



Students' Attitudes on Electronic Versus Traditional Print Textbooks: Is Cognitive Performance Affected?

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Abstract. Despite technological advancements, electronic textbooks have yet to be used prominently in college classrooms. The current study investigated the effects of reading medium and computer attitudes on performance. It was predicted that among those with less positive computer attitudes, there will be better performance on a comprehension test from a printed text compared to that from an electronic text. Conversely, it was predicted that among those with more positive attitudes towards computers, there will be better performance on a comprehension test from an electronic text. College undergraduates' cognitive performance was assessed accounting for their computer attitude, as they read an excerpt from an abnormal psychology textbook in electronic or print form. Results showed no significant performance differences for textbook medium, computer attitudes, or the interaction. Moving forward, this research is beneficial because it may help educators as they decide what textbook medium to implement in their classroom as well as textbook companies as they manufacture new products.

Essential to higher education is the use of textbooks as a tool for learning. The textbook may be the main source of information or may be a supplementary guide that helps students further expand on what is lectured in the classroom (Rockinson-Szpkwi, Courduff, Carter, & Bennett, 2012). With technological advancements, the use of electronic devices for reading has become more widespread (Hue, Rosenfield, & Saa, 2013). Electronic devices such as e-readers, tablets and smartphones have started taking the place of traditional print media. Although this may be changing and shifting as we move further into the digital age, electronic textbooks have not yet been widely adopted at the college level (Daniel & Woddy, 2013).

Looking ahead, electronic text is still in its infancy. This being true, users and manufacturers of electronic devices are continuing to adapt. To date, most studies conducted have found some advantages and

disadvantages to electronic text. As research advances, these findings will be beneficial for the developers of electronic devices as they seek to maximize the functionality of their products.

Multiple studies have found similar advantages in using an electronic device for reading. Some advantages of an electronic device are its portability, long battery life and readability despite bright sunlight (Shin, 2011). To support Shin's findings as well as add to the list of advantages, Woody, Daniel, and Baker (2010) suggest electronic devices have features that enhance learning. These features are lower cost, moving graphics, video clips, and hyperlinks to websites that support learning through different activities.

Despite the advantages of an electronic device, there still are drawbacks. Although an electronic device's portability is an advantage, some still require a desk or table (Shepperd, Grace, & Koch, 2008). Some have mentioned





that an electronic reading device leads to skimming through the text and can leave the reader feeling disjointed compared to a traditional print text. Electronic devices also lead to eyestrain, technical issues, and require students to own a computer or electronic reading device (Sun & Flores, 2012). In contrast to Shin's (2011) findings, Sun et al. (2012) found that the battery life of an electronic device was limiting.

The technological period has led the way to developing new critical thinking skills (Cartes-Enriquez, Rodrigez, & Letelier, 2004). The main role of educators has shifted to a more supporting role that encourages students to be increasingly self-taught in classrooms where technology is prominent (Cartes-Enriquez et al., 2004). With advances in technology Albert, Hockemeyer and Mori (2006) found electronic textbooks have become a personal teacher of sorts, expanding on an earlier study by Cartes-Enriquez et al. (2004). Teaching has become more focused and centered on the student as opposed to centered on the textbook, accommodating the student's individual needs, having the ability to transform traditional classrooms as well as whole universities (Dillon & Gabbard, 1998).

As students continue to educate themselves more independently due to technological advancements, they have begun utilizing new learning strategies involving electronic devices. With the introduction of electronic texts, the structure of the text can be in a linear or nonlinear form, creating different ways of learning. When text is presented on a computer or electronic device it can be in a nonlinear form, changing based on the contents of the screen as opposed to books, which are in a linear form, with text in a fixed layout (Kerr & Symons, 2006). This leads the reader to sort through more information, taking more time overall to read the electronic text, before they can process what they are learning. The idea that text on an electronic device can be presented in a nonlinear form was supported in a later article, though they also found e-readers' text can be presented in a

linear form similar to traditional print books (Margolin, Driscoll, Toland & Kegler, 2013).

With differences in presentation, it has also been found there are different ways of processing and comprehending information. Readers who have been using electronic text have predominantly used a top-down reading strategy comprehending the thoughts behind the material, as opposed to readers who read primarily from a print text who predominantly use bottom-up reading strategies, reading each word individually (Cartes-Enriquez et al., 2004). The use of top-down reading strategies when reading from an electronic source has enabled readers to better comprehend the text. This strategy helps readers to stay engaged in what they are reading. In contrast, a later study found that bottom-up reading strategies used when reading from a print source has led to better comprehension, because readers typically remember the location of the text they have read on each page (Kerr et al., 2013). On a print source, text is not able to be moved, enlarged or changed as it could be on an electronic source, which leads to better comprehension.

