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E-textbooks at what cost? Performance and use of electronic v. print texts

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ABSTRACT

While e-book sales continue to increase, electronic textbooks are not very popular with college students. This may be due to the fact that e-textbooks are read for different reasons and with different strategies than are e-books. Although previous research has documented this lack of preference for e-textbooks, student performance and use of electronic texts has yet to be thoroughly investigated, especially in naturalistic settings. This study examines students' use and performance on a variety of print and electronic formats in both laboratory and at-home conditions. Although students scored similarly across formats and conditions, reading time was significantly higher in the electronic conditions with this difference increasing for the home conditions. Similarly, self-reports of multi-tasking were significantly higher for electronic conditions in the home condition, possibly accounting for the disparities in reading time. We conclude by urging caution in the rush to assume that electronic textbooks are equivalent substitutes for traditional textbooks and argue for further investigation into the unique ways that students may interact with electronic texts to promote more effective design.

1. Introduction

Since April of 2011, e-book sales have outsold printed books on Amazon.com (Miller & Bowman, 2011) and continue to grow throughout the marketplace (Publisher's Weekly, 2012). Yet, e-textbook sales have yet to take-off at the college level (National Association of College Bookstores, 2011). Reviews of student perceptions e-textbooks consistently demonstrate this lack of preference, which seems not to be positively affected by familiarity and or prior use (Shepperd, Grace, & Koch, 2008; Woody, Daniel, & Baker, 2010). Clearly e-books and e-textbooks are not equivalent products (see also Daniel & Willingham, 2012). Unlike regular e-books, which are commonly read for personal goals and enjoyment, e-textbook readers have the additional goals of learning, even memorizing, portions of the text. Indeed, textbooks are constructed with these goals in mind. Although often a simple copy of the textbook page, most students do not prefer e-textbooks as productive alternatives for meeting these goals (Woody et al., 2010).

Student preferences, however, are not necessarily the best criteria upon which to make pedagogical decisions. Students, whose goals often revolve around efficiency moreso than learning impact (Kvavik, 2005), have often been demonstrated to prefer pedagogical strategies that are not associated with learning (Gurung, 2003, 2004; Gurung & Daniel, 2005; Gurung, Weidert, & Jeske, 2010; Wesp & Miele, 2008). This is not unique to college students: Humans in general are poor judges of how much they know (see Dunning, Johnson, Ehrlinger, & Kruger, 2003, for a review). Although students may not make the best initial choices, there is evidence that they do shift toward more productive decisions with appropriate feedback (Daniel & Woody, 2010). In the case of students who have had experience with e-textbooks (Woody et al., 2010), is their aversion to electronic textbooks warranted?

What are some known benefits of using student-level technology in an educational setting? Clyde (2005) noted a number of potential advantages that e-textbooks have over their paper-based counterparts. One advantage is the superior flexibility and accessibility of e-textbooks over paper-based textbooks (Coleman, 2004; see also Cavanaugh, 2002; Long, 2003; Myers, 2009). The common reasoning among these and many other authors is that characteristics such as attractiveness, cost, flexibility, features, and ease of availability encourage students to consult a computer for textbook information rather than a paper textbook. Hence, some students may be attracted to this new technology, but what effect does this attraction have on learning?

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If e-textbooks are to become a constructive option for college-level students, it is important to investigate the potential learning impact of text delivered in this medium. The relatively few studies that have directly assessed student performance and/or retention for material delivered via e-textbooks indicate that learning may not be impeded in this delivery mode (e.g., Shepperd et al., 2008; Taylor, 2011).

Recently, Shepperd et al. (2008) assessed preference and inferred performance for an available e-textbook option within the context of an introductory psychology course. Students were not assigned to print or e-textbook conditions. Rather they were given the choice after a class presentation on the available e-textbook. With regard to preference, no students who had previously used an e-textbook opted to use one in this course, and end-of-semester evaluations indicated that students who did opt to use them would not do so again (see also Woody et al., 2010 for a more thorough assessment of print and e-textbook preferences in college students). Although there was no direct measure of student learning by condition, Shepperd et al. found no difference in final course grades between students using e-textbooks (see also Muter & Maurutto, 1991). The students in this study were not randomly assigned to conditions, and there was little control for other variables that could have influenced course grades; therefore, there remains a need for a more controlled investigation into learning and performance with regard to e-textbooks. Further, there was no report of how students used each medium to achieve their grades, leaving open the possibility that students use different strategies when interacting with printed textbooks compared with e-textbooks. Similarly, Taylor (2011) found similar levels of retention on a short multiple choice quiz for traditional vs. electronic textbooks in a lab-based study but did not assess reading time or other measures related to students potentially using different strategies for interacting with each medium.

