An Annotation Support System for Middle School Teachers and Students

Kendra Knudtzon, Adam Perer
Department of Computer Science
Human-Computer Interaction Lab
University of Maryland
College Park, MD 20742
{kendra,adamp}@cs.umd.edu

ABSTRACT
In this paper we describe a system for middle school students and teachers that combines the affordances of paper with the affordances of digital books. Our teacher composer tool provides teachers the capability to annotate books with reading comprehension hints for their students. The student annotation tool provides students with highlighters, stamps and sticky notes to help them better understand their reading assignments. The tools we have designed successfully make use of paper affordances in the digital domain, giving teacher and students a powerful alternative to paper-based worksheets and books.

Author Keywords
Educational technology, annotation, children, paper and computers, digital books.

ACM Classification Keywords
H5.2. Information interfaces and presentation: User Interfaces.

INTRODUCTION
Paper offers many advantages over electronic documents, especially for interweaving reading and writing. Paper has four primary affordances for a user’s interactions between reading and writing: tangibility, spatial flexibility, tailorability, and manipulability [7]. Digital documents have their own benefits, such as being easy to copy, store, retrieve, search and distribute. By combining the affordances of paper with the advantages of electronic media, users can profit by receiving the best of both worlds.

This paper describes our preliminary system that addresses some of these affordances of paper in a digital setting. Our system, an annotation support system for middle school teachers and students, is the result of our research into people, paper and computers, and our design work with an intergenerational design team [3, 6].

There were three main goals when developing this annotation support system. The first goal was to use knowledge of people, paper and computer interaction to encapsulate the affordances of both paper and digital media in our system design. The second goal was to include children and teachers as design partners while creating an annotation system to teach children about annotating while reading. The third and final goal was to build an initial prototype of such a system to better understand how the design ideas from the children, teachers and current HCI literature will interact.

In our attempt to achieve these goals, we designed an annotation book-reader that has two parts. The first is the student-centered annotation system that our child design partners helped to create. This interface supports highlighting, adding stamps to a book to indicate various levels of understanding, and a sticky note function that allows the students to add notes to the stamps. The sticky notes can be used to further clarify questions or comments about a highlighted section or to add general remarks about a page of a book.

The second part of the annotation book-reader is the teacher-focused composing tool. This interface supports teachers’ annotations of a book, which can help their students better understand the text that they are reading. Teacher annotations are focused around adding stamps to the margins to give students feedback about a particular section of a book. In addition, teachers may want to underline vocabulary or unknown words within the text to indicate to students that they should look up those words in a dictionary.

We believe that students provided with our annotation system will learn better reading comprehension skills than students reading traditional paper books. This is due, in part, to the fact that our system allows direct manipulation of books and allows teachers to incorporate annotations within a text. These capabilities are discouraged and
limited in most classrooms at present due to constraints of paper and rules of book ownership and care. By working with both students and teachers while designing the system, we were able to implement features that reflect the needs of middle-school classrooms and their unique learning goals.

A TYPICAL SCENARIO
Imagine a situation in which a teacher assigns students to read a chapter of a book. The students are able to use the computers in the school computer labs, the library or even at home. The teacher has assigned a book that is technically above their current reading level. Doing so in the past would have been impossible, as most of the students would have become confused and unable to continue. But the teacher is confident that the students will be able to complete the reading due to well-placed teacher stamps that warn the students of difficult parts and sticky notes that provide explanations of confusing sections. The teacher is able to ascertain if the annotations and assignment were successful or not by seeing where the students place Clicks and Clunks, a reading technique where students decide after each section if it made sense, and mark it accordingly [5]. Once the students complete their assignment, they can send it back to the teacher. The next day in class, the teacher is able to jump immediately into an explanation of the most challenging parts of the text by simply analyzing the portions of the book that have the highest frequency of Clunks. The teacher can gain more valuable feedback than was ever obtained in the past, as students that may feel shy or inhibited to talk about their confusion in front of their peers may not feel the same intimidation while working at their computers. Furthermore, the teacher has the ability to prepare in advance for specific questions that the students had annotated the previous night. The teacher is also able to determine which portions of the book sparked the most interest from the students, and therefore create an in-class project that will be sure to captivate the attention of the class.

