E-Book Efficacy and User Preference

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Abstract

The author reviews current research regarding the efficacy of electronic textbooks in relation to quantitative, performance based outcomes. Outcomes are generally found to be equivalent regardless of delivery format, with various minor advantages for digital formats regarding application to students with learning disabilities and in the area of time management. Included is an evaluation of the current research on student perception of electronic textbook usability and convenience. Students are found to have distinct preferences for print textbooks due to better mobility, readability, and non-linear navigation despite lower textbook costs.

*Keywords: electronic textbook, e-book, e-reader, test performance, student perception*
In the higher education classroom, the textbook is one of the many tools used for learning. In some courses, the textbook is central to class discourse. In other courses, the text is supplementary and acts as a guide for segueing among the topics covered. Whatever role the faculty chooses for the textbook to play in the course, instructors and students alike consider the textbook an essential learning tool.

In this digital age, the nature of the textbook is changing. Eighty percent of college and university students own laptops, and an increasing number are purchasing tablets, smart phones, and other handheld devices (Smith & Curuso, 2010). Recognizing the increased adoption of mobile devices, publishers are offering an increased number of textbooks in digital format. These digital texts, also called e-textbooks, can be downloaded on tablets, e-readers, smart phones, and laptops. Offerings and the adoption of e-textbooks via mobile devices is projected to exponentially grow within the next two to three years (Becker, 2010; Reynolds, 2011). Unfortunately, as is true with many technological advances, the educational research to support the efficacy of e-textbooks via mobile devices lags behind development and adoption.

Efficacy of technological tools has been measured in a variety of ways in education; the primary focus has been on cognitive growth and development. Past research has shown that the cognition can be influenced by the format of the text (Mayer et al., 2001; Morineau et al., 2005; Nelson & O’Neil, 2001); thus, suggesting that the influence of the e-textbook format on learning needs to be studied. To date, researchers have focused primarily upon faculty and student preferences of e-textbook formats in higher education environments (Clark, Goodwin, Samuelson, & Coker, 2008; Kang, Want, & Lin, 2009; Jamali, Nicholas, & Rowlands, 2010; Robinson, 2011; Shepperd, Grace, & Koch, 2008; Woody, Daniel, & Baker, 2010), and many of these studies do not exam the medium used to access the textbook (e.g. mobie-reader, tablet,
computer; Woody et al., 2010). Only a few studies have begun to examine the influence of e-textbooks on university students’ learning when used via a mobile device, and each of these researchers call for the need of more research in this area prior to widespread adoption of the digital textbook format (Connell, Baliss, & Farmer, 2012). An improved understanding of the efficacy of e-textbooks, specifically how they influence factors related to academic success, is needed. Thus, the purpose of this study is to examine the efficacy of e-textbooks as compared to traditional textbooks when used by residential and online university students for undergraduate and graduate coursework.

**Defining e-textbooks**

As the definition of an e-textbook varies, as does the format and location in which they are consumed, it is important to discuss definitions to understand what is being studied. Most research on e-books defines them as texts that are digital and consumed via screens (Jeong, 2012; Nelson, 2008; Vassiliou & Rowley, 2008). The majority of current e-textbooks come in two formats: page fidelity e-textbooks and reflovable digital textbooks (Chesser, 2011). Page fidelity formats are pictures of the print version of the textbook. An example is a PDF file with no dynamic media, linking, or font and picture manipulation. Page fidelity textbooks can be difficult to view or unavailable on handheld mobile devices (Chesser, 2011). Reflovable formats use a flexible format system allowing the software to modify the layout and features of the e-textbook to suit the display medium (Chesser, 2011). The latter are becoming more readily available and are the focus of this study.

The manner in which an e-textbook is consumed has been has also been discussed in the literature; e-textbooks are consumed in two environments, a static location and a mobile format. Sheppard et al.’s (2008) study demonstrates the examination of the e-textbook in a static
location. The e-textbook was distributed on a CD and needed to be installed on a computer, removing the potential use on handheld devices and, in essence, anchoring the product to a static location (Sheppard et al., 2008). Students who used the e-book rated the usability positively but rated convenience as unfavorable due to the lack of mobility (Sheppard et al., 2008). The interaction of readers with e-books in a static environment may soon be considered obsolete as current mobile delivery technologies have created more options that are potentially more viable. However, to date, much of the available e-textbook research has been conducted using static computer screens (Berg et al., 2010; Jeong, 2012; Morineau et al., 2005; Murray & Perez, 2011; Shepperd, et al., 2008; Shamir & Shlafer, 2011; Sun et al., 2012) versus newer portable technologies (Connell et al., 2010).