Questions remain regarding differences between students' interactions with print and electronic media regarding subjective fatigue (Dillon, 1992), text scanning patterns (Nielson & Pernice, 2010), and other factors (Kropman, Schoch, & Teoh, 2004). If there are not differences in comprehension, e-textbooks may actually be less efficient than paper-based textbooks because students take significantly longer to read the e-textbook than the paper version (e.g., Clyde, 2005). This potential time difference could be due to the extra audio and visual components the e-textbooks have over the paper-based textbooks or to factors associated with reading from a screen. Further studies are needed in order to determine whether the extra time pays off, which would require consistent findings of higher comprehension scores in electronic versions over paper versions.

Measures of learning as well as methods of use are important considerations as e-textbooks increasingly include features that are not part of the traditional textbook experience, including links to supporting assets and interactive tutorials. We are currently unaware of all the repercussions of using technology as a learning tool at the student level, however, and even less aware of how students interact with pedagogical tools outside of the structure of the laboratory (e.g., Daniel & Poole, 2009). The current study examines differences in learning and differential usage that result from using a variety of print and electronic textbook modes in both lab and more naturalistic conditions.

2. Method

2.1. Participants

Participants were 298 students (124 males and 174 females) with no formal previous exposure to the target chapter's content. They participated to fulfill a course requirement at a medium-sized regional university in the United States. Additionally, 20 participants (6 males, 6 females, and 12 unreported) took only the quiz and did not read the chapter or complete any other measures. We treated all participants in accordance with American Psychological Association [APA] ethical guidelines (APA, 2002).

2.2. Materials

Participants in both conditions read a textbook chapter titled "Social psychology" from Myers's (2007) introductory textbook, *Psychology,* and were randomly assigned to one of five formats: print textbook, printed text pages, printed manuscript in Microsoft Word, electronic pdf file, or electronic textbook. Students reported their college Grade Point Averages [GPAs] and completed a questionnaire about their previous interactions with the print or electronic textbooks, motivation to perform well on the quiz, and perceived mastery of the reading material. Specifically, they used a Likert scale (*1 = not at all, 9 = extremely*) to report their perceptions of how well they remembered and understood the material and how motivated they were to pay close attention to the reading and to perform well on the quiz; they used a Likert scale (*1 = not at all useful, 9 = extremely useful*) to rate the usefulness of several common textbook features (e.g., photographs and figures). Additionally, students in the home condition also used a Likert scale (*1 = never, 9 = always*) to rate how often, if at all, they engaged in competing activities (see Table 3) as they read the chapter.

Participants the completed a 30-question quiz that included equal numbers of easy, medium, and hard questions as identified by the accompanying testbank (Brink, 2007). Additionally, the researchers precisely recorded reading times for students in the laboratory condition, and students who read the chapter at home self-reported the amount of time they spent reading for the quiz.

2.3. Procedure

After being screened for previous exposure to the chapter's material, students were randomly divided into 2 groups: One group of students read in the laboratory and the other read at home. Participants in the lab condition read the chapter while being observed and immediately completed the survey followed by the quiz; participants in the home condition read the chapter at home and completed the survey and the quiz two days later when they returned to the classroom.

Students in the lab condition were either handed a packet containing the reading or sat in front of a computer, depending upon format. When told to do so, students read the material. Experimenters in the lab unobtrusively recorded reading time for each reader in all formats and distributed separate survey and then quiz packets to students upon completion of the previous task: Immediately after finishing the reading, students were given the survey materials and, upon completion, were then given the 30-question performance quiz.

Students in the home condition reported to a classroom where they were given instructions to read the provided material for a later quiz. They were then handed either a reading packet or a CD, depending upon condition, and a form to record their reading time and study and non-study-related (e.g., competing activities) activities that they may have been engaging in related to their attempts to master the material.

Table 1
Means, standard deviations (in Parentheses), and ns per condition for quiz scores as a function of format and location of study.