THE ANNOTATION SYSTEM
We believe that by creating an intuitive annotation system, children will implicitly learn the value of active reading [1]. To achieve this goal, the system must make annotating as friendly as taking notes on paper – while also providing additional digital benefits to what paper can provide.

Although both the students and the teacher will be annotating the same books, it became clear that they each would need more specialized annotation systems reflecting their personal uses. The teacher’s system focuses on providing guidance to the students reading the book, such as giving hints about difficult parts of the text, appending direct reading comprehension questions, and underlining words or sections the students should pay special attention to. The student’s system focuses on understanding the text by taking notes and responding to reading comprehension questions.

Figure 1: Question and Exclamation Highlighters

SUPPORTING STUDENT’S ANNOTATIONS
Aside from simply providing the ability to take notes and respond to reading comprehension questions, we knew it was important that the additional tools did not interrupt the student’s reading flow. With this in mind, we designed and implemented the following tools based upon our work with the intergenerational design team.

Symbolical Highlighting
Based on ideas from our design sessions and using concepts from the Click and Clunk technique, we give the student users three different highlighters. When students do not understand a section of text, they can highlight it using the question mark highlighter. This highlights the text in red, a color that our design partners felt signaled an alert. Color alone was not enough of an indicator, so a question mark stamp is placed in the right margin next to the highlighted text to draw attention to the “clunk” (Figure 1). Similarly, the exclamation highlighter is designed to show importance of text selections. This highlighter was chosen to be yellow, the typical highlight color usually indicating significance, according to our child partners. A corresponding exclamation stamp is also placed in the margins to show the student’s “click”. The third highlighter is the sticky note highlighter. This blue highlighter and sticky note stamp could be used for neutral reactions to the text or to indicate a general comment about the page without attaching it to a particular passage of text.

Enhancing Symbols with Text
There are situations where highlighting and stamps don’t provide enough information. For instance, if there were a particular question a student has about what was just highlighted, it would make sense to give the student an opportunity to record the question. To facilitate this need, we created zoomable sticky notes.

If a student would like to record text about a particular annotation, he or she can simply click on the corresponding margin stamp and a movable sticky note will appear (Figure 2). The student can then input any question or comment on the note. When the child is done creating the sticky note, clicking on the margin stamp will shrink the sticky note to a fraction of its size and attach it behind the margin stamp. The sticky note will no longer obstruct other text or annotations – but the zoomed-out representation will still give a visual clue that there is a sticky note attached with that margin stamp.
Intelligent Bookmarks

Another tool students can use is intelligent bookmarks, which are not just used to mark the page where the student was last reading but also to easily draw attention to any page within the book. The bookmarks are described as intelligent because once a student marks a page, the bookmark will be automatically created with useful information, such as the page number and an analysis of what type of margin stamps the student has placed on that page. The bookmarks also capture the affordances of tangible bookmarks because they are visually accessible by simply glancing at the top of the book.

The bookmark feature that we have built automatically includes the page number of the bookmark and the number of questions or exclamations the student has annotated on the page. Size, shape, or color can also be used to give a more powerful visual representation of distance, importance, or problems within the book.

SUPPORTING TEACHER’S ANNOTATIONS

During our initial design of the annotation system, we assumed that students could take freeform notes based on worksheets or written assignments their teachers gave, such as reading comprehension questions or book reports. When it became clear that our system would be more powerful if we created a separate system for teachers, we implemented the following initial set of tools for teacher users.

Pictorial Clues

As with the student system, the teacher system retains the ability to stamp the text as well. We identified several initial stamps (Figure 3) that would be useful for teachers annotating a text to help their students.

The checkmark stamp can be used for the teacher to point out a particular fact or interesting section of the book. As a result of our feedback from a sixth-grade reading teacher, there is also a speed limit stamp. This stamp was designed to inform students of difficult sections of text where they should slow down and read more carefully. Another stamp in our system is the “Q” stamp, which is used for the teacher to include some direct reading comprehension questions for a specific passage or page in the book. Teachers can also include all-purpose sticky note stamps anywhere on the page for general comments.