These newer devices which allow for mobile display options for e-books include laptops, net books, tablets, smart phones, and e-readers. Research is beginning to suggest that mobile formats have the potential to transform the interaction of students and e-books, in terms of both perception and reading experience, and are readily advancing so that limitations once noted are now removed. A Chinese study demonstrates the examination of the e-textbook in a mobile format, as Wu et al. (2007) evaluated students’ perceptions of three delivery mediums, personal digital assistant (PDA), an e-reader, and a notebook computer. Eye fatigue was diminished using the notebook computer in comparison to the PDA and e-reader, while reading speed and comprehension were not appreciably different (Wu et al., 2007). The study found that the most limiting factor in the use of the e-reader was the small screen size and small font size, causing the e-reader to less desirable to the students despite the perception of optimal mobility and flexibility (Wu et al., 2007). E-reader products and other mobile devices developed recently are
more advanced and, thus, may be more suitable for academic use and may continue to change the reading experience. A 2011 study found that one of the major drawbacks in older e-readers was the limited ability to navigate in a non-linear fashion, which is a vital ability when studying academically (Foasberg, 2011). However, current and emerging technologies for e-readers offer reflowable text and enhanced features to support academic use of electronic textbooks (Hoseth & McLure, 2012; Reynolds, 2011). As psychological theories on learning purport that there is a relationship between cognition and context (Thelen, Sch¨oner, Scheier, Smith, 2001) and as e-textbook become more readily available and features of the e-reader and tablets improve, additional research, especially in higher education, examining how learning is impacted not only by the electronic format, but also the technological medium, is needed.

**Existing Research on E-textbook Efficacy**

Textbooks are considered a learning tool and essential for understanding the variety of topics covered in a course (Bloom, 1987), and, as such, faculty members expect students to read their textbooks and demonstrate their knowledge on assignments and exams. As textbook reading is a cognitive process that may be affected by the nature of the text and the medium in which it is consumed, the efficacy of textbook format has primarily focused on cognitive measurements. Researchers have documented differences in reading speed and reading comprehension based on format.

Difficulty reading the screen is among the most cited limitation of the electronic book (Clark, Goodwin, Samuelson, & Coker, 2008; Gunter, 2005; Kang et al., 2009; Jamali et al., 2010; Jeong, 2012). Due to eye strain, electronic book users tend to read a chapter or less at a time and often print longer chapters and sections of the book to read (Nelson & O’Neil, 2001). Experimental studies demonstrate that reading long passages of information takes more time to
read when using an electronic format compared to a paper format (Dillion, 1992; Mayer et al., 2001). Dillion (1992) found reading from a screen increased reading time by 20 to 30%. During 25 minute reading sessions, Mayer (2001) found that readers have faster reading rate for paper text as compared to screen text. More recently, researchers have supported previous findings by reporting a slightly, although not significantly, longer reading time for e-books on handheld devices when compared to paper text (Connell et al., 2012; Kang et al., 2009).

While literature has documented that reading time is consistently higher when reading on screen, results related to reading comprehension and learning based on textbook format have been unequivocal. Morineau et al. (2005) studied 40 adults who were randomly assigned to read text from either a paper or an electronic format. Results demonstrated that participants in both groups had similar recall and ability to reinterpret information that they read, suggesting that retrieval of information is not affected by format. Connell et al. (2012), in a study of 201 undergraduate students randomly assigned to use an iPad or Kindle e-Book reader e-textbook, a tablet computer e-textbook, or a print version, noted no significant difference in reading comprehension on one posttest, further substantiating this. Aust, Kelly, and Roby (1993) and Kang et al. (2009) also found the similar results. However, other studies have demonstrated that recall and retrieval is poorer when reading from an e-text as compared with a print text (Jeong, 2012; Mayes, Sims, & Koonce, 2001; Noyes & Garland, 2003; Berg, Hoffmann & Dawson, 2010). Several reasons for these differences have been documented throughout the literature; passage length could influence the differences in results. Studies involving shorter reading sessions tend to indicate no substantial variance with respect to reading comprehension and understanding (Morineau, 2005; McFall, 2005). Studies involving longer reading passages indicate poorer comprehension. Eye fatigue and mental workload (Kang et al., 2009; Mayer et
al., 2001) may be two explanations for this. In terms of eye fatigue, Kang et al. (2009) noted that a notably lower contrast for handheld electronic device compared to the print version may contribute to eye fatigue. This research suggests that university students, who choose to read hundreds of pages of textbooks via a screen, may experience more eye fatigue and increased mental workload than their peers who choose traditional textbooks. This may thus result in spending more time reading as well as poorer comprehension; thus, this may negatively impact learning outcomes in courses. Researchers are only beginning to examine the influence on e-textbooks via mobile devices on university students’ learning.