Location	Media						
	Control	Print textbook	Print text pages	Print manuscript	Electronic pdf	Electronic textbook	Means (text conditions only)
Lab	12.42_a (4.13)	18.10_b (5.03)	18.63_b (4.72)	19.14_b (5.50)	18.92_b (3.62)	19.04_b (4.32)	18.75_c (4.66)
	$n = 20$	$n = 30$	$n = 30$	$n = 29$	$n = 26$	$n = 26$	$n = 141$
Home	N/A	18.52 (6.26)	17.43 (5.00)	18.33 (3.93)	16.82 (6.24)	17.24 (5.01)	17.54_d (5.41)
		$n = 28$	$n = 31$	$n = 30$	$n = 34$	$n = 34$	$n = 157$
Means	12.42 (4.13)	18.27 (5.51)	18.14 (4.83)	18.83 (4.92)	17.75 (5.31)	18.09 (4.74)	18.19 (5.05)
		$n = 58$	$n = 61$	$n = 59$	$n = 60$	$n = 60$	$n = 298$

Note. Means with different subscripts differ $p < .05$.

Participants were asked to report back to the same classroom 2 days later at the same time to take the survey and quiz as well as to hand in their assigned materials, similar to what may happen in a course.

3. Results

Results included quiz scores, recorded or reported reading times (for students who read in the lab or at home, respectively), students' self-reported college GPAs, students' self-reported ratings of motivations for performance, students' perceptions of the usefulness of several textbook features, and self-reported competing activities (for students in the home condition). A substantial majority (92.7%) of students in all conditions reported reading most or all of chapter, and there were no significant differences in this measure across media or location.

3.1. Quiz performance

3.1.1. Control

To evaluate the effects of reading, we compared the quiz scores of the 20 control participants who completed the quiz without reading the chapter to the quiz scores of the participants who read the chapter. We included the data from the control condition in an ANOVA with format of text (control, print textbook, text pages, manuscript, pdf, or electronic textbook) as a between-participants independent variable. The ANOVA was significant, $F(1, 284) = 5.57$, $p < .001$, $\eta_p^2 = .09$. As shown in Table 1, post-hoc tests revealed that quiz scores in every reading condition were significantly higher than quiz scores in the control condition ($M = 12.15$, $SD = 4.20$), all Scheffe $ps < .005$, but that reading conditions did not differ from each other (all Scheffe $p > .90$). All analyses below include only data from participants who read the chapter.

3.1.2. Formats and locations

We ran an Analysis of Covariance [ANCOVA] with reported college GPA as a covariate, format of the text (print textbook, text pages, manuscript, pdf, or electronic textbook) as a between-participants independent variable, and location of study (lab v. home) as a between-participants independent variable. We found that GPA was a significant predictor ($r = .18$, $p = .006$) of overall quiz score, $F(1, 224) = 8.91$, $p = .003$, $\eta_p^2 = .04$. Additionally, students who read in the lab ($M = 18.76$, $SD = 4.71$) performed better than students who read at home ($M = 17.61$, $SD = 5.25$), $F(1, 224) = 4.06$, $p = .045$, $\eta_p^2 = .02$. There were not significant differences across the five media formats, $F(4, 224) = .09$, $p = .99$, $\eta_p^2 = .002$.[1]

To further investigate differences between the modes of texts, we used a similar ANCOVA to compare students' performance after reading print media (i.e., print textbook, text pages, or manuscript) to performance after reading electronic media (i.e., pdf or electronic textbook). As noted previously, GPA and location were significant, but media (print or electronic) was not, $F(1, 230) = .06$, $p = .81$, $\eta_p^2 < .001$.

3.2. Reading times

We evaluated the amount of time students spent reading the chapter in two ways. Researchers precisely timed the students in the lab condition, and students at home self-reported the amount of time they spent reading the chapter. Despite these methodological differences, to evaluate the ways that students read print and electronic media, we ran an ANCOVA with reported GPA as a covariate, format of the text (print or electronic) as a between-participants independent variable, and location (home or lab) as an independent variable. Means and standard deviations are in Table 2.

Students' reported GPAs were not associated with observed or reported reading times, $F(1, 247) = .14$, $p = .71$, $\eta_p^2 = .001$. Students who read at home reported spending much more time reading the chapter than did students who read in the lab, $F(1, 247) = 100.67$, $p < .001$, $\eta_p^2 = .29$. Across both locations, students reported or were observed spending more time reading the electronic media than the print media, $F(1, 247) = 5.25$, $p = .02$, $\eta_p^2 = .02$. To evaluate main effects, we conducted an independent t-test that demonstrated electronic media reading times were significantly longer (i.e., 7% longer) than print reading times in the lab, $t(139) = 2.18$, $p = .03$, $d = .38$. As shown in Table 2, the data from the home study conditions had much larger standard deviations than the lab data (Levene's test $F(1, 282) = 105.17$,