Since a student user should generally examine or read the teacher annotations before beginning to read, teacher margin stamps are placed to the left of the text (we are currently working with texts that are read from left to right). This visual indication will reinforce and remind students that they should read the teacher’s comments or questions before adding their own annotations.

Context Clues

A second tool for teachers is underlining. Although this may seem like a trivial feature, the teacher can use underlining to emphasize individual words within the text. Underlined words indicate to the students that if they’re not sure what the word means, it is important that they look up the words in a dictionary. These could be vocabulary words or other words that the teacher thinks are important or difficult to understand. By underlining vocabulary words in a story, teachers can give vocabulary words in the context of the story, instead of detached list of words on a worksheet that may seem irrelevant to the students.

DISCUSSION

One of the most challenging parts of the design phase was to ensure that our system was able to capture the ease of use of paper while offering all of the benefits of a digital medium. One such example is bookmarks. We were interested in having the bookmarks being visible at all times so that the reader would be able to instantly jump to whichever marked section of the book was wanted. We also wanted to give the bookmarks a digital enhancement: intelligence of what kind of annotations took place on that bookmarked page. Unfortunately, this data requires a substantial amount of screen real estate – if there are too many bookmarks, they become useless. Perhaps providing a color-coded representation of the data instead of text would help. Zoomable sticky notes have a similar screen real estate problem, as we do not wish for any text to be obscured while users create sticky notes. These issues will have to be dealt with in future versions of the annotation system.

This implementation was built in Java using the Piccolo zoomable user interface toolkit [2] book-reader code of the International Children’s Digital Library [4].

Our current implementation has several additional limitations, but in spite of them, we think that we have a
very powerful educational tool. The ideas we expanded from working with the design team and with teachers have resulted in an annotation system that we could easily imagine being used in a classroom setting in the near future. These tools do not just mimic or marginally enhance current classroom practices; rather they use technology to provide new functionalities that were not possible with paper books. So, while there are some limitations, it is clear that these prototypes are moving in the right direction for our user populations.

CONCLUSION
The intent of building our annotation system was to better support learning. It is clear that poorly designed interfaces can impede productivity. It is also clear that paper has been a successful instrument for annotation for many years. By providing the affordances of paper and augmenting them with benefits only possible in a digital world, we were able to design a powerful annotation system for students and teachers.

By working with middle-school children as design partners, we can be sure that our system addresses what students feel are requirements to enhance learning. By working with middle school teachers, we also were able to be sure that the features included in our final design were in accordance with effective reading strategies. Although we have had some promising results with even our initial prototype, we will not be able to tell for sure how effective our system is until it is complete and extensive user studies are performed.

Annotation while reading is a proven technique to assist learning by engaging people in active reading. Our system incorporates this reading strategy into an interface whose simplicity is comparable to paper. In addition, the functionalities that we have provided for students and teachers allow them to interact with the text and with each other in ways never before possible in a school setting. Due to these factors, we believe our system will give a clear advantage over paper solutions, and will provide learning advantages in the classroom.

FUTURE WORK
We are currently porting our system to Adobe Acrobat. The teacher composing system and the student annotation system are now Visual Basic applications running Acrobat with plug-ins to support the stamp, highlighting and sticky note tools. We are also adding an Interactive Workbook, where teachers will compose activities for students to complete while reading. We think there are many interesting research areas to explore in the Interactive Workbook, from the educational technology aspect and the people, papers, computers aspect. A final aspect of future work will involve designing a network interface for both the student and teacher tools to facilitate coordination between students and teachers outside of the classroom.

ACKNOWLEDGMENTS
We would like to thank our adult and child design partners at the University of Baltimore and the University of Maryland for their wonderful design work. We would also like to thank François Guimbretière for his invaluable input and feedback throughout the design of our system. In addition we would like to thank the members of our People, Paper and Computers course for their comments throughout the research process and Mimi Chiarella for her input about the teacher tools.

This material is based upon work supported under a National Science Foundation Graduate Research Fellowship. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

REFERENCES