**E-textbooks Efficacy in Higher Education Research**

To date, most research on e-textbooks in higher education has focused on use and preference. Recently, a few research studies that examined the influence of e-texts consumed via computer or laptop screens on learning (Berg et al., 2010; Jeong, 2012; Morineau et al., 2005; Murray & Perez, 2011; Shepperd, et al., 2008; Shamir & Shlafer, 2011; Sun et al., 2012) rather than mobile devices (Connell et al., 2012). Research that has examined the consumption of e-textbooks in reflowable format via mobile devices has been limited to the study of one passage (Connell et al., 2012). Although comparable results between the two formats have surfaced, students still prefer the print versions of the text.

Sheppard et al. (2008) examined 392 undergraduate psychology. Students who chose either electronic or paper based text according to their own preference. Most of the students choose to purchase the paper text (n = 330, 90%); only 37 (10%) choose to purchase the compact disc (CD) version of the text. When compared, the two groups did not differ in terms of their course grades and the e-textbook group - reported spending less time reading the their text. Although this indicates a potential ability to achieve similar levels of performance with reduced effort when an
e-textbook is chosen, the researchers caution students and educators in adopting e-textbooks as the e-textbook users did not rate their text favorable and reported that they would not recommend adoption (Sheppard et al., 2008).

Other research further substantiates the comparable effectiveness of e-textbooks compared to printed text when consumed via a computer screen in primarily static location as well as students’ preference for traditional printed textbook. At the Kennesaw State University Murray and Perez (2011), compared of the exam scores of 68 online students taking an asynchronous, online class. Thirty-two students were randomly assigned to read the printed textbook, and 36 students were assigned to read the e-textbook. Students did not differ in their scores on the two exams (Murray & Perez, 2011). Additionally, Sun et al. (2012) supports the Sheppard et al. (2008) findings that students prefer print text. The participants, 228 undergraduate students, had access to an electronic version of the textbook via a static computer screen and the option to a print version of the text for $15. Of the 228 participants, 137 reported using the electronic text during class and an increase in engagement due to the enhanced features available. However, students continued to prefer the print version over the e-textbook for their course work and reading.

**Purpose statement**

To date, research has demonstrated that students find digital textbook formats to be generally usable but not convenient due to lack of availability in mobile formats and restricted linear navigation inherent in the majority of older versions of mobile e-reader devices (Foasberg, 2011; Reynolds, 2011; Sheppard et al., 2008). The key to widespread adoption of e-book technology appears to rely mostly on the development of mobile devices and student exposure to
academic reading using these devices (Connell et al., 2012). Currently, little research exists on the how the use of e-textbooks, in reflowable format consumed via a mobile device, over a course semester influences learning. As such, defining efficacy as grades and perceptions about learning, this study sought to contribute to the body of literature and provide an improved understanding of how a text format influences the learning of university students. This research study investigated the following questions: (a) Is there a difference between learners’ perceived learning based on the format of textbook they choose for a course? (b) Is there a difference between learners’ learning (e.g. final grade) based on the format of textbook they choose for a course?

Methodology

Participants and Setting

The present study examined a convenience sample of 538 undergraduate and graduate residential and online students at a private university located on the eastern United States. During the Spring 2012 semester, participants in 59 education courses were sampled as they were enrolled in a course that offered the primary textbook in both a traditional print format and an electronic format. Students participating in the courses self-selected their textbooks prior to the beginning of the course. The volunteer rate was 53.2%.