[1] We also evaluated the testbank author's claims regarding the difficulty of questions (Brink, 2007). We ran a within-participants Analysis of Variance with difficulty as an independent variable and number correct as a repeated measures dependent variable. Across dependent measures, difficulty was significant, $F(2, 285) = 86.75$, $p < .001$, $\eta_p^2 = .38$, but not in the predicted ways. Participants correctly answered more moderate questions ($M = 6.69$, $SD = 2.03$) than easy questions ($M = 6.15$, $SD = 2.02$) and more easy questions than hard questions ($M = 5.17$, $SD = 2.02$); least significant difference tests revealed that all difficulty ratings were significantly different (all $p < .001$). Although this evaluation is limited by the relatively small number of questions, it may not be wise to rely solely upon publisher-provided designations when constructing tests of various question levels.

Table 2
Means and standard deviations (in Parentheses) of observed or reported reading times as a function of format of text and location.

Location	Media		
	Print	Electronic	Means
Lab	33:55 (6:09)	36:22 (6:23)	34:47 (6:19)
Home	1:03:31 (26:18)	1:17:14 (50:37)	1:09:37 (39:26)

Note. Lab and Home condition means differ, $p < .001$, $\eta_p^2 = .29$. Within the lab condition, means differ, $p = .03$, $d = .38$; within the home condition, without assuming equal variances, means differ, $p = .16$, $d = .24$; and across both the home and the lab conditions, students were observed or reported spending more time reading electronic media than print media, $p = .02$, $\eta_p^2 = .02$.

$p < .001$), and, in particular, the electronic home study condition had a substantially larger variance than the print home study condition (Levene's test $F(1, 141) = 9.147$, $p < .003$). Therefore, we compared reading times for print and electronic home conditions without assuming equal variances; students at home reported spending more time reading electronic materials (i.e., 22% longer) than print materials, $t(141) = 1.43$, $p = .16$, $d = .24$. As shown in Table 2, the marginal significance of the 14 m mean difference at home results from the extensive variability of reported home reading times across both print and electronic conditions and the greatly increased variability of the home electronic condition. As noted previously, the significant reading time difference did not reflect a performance difference.

3.3. Students' perceptions of motivation and learning

Could differences in reading motivation between students who read print or electronic materials shed light on these questions? Students used a 9-point Likert scale (*1 = not at all, 9 = extremely*) to rate the degree to which they were motivated to pay close attention while reading ($M = 5.77$, $SD = 1.66$), the degree to which they were motivated to perform well on the quiz ($M = 5.80$, $SD = 1.79$), the difficulty of the chapter ($M = 5.32$, $SD = 1.28$), the amount they learned from the text ($M = 5.65$, $SD = 1.50$), and their enjoyment of the text ($M = 4.73$, $SD = 1.96$). We used a Multiple Analysis of Covariance [MANCOVA] with reported GPA as a covariate, media (print or electronic) and location (home or lab) as between-participants independent variables, and these five dependent variables.

Reported GPA was not significantly associated with responses across the five dependent variables, *Wilks'* $\Lambda = .97$, $F(5, 245) = 1.56$, $p = .17$, $\eta_p^2 = .03$, and neither media [*Wilks'* $\Lambda = .99$, $F(5, 245) = .61$, $p = .70$, $\eta_p^2 = .01$] nor location [*Wilks'* $\Lambda = .97$, $F(5, 245) = 1.64$, $p = .15$, $\eta_p^2 = .03$] was significant. Only one univariate outcome was significant; reported GPA was significantly associated ($r = .17$, $p = .007$) with motivation to perform well, $F(1, 249) = 5.42$, $p = .02$, $\eta_p^2 = .02$.

Students used a Likert scale (*1 = not at all*, *9 = extremely*) to report the degree to which they knew the materials ($M = 5.07$, $SD = 1.59$), the degree to which they understood the materials ($M = 5.90$, $SD = 1.70$), and their confidence that their understanding of the materials was accurate ($M = 5.34$, $SD = 1.66$). We performed a Multiple Analysis of Covariance [MANCOVA] with these three dependent variables and with reported GPA as a covariate, media (print or electronic) and location (home or lab) as between-participants independent variables. No multivariate or univariate outcomes were significant (all $p > .05$).

