the side, so I am easier to ignore it if I want to ignore it."

Smooth Switch between tasks. ShaReader also supports the smooth between tasks better than KReader with the support of the Annotations Indicator Bar. Instead of going to a new window to see the annotations in KReader, users can view the annotations within the reading screen in ShaReader.

"When I am reading something, I want to see the comments quickly and get back to what I'm reading like this. It does this very well. If I want to comment, I will go to the next

page and interact with it that way. But otherwise I can just dismiss the comments and get back to the reading which I really like."

Weakness of ShaReader

Annotation Indicator Bar is not very intuitive. In the study, only 4 out of the 10 participants discovered the Annotation Indicator Bar by themselves. Even among the four participants, the Annotation Indicator Bar was the last thing the found on ShaReader.

"It is not too bad but it is like the last thing I found. So I guess it is not too intuitive until I see the color, which is till the very end."

And none of the four participants who found the Annotation Indicator Bar used the drag gesture as supposed before we taught them. Instead, they simply clicked on the area that's in deeper color. What's more, four out of the ten participants still liked to click on the darker color area on the Annotation Indicator Bar when they performed the actual tasks after we taught them the correct dragging gesture.

Possible Applications

In addition to identifying the design strengths and weaknesses of ShaReader, the participants were also asked to talk about the possible applications of the eReader that supports social annotations. Eight participants expressed their desire to use such products if it is actually available.

Academic Reading. Five participants mentioned that products like ShaReader would be very helpful for them in academic reading. They thought it could encourage more discussions among the group members or classmates when they were reading the same paper, and could prompt them to think deeper.

"It is like a virtual seminar. Instead of discussing it in class after we all read it (the paper) by ourselves, we can interact with each other while reading it and post questions in real time. It will prompt everyone in the group to think about it and they are able to see what exact the part of the text you are referring to."

Read for Fun. Two participants thought they would like to use such products like ShaReader when they are reading for fun.

"Possibly reading for fun. Mostly when I read novels, I found something interesting and I want to share with people"

Read to Learn. There was also one participant specifically mentioned that such products would be very useful when reading materials for learning new languages.

"I think if it is a book for learning, like learning a language, it will be super helpful because I don't need to go to dictionary every time... And there are a lot of things beside the definition that people could talk about, which is very helpful to learning the language"

DISCUSSION

Based on the findings from the formative study, we designed the ShaReader with a user-centred approach. During the evaluation process, we employed multiple methods including observation, questionnaire and in-depth interviews to collect data and triangulate our findings. By comparing ShaReader with our counterpart prototype KReader in a task-based study, we found that ShaReader is a better design to support social annotating with minimal distraction to the users. ShaReader is also well designed to support smooth switch between reading and annotation viewing. Although the Annotation Indicator Bar was recognized as easy to use, it was not intuitive enough for uses to notice. The color and width of the bar as well as the gestures to control it need to be modified to make it more visible to users and more natural to use.

There are several limitations of our user evaluation; first, the prototypes we designed are not very sophisticated, and the response time depended on the internet speed, which may affect the participants' performance on the prototypes; second, the participants we recruited were all students in an esteemed university, who may have relatively higher education level and more digital product experience than the general public. Such sample may result in bias in our findings; third, evaluation conducted in the lab setting with imposed tasks removed the users from natural settings. Thus our findings of participants' behavior on ShaReader and the product's usefulness may differentiate from the actual situation.

CONCLUSION AND FUTURE WORK

While most of previous work about social annotations only focus on the paper-based reading environment, we developed ShaReader, a high-fidelity prototype that facilitates annotation sharing in the digital reading environment, on the basis of our understanding of the potential users and tested it for its usefulness and usability. Results showed that ShaReader is able to facilitate social annotating with minimal distraction to the users. It also allows users to smoothly switch between the reading and the annotation viewing tasks.

Our future work includes improvements of our design on the basis of findings from the evaluation process as well as the implementation of more features that allow the application to be used in natural settings. For the usability side, we are interested in more potential designs that can improve the intuitiveness of the indication of shared annotations with minimum cost in immersion. A field study is also expected to further understand users' behaviors and needs when they are using such a product in natural settings. Finally, future studies should also take a closer look at the changes of users' reading and annotating behaviors when they realize the fact that other users may be able to see what they have annotated on the book.

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