Multiple areas of demographic information were collected, including data concerning age range, ethnicity, and academic level. The participants self-identified their ethnicity as Hispanic, (n = 17, 3.2%), African-American (n = 79, 14.7%), and Caucasian (n = 442, 82.2%).

The participants ranged in age from 20 to 69, with 142 (26.4%) ranging between 20 and 29, 126 (23.4%) ranging between 30 and 39, 137 (25.5%) ranging between 40 and 49, and 133
(24.8%) 50 and over. Undergraduate (n = 93, 17.3%), graduate (n = 277, 51.55%) and doctoral (n = 168, 31.2%) students were each represented in the sample population.

Four hundred and thirty two (80.3%) students choose to use traditional print textbooks; one hundred and six (19.7%) students choose to use e-books.

Students selecting e-textbooks tended to have less experience in the higher educational setting, with over 40% of the undergraduate participants selecting the electronic version, with most users in the 40-49 age range. This is compared to less than 20% of the graduate and less than 15% of doctoral level participants. With the majority of participants being Caucasian, it is no surprise the majority of e-textbook users were Caucasian. It is surprising that a higher percentage of traditional students selected the e-textbook compared to online participants. Half of the e-textbook participants continue to use laptops to access the text, but one out of four were most likely to use handheld tablet devices for access.

Students who used the traditional textbook format reported that they choose it for portability (n = 35, 8.1%); familiarity (n = 247, 57.2%); useful features (e.g. making note taking easier, dog earring pages, etc.; n = 36, 7.7%); the price (e.g. used or online purchase of text was cheaper than the e-textbook; n = 42, 9.7%); the ability to keep the traditional text after the course (n = 17, 4%); inability to buy the e-textbook with loan money (n = 16, 3.8%); difficulty reading from the screen (n = 16, 3.8%); and learning preference or style (n = 8, 1.9%). Fifteen students explained that they liked using e-textbooks, however, e-textbook formats differ and they did not
like the format offered for the present course. Nine of these students commented that the format was “too restrictive.”

One hundred and six (19.7%) students choose to use e-books. Students who used the electronic book format reported that they choose to adopt the electronic version for portability ($n = 17$, 16%), the price (less expensive; $n = 67$, 63.2%). Twenty two students (20.8%) reported that they adopted the e-textbook because the textbook company recommended it as an alternative and they wanted to try it.

Students self-reported concerning the device they most often used for accessing the e-textbook. As reflected on Table 1, almost 90% of the students reported accessing their e-textbook via a mobile device such as an e-reader, laptop, or tablet. A Of the e-book readers, 51 (48.1%) said that they would not adopt an e-book in the future, whereas 55 (51.9%) said that they would.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>What device did you use most often to read your electronic text?</th>
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<tbody>
<tr>
<td>Device</td>
<td>Most Frequently Accessed for Reading</td>
</tr>
<tr>
<td>No Answer</td>
<td></td>
</tr>
<tr>
<td>Desktop computer</td>
<td></td>
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<tr>
<td>E-reader (e.g. Nook, Kindle, etc.)</td>
<td></td>
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<tr>
<td>Laptop</td>
<td></td>
</tr>
<tr>
<td>Tablet (e.g. iPad, Google Android, etc)</td>
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</table>

The two groups used their textbooks in similar manners for studying. Sixty five percent ($n = 281$) of the traditional textbook group reported that they read their text word for word. Thirty five percent ($n = 151$) reported skimming their traditional textbooks. Sixty eight (64.3%)
of e-textbook group reported that they read their text word for word. Thirty eight (35.8\%) reported skimming their e-textbooks. A chi square analysis demonstrated that the e-textbook and traditional textbook groups did not significantly differ in the manner in which they approached reading their texts for the courses, p < .05. The e-textbook group ($M = 11.18$, $SD = 8.05$) and traditional textbook group ($M = 12.65$, $SD = 9.05$) did not differ in the number of hours per week that they reported using the textbook to study for their courses, $t (1) = 2.34$, $p = .13$.

Note taking styles varied considerably per group. E-textbook users were almost three times more likely to make notations directly into the text when compared to print text users. Both groups regularly used hand written notes on paper; however, print book users were more than twice as likely report, “I did not take notes.” Tables 2 show the comparison of participant note taking styles by print version users and e-textbook.