Different factors have been examined that influence student learning and performance, as well as the efficiency of the different textbook mediums. One factor that influences efficiency of students learning is the time that it takes to read a textbook, depending whether is in print or electronic form. A within-subjects study was conducted to observe the differences of reading text from an electronic device and reading text on paper (Askwall, 1985). Findings from the study indicate that reading and search time for both mediums did not differ from one another. In contrast, a later study found that it took longer to read from a computer supported device (Daniel et al., (2013). Contrasting both of these studies, it was found that reading time for an electronic reading device took less time than a traditional print text (Shepperd et al., 2008). With conflicting findings, a meta-analysis, found that reading speed across medium was inconclusive, suggesting that a

number of different variables across different studies have not been constant (Dillon, 1992).

Learning has been predominately defined in terms of cognitive performance (Rockinson-Szapkiw et al., 2012). Cognitive performance can be measured, for example, by grades, comprehension of information or achievement tests.. Across studies it was found that cognitive performance has not been affected by the type of medium used (Daniel et al., 2013). Although as mentioned previously, reading strategies do vary across mediums. With different reading strategies used, a study compared undergraduate and graduate students' grades to measure the efficacy of their reading across mediums (Rockinson-Szapkiw et al., 2012). They found that the type of text did not significantly influence cognitive learning measured by grades. They also found that students who used an e-textbook thought they would do better because they had used more psychomotor and affective learning strategies. To support results found in this study, a later study found that the type of medium used for reading did not affect cognitive learning of students measured by grades (Daniel et al., 2013).

Another factor that may influence student learning is their attitudes and initial preferences for one medium over the other. A common finding is that many students prefer print textbooks compared to electronic textbooks, despite previous use of the electronic textbooks. A study was conducted surveying 91 university students in a general psychology class who previously had an option to use an e-book in a college class (Woody et al., 2010).. They anticipated students would have a greater approval rate for an e-book compared to traditional textbooks. Contradictory to their hypothesis, the authors found that no matter how much previous use students had with e-books, they still preferred traditional textbooks. To support this, Shepperd et al. (2008) in an earlier study also found that students, despite

cognitive performance, prefer a traditional textbook over an e-book.

With the rise in sales of electronics, it is important to further advance research on the effectiveness of e-books (Kang, Wang & Lin, 2008). Research on the use of electronic books is still in its infancy and it is currently difficult to identify a single factor that influences reading across different mediums (Dillon, 1992). It will be interesting to see, as technology advances, if cognitive performance will increase. The use of electronics starting at a younger age could also be an influential factor.

As of now the analysis of literature is inconclusive, suggesting the need for continued research of electronic devices and their effects on cognitive performance. Accordingly, the aim of this study is to examine the currently known factors that influence cognitive performance across mediums. It was predicted that among those with less positive computer attitudes, there will be better performance on a comprehension test from a printed text compared to that from an electronic text. Conversely, it was predicted among those with more positive attitudes towards computers, there will be better performance on a comprehension test from an electronic text compared to that from a print text.

Method

Design

The study employed a 2(computer attitude) x 2(textbook medium) between-subjects design. Participants were randomly assigned into two groups; each group read an excerpt from a textbook in one medium or the other (print textbook or an electronic textbook). The dependent variable was the participants' performance on a comprehension quiz.

Participants

Participants consisted of 62 Minnesota State University Moorhead undergraduate students. The sample consisted of more females (69.4%) than males. The participants

volunteered via sign-up sheet in the psychology department. They earned extra credit by partaking in the study, as determined by their respective professors. The average age of participants was 21.56 ($SD=1.52$) years.

Materials

The stimuli included an excerpt on Dissociative Identity Disorder from an abnormal psychology textbook titled "Fundamentals of Abnormal Psychology" (Comer, 2014). The text was presented either in print or electronic form. The excerpt was three pages long, describing subpersonalities and the prevalence of Dissociative Identity Disorder. On the side of the pages there were definitions of key words, and on the second page of the text there was a picture of a movie that dramatizes Dissociative Identity Disorder in Hollywood.

The electronic version of the text was presented on an iPad mini with Retina Display. The iPad mini's screen is 7.9 inches with a resolution of 2048x1536 pixels. The textbook was presented via the Kindle application on the iPad.

A demographics survey was used, to measure age and sex of the participants in the study. It also measured the amount of experience participants had with electronic reading devices as well as what brands of devices they have used prior (i.e., Kindle, iPad, Nook, other or none). The survey was created specifically for this study.