3.4. Perceived usefulness of textbook features

Students used a Likert scale (*1 = not at all*, *9 = extremely*) to rate the usefulness of several features of print and electronic textbooks. Because only print textbooks and electronic textbooks contained the features in question, only the 114 students who read the chapter in these formats are included in the subsequent analyses. We ran a MANCOVA with reported GPA as a covariate, media (print or electronic textbook) as a between-participants independent variable, and location (lab or home) as a between-participants independent variable. Across all dependent variables, location was a significant predictor [*Wilks'* $\Lambda = .83$, $F(8, 86) = 2.24$, $p = .03$, $\eta_p^2 = .17$], but there were not multivariate effects for reported GPA [*Wilks'* $\Lambda = .98$, $F(8, 86) = 1.31$, $p = .25$, $\eta_p^2 = .11$] or media [*Wilks'* $\Lambda = .89$, $F(8, 86) = 1.31$, $p = .25$, $\eta_p^2 = .11$]).

Univariate outcomes revealed a more complex situation. Reported GPAs were associated with higher ratings of usefulness for "research" (i.e., descriptions of specific studies) [$F(1, 93) = 4.99$, $p = .03$, $\eta_p^2 = .05$] and "examples" (i.e., exemplars of psychological phenomena) [$F(1, 93) = 8.98$, $p = .004$, $\eta_p^2 = .09$]. Students who read electronic texts rated "research" [$F(1, 93) = 6.86$, $p = .01$, $\eta_p^2 = .07$] and "examples" [$F(1, 93) = 5.92$, $p = .02$, $\eta_p^2 = .06$] as more useful ($M = 6.94$, $SD = 1.52$ and $M = 7.67$, $SD = 1.45$, respectively) than did students in the print conditions ($M = 6.18$, $SD = 1.60$ and $M = 7.02$, $SD = 1.57$, respectively). Additionally, students in the lab condition rated "tables" [$F(1, 93) = 10.05$, $p = .002$, $\eta_p^2 = .01$] and "photos" [$F(1, 93) = 8.04$, $p = .006$, $\eta_p^2 = .08$] as more useful ($M = 5.54$, $SD = 1.86$ and $M = 6.17$, $SD = 1.64$, respectively) than did students in the home condition ($M = 4.37$, $SD = 1.86$ and $M = 5.09$, $SD = 2.23$, respectively).

We specifically compared participants' self-reports regarding their use of activities in print textbooks and electronic textbooks. We asked students whether they did the activity during their reading, went back to the activity later in the chapter or the section, or did not complete the activities. Among the 57 print textbook users, 11 (12.3%) completed the activities immediately, 19 (33.3%) returned to the activities, and 31 (54.4%) did not complete the activities. For electronic text users, 6 (10.5%) completed the activities immediately, 14 (24.6%) returned to complete the activities, and 37 (64.9%) did not do the activities. These responses did not differ significantly as a function of the media ($X^2 = 1.36$, $p = .51$, *phi* = .11).

3.5. Competing activities

Researchers observed participants in the lab condition, but the 146 students in the home condition used a Likert scale (*1 = never*, *9 = always*) to report how often they engaged in competing activities as they read. We used a MANOVA with media (print or electronic) as a between-participants variable and participants' responses to nine questions about competing activities as dependent variables (see Table 3).

Table 3
Means and standard deviations (in Parentheses) of home participants' ratings of how often they engaged in each competing activity as a function of media.

Activity	Print	Electronic
TV	2.89 (2.65)	2.77 (2.29)
Music	3.41 (2.74)	3.69 (2.95)
Roomates/family/friends	$4.84\ (2.61)_a$	$6.02\ (2.53)_b$
Random People	2.46 (2.19)	2.71 (2.52)
Both familiar & random	3.35 (2.55)	3.71 (299)
IMing/Emailing	$2.48\ (2.34)_c$	$3.35\ (2.81)_d$
Facebook/Myspace	$2.01\ (2.01)_e$	$2.91\ (2.52)_f$
Text messaging	3.46 (2.65)	4.12 (2.79)
Talking on phone	2.07 (1.73)	2.28 (2.08)

Note. For each competing activity, means with different subscripts differ $p < .05$.

There was a multivariate effect of media across all dependent variables, *Wilks'* $\Lambda = .88$, $F(9, 136) = 2.01$, $p = .04$, $\eta_p^2 = .12$. As shown in Table 3, univariate analyses revealed that participants who read electronic media reported that they had roommate/family/friends around more often, $F(1, 144) = 7.53$, $p = .007$, $\eta_p^2 = .05$, responded to instant messaging/email more often, $F(1, 144) = 4.19$, $p = .042$, $\eta_p^2 = .03$, and used Facebook/Myspace more often, $F(1, 144) = 5.72$, $p = .018$, $\eta_p^2 = .04$, than did those in the print conditions.