Computer attitudes were assessed by the Computer Attitude Scale (CAS; Nickell & Pinto, 1986). The CAS is a 20-item measure that asks participants about their attitudes towards the use of computers in society. Participants rated the items on a 5-point Likert-type scale with a range of 1 (Strongly Disagree) to 5 (Strongly Agree). Prior to results being calculated, twelve of the items' scores were reversed. Higher scores indicate a positive computer attitude. Example statements from the survey include, "Computers make me uncomfortable because I don't understand them.", "Computers can eliminate a lot of tedious work for people.",

and "Computers will replace the need for working human beings." Reliability (Cronbach's alpha) for CAS was .81 in a later study (Garland & Noyes, 2007).

A 10-question multiple-choice comprehension quiz, with scores ranging from 0 to 10, was given to test the performance of the participants. The quiz was comprised of questions from the material in the excerpts on Dissociative Identity Disorder from the textbook "Fundamentals of Abnormal Psychology" (Comer, 2014). Example questions from the quiz include "What are subpersonalities also known as?" and "Which of the following was not mentioned in the text as a way that subpersonalities interact with one another?"

Procedure

As participants entered the lab they read and signed an informed consent form. The study was presented as research on cognitive performance. Participants were tested individually and were allowed as much time as they needed to complete the tasks. The participants first filled out a demographics survey. Then they completed the CAS. Participants were randomly assigned to one of the two mediums (iPad or traditional textbook) to read an excerpt on Dissociative Identity Disorder. The excerpt had identical content across mediums. At the completion of reading the excerpt, participants took a 10-question multiple choice comprehension quiz with content associated with what they read. After taking the quiz the participants were debriefed and thanked for participating.

Results

A hierarchical multiple regression analysis was run in order to test the hypothesis that among those with less positive computer attitudes there will be better performance on a comprehension test from a printed text compared to an electronic text. Conversely, it was predicted among those with more positive attitudes towards computers, there will be better performance on a comprehension test from an electronic text compared to that from

a print text. Before the analysis was run, the computer attitude survey was scored and summed to create a single testable variable. An interaction term was also created by multiplying the computer attitude score by the textbook condition to which the participant was assigned.

The multiple regression analysis was chosen to test the significance of results because the computer attitude score is a continuous variable. Table 1 outlines the results, showing that step one of the analysis the model was not significant, $F(2, 59)=1.38$, $p<.05$, $\Delta R^2=.05$. The main effects were examined, and there were no significant findings present for either computer attitude, $\beta = -.21$, $p<.05$ or textbook medium, $\beta=.02$, $p<.05$, in predicting quiz scores.

At step two of the analysis the interaction term was added. Again, the model was not significant $F(3,58) = .97$, $p>.05$, $\Delta R^2 = .05$. Results failed to show evidence of an interaction between computer attitudes and reading medium as they relate to comprehension quiz scores, $\beta = -.57$, $p>.05$.

Figure 1 depicts predicted means determined by the regression equation, where positive and negative attitude values were defined as one standard deviation above and below the overall attitude mean, respectively. These values were entered into the equation along with 0 (traditional) and 1 (electronic) to represent the textbook medium conditions.

Discussion

Essential to higher education is the use of textbooks as a tool for learning. The textbook may be the main source of information or may be a supplementary guide that helps students to further expand on what is lectured in the classroom (Rockinson-Szpkwi, Courduff, Carter, & Bennett, 2012). Although this may be changing and shifting as we move further into the digital age, electronic textbooks have not yet taken off at the college level (Daniel & Woody, 2013). As of now, previous research is inconclusive as to whether traditional print textbooks or

electronic textbooks lead to higher comprehension. Accordingly, the aim of this study was to look at the currently known factors that influence cognitive performance across mediums and test to see if computer attitude or textbook medium used affected comprehension.

This study hypothesized that computer attitudes, would influence performance on a comprehension test. However, this hypothesis was not supported. Because prior research remains inconclusive, the aim of this study was to investigate further this finding to see if computer attitude would influence comprehension (Wood et al., 2010; Sheppard et al., 2008). The insignificant results in this study could be due to many factors. Some limitations of this study include the sample size, the use of convenience sampling and prior subject knowledge. The participants were primarily white, undergraduate women around the age of 21. Even if there were significant results there would have been a limitation in the ability to generalize results to a broader population. Another limitation of this study was that participants were only tested one time on a short excerpt from a psychology textbook. Outside factors could have influenced how well the participants were able to perform on a comprehension quiz. Some of these may have been the state of mind the participant was in, and whether they took the quiz seriously. A final limitation of this study was that some participants were not native English speakers. This may have inhibited their comprehension as well. Some non-native English speakers expressed after participation that they did not fully understand the content.