4. Discussion

The results provide a rich set of observations to guide future research and development in addition to adding pause to current efforts to make e-textbooks ubiquitous. The results also offer promise with respect to learning as assessed by the most common form of assessment: multiple-choice items. We found that students in electronic conditions did not perform differently from those in the text conditions all levels of question difficulty. Encouragingly, this was the case in both lab and at-home conditions, although the students in the lab conditions performed slightly better on the quiz. This difference could be due to the immediate recall nature of the lab condition or to the inability to multi-task in the lab, as described subsequently. Not surprisingly, student GPA was positively associated with quiz scores and reports of student motivation, but we did not find any differences in students' self-reported motivation, enjoyment, or perceived comprehension of the material as a function of media or location. Although performance with various questions formats (e.g., essay, short answer, etc.) and taxonomies (e.g., Anderson & Sosniak, 1994; Bloom, Engelhart, Furst, Hill, & Krathwall, 1956) needs further investigation, these results provide support for the claim that e-textbooks may not differ from print textbooks with respect to student learning.

This performance with e-textbooks comes at a cost, however (see Table 2). Students in the electronic conditions generally took more time to read than those reading from traditional textbooks. We found this effect in both the highly structured conditions of the lab condition as well as under more realistic study contexts in the home condition. Additionally, the selection in the study was only a portion of a typical textbook chapter, and it is reasonable to infer that these time differences would increase as the amount of reading increased, as would subjective feelings of fatigue (e.g., Dillon, 1992). Importantly, the reported reading times in the home condition, while significantly higher for both electronic and print conditions, yielded dramatically variable results compared to print conditions. These larger and more variable values could result from additional multitasking (as discussed subsequently), poor recording of reading times, or intentional misreporting of reading times for students. Clearly there are important differences in how students interact with textbook materials at home, and these differences were magnified for electronically presented text.

Our data offer some suggestions for the increased time students reported reading electronic text. Although students in the lab were not able to multitask (anecdotally, however, we did prevent several students in the electronic conditions from trying to check email or social media), students at home were free to read anytime between receiving the material and taking the quiz, and they were free to engage in other activities as they chose. It is reasonable to speculate that students reading text from the same computer on which they check e-mail, Facebook, etc. may be tempted to pursue these same activities as they read. Indeed, we asked students to track and report their multitasking behaviors as they read. Although students in both electronic and print formats report multitasking as they read, students in the electronic formats were much more likely do so and, in particular, were more likely to engage in computer-based competing activities (e.g., chat/IM and Facebook/MySpace). Students are notoriously resistant to changing their study habits, even in the face of feedback about their ineffectiveness (Hattie, Biggs, & Purdie, 1996), and we would not expect their tendency to multitask in this fashion to reduce while on a web-connected electronic device. These findings about multitasking add a layer of user-oriented complexity to this issue. The manner in which typical users tend to interact with a given device is an important factor when considering the value of placing text on a multi-use electronic device. In addition to the design implications, more research is needed to determine whether there are greater effects on learning, efficiency, effort or other variables with larger sections of text, more complex material, and different assessments.

Given that students performed similarly on the quiz but took longer to do so in the electronic conditions, we wonder if students use different strategies for reading in each medium. Although the present study was not designed to address this issue in suitable detail, the evidence suggests that readers interact with text differently depending upon whether it is electronic or print. Although there were no differences between the groups on quiz scores, readers of e-textbooks took more time and rated different aspects of the product as useful. The reading time differences across formats, especially in the lab condition, evidence the possibility that students in electronic conditions interacted with the material using different strategies or, at the very least, faced different issues while reading. More research is needed to determine how students interact with electronic text in order to determine optimal design and strategy for learning.

As economic pressure and ease of access make e-textbooks an attractive option for students, faculty, and administrators, these results argue that much more research is needed before we can safely determine that they are equivalent to, let alone superior to, print textbooks. Indeed, our results demonstrate significantly more reading time involved when using electronic texts without the benefit of additional learning. The results also offer encouragement, however, in that the learning outcomes, albeit modestly measured, are achievable in this

medium. The challenge will be to design a more efficient and productive learning experience that leverages the positive aspects of the medium while minimizing some of the hurdles. Future research is needed to determine the manner in which learners tend to interact with electronic text in natural contexts and how e-textbooks can be designed to most efficiently maximize learning in this medium.

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