Despite limitations, there were also strengths that could be drawn from this research. Although there were not significant results found in regards to textbook medium, this could be beneficial as students are choosing a textbook medium to use. Based on this study, either textbook medium leads to the same level of comprehension giving students the freedom not to worry about how well they



will perform. Another strength of this study is that the research is relevant to textbook companies. This study is beneficial because it could potentially help them make decisions as they are manufacturing their textbooks and considering creating their textbook in the electronic form.

With the rise in sales of electronics, it is important to further advance research on the effectiveness of e-books (Kang, Wang & Lin, 2008). It is essential to know if e-books are enhancing or inhibiting cognitive performance of students in classrooms. Research on the use of electronic books is still in its infancy, and it is currently hard to identify a single factor that influences reading across different mediums (Dillon, 1992). A number of factors that influence reading across mediums include attitude, reading time, and how thorough readers are while reading from an electronic textbook. Any of these factors could affect comprehension, and researchers are looking for what textbook medium give way to the best comprehension. With this being the case this research leads way to future research. Future research could examine different factors beyond computer attitude as it relates to comprehension. For some, their computer attitude could be different than their attitude towards electronic books or textbooks specifically. In the future researchers could use a different assessment of attitude as it relates to electronic books to textbooks. Another future direction that this research could take would be to expand the study over a longer period of time. A researcher could have participants use different textbook mediums over the course of a semester. By doing this they would have better overall analysis of how comprehension could vary pending on textbook mediums. This would eliminate the fact that at times the people being tested may have been distracted or not in the mood to be tested. Future researchers could also expand this study by increasing the sample size that was used. More participants could be tested doing a similar study or there could be a broader age range of participants

tested. If possible in the future younger aged participants could be tested to see if middle or high school students' comprehension was affected by textbook medium. This would be crucial information that would benefit educators as they choose the type of textbook medium to use in their classroom as the technological age advances.

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Table 1
Hierarchical Multiple Regressions Analysis predicting quiz score from the interaction between textbook medium and computer attitudes.

	β	ΔR^2	F	p
Step 1		.05	1.38	.26
Medium	-.21			
Attitude	.02			
Step 2		.003	.97	.41
Medium	.37			
Attitude	.21			
Interaction	-.57			

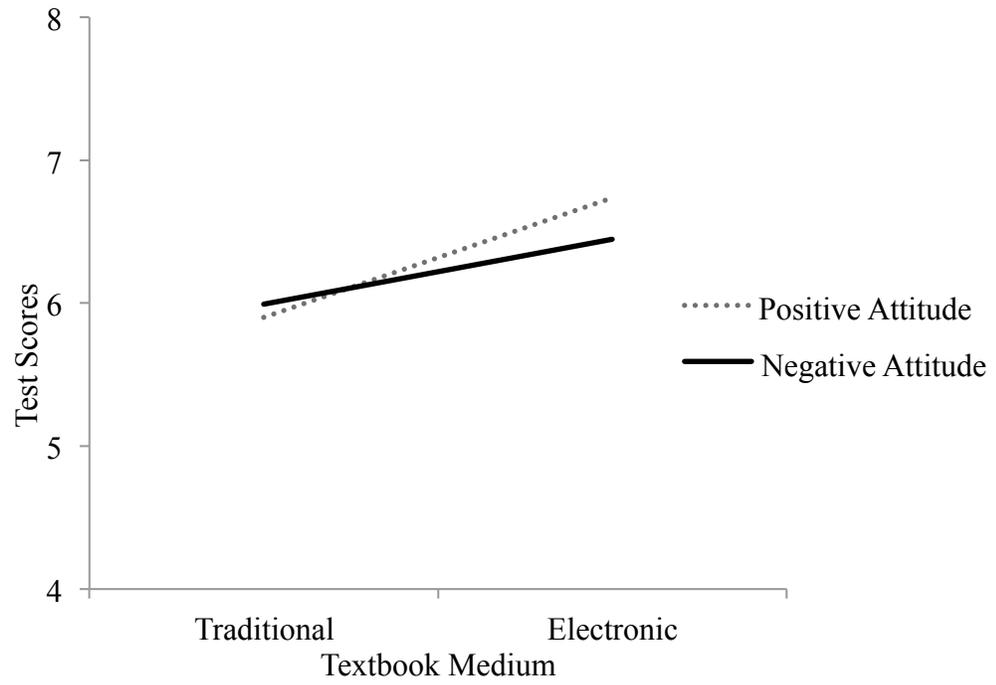


Figure 1. The effects of textbook medium on quiz performance as a function of computer attitude.