<table>
<thead>
<tr>
<th>Note Taking Style</th>
<th>Print</th>
<th>e-book</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Answered</td>
<td>8 (1.9%)</td>
<td>n/a</td>
</tr>
<tr>
<td>I did not take notes from the book</td>
<td>85 (19.7%)</td>
<td>8 (7.5%)</td>
</tr>
<tr>
<td>Type on Word document</td>
<td>93 (21.5%)</td>
<td>9 (8.5%)</td>
</tr>
<tr>
<td>Write in textbook / Type in text</td>
<td>49 (11.3%)</td>
<td>33 (31.1%)</td>
</tr>
<tr>
<td>Write on paper</td>
<td>197 (45.6%)</td>
<td>56 (52.8%)</td>
</tr>
</tbody>
</table>
Instrumentation

Students completed a web-based assessment that consisted of questions related to their textbook choices and learning. Grades were obtained from the Blackboard grade book. In each course a 1,000 point grading scale was used: A = 960–1000, A- = 940–959, B+ = 920–939, B = 890–919, B- = 870–889, C+ = 850–869, C = 820–849, C- = 800–819, D+ = 780–799, D = 750–77, D- = 730–749, and F = 729 and below.

The web-based assessment consisted of demographic and textbook related questions. The following question was asked about textbook choice, “What type of text book did you purchase or rent to use in this course?” Students were given two options, electronic textbook or traditional print textbook. The students’ answer to this question determined their grouping for the independent variable. The Perceived CAP Learning Scale (Rovai et al., 2009) was used to assess students perceived learning. The instrument is a 9 item self report measure that uses a 7-point Likert scale (i.e. 0 = Not at All to 6 = Very Much So). The Perceived CAP Learning Scale has 3 subscales, cognitive learning, affective learning, and psychomotor learning. The composite score ranges from a 0 minimum to a 54 maximum; each subscale score ranges from a 0 minimum to an 18 maximum. Cronbach’s coefficient alpha reported was .79, and construct validity is reported to be good (Rovai et al., 2009). In the present study, the Cronbach’s coefficient alpha coefficients for the each subscale, cognitive, psychomotor, and affective, is .49, .25, and .77, respectively. The Cronbach’s coefficient alpha coefficient for the full scale is .55. As the scale has fewer than 10 items, inter-item correlations were analyzed and found acceptable according to Briggs and Cheek’s (1986) recommendations of no less than .20 value.

Procedures
During the last three weeks of the identified course, students were sent an e-mail from the researcher forwarded by their course instructor. The e-mail requested that they complete an informed consent and web-based assessment. Grades of participants who signed the informed consents to participate in the study were obtained from the instructor’s online grade book once final grades were assigned.

**Results**

This casual comparative research study used a one-way multivariate analysis of variance (MANOVA) to examine if university students’ cognitive learning, affective learning, psychomotor learning, and grades differed based on their textbook format choice. Descriptive statistics disaggregated by group are presented in Table 3, and the correlations among the variables are displayed in Table 4. Correlation analyses yielded significant low to moderate correlations among all most of the dependent variables, \( p > .05 \).

**Table 3**

*Descriptive Statistics Disaggregated by Dependent Variable*

<table>
<thead>
<tr>
<th>Variable</th>
<th>ebook</th>
<th></th>
<th>Traditional Textbook</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
<td>((n = 106))</td>
<td>Group</td>
<td>((n = 432))</td>
</tr>
<tr>
<td>Cognitive Learning</td>
<td>11.78</td>
<td>2.97</td>
<td>11.37</td>
<td>2.11</td>
</tr>
<tr>
<td>Affective Learning</td>
<td>13.73</td>
<td>4.22</td>
<td>12.09</td>
<td>3.95</td>
</tr>
<tr>
<td>Psychomotor Learning</td>
<td>11.64</td>
<td>5.79</td>
<td>10.62</td>
<td>10.62</td>
</tr>
<tr>
<td>Grades</td>
<td>954.52</td>
<td>32.34</td>
<td>954.14</td>
<td>35.08</td>
</tr>
</tbody>
</table>

**Table 4**

*Variable Correlations*
Preliminary assumption testing indicated minor violations in assumptions. Histograms demonstrated that univariate normality was not tenable; there were modest violations in normality across all variables. Since univariate normality was not tenable, multivariate normality could not be assumed; however, when sample sizes are large (i.e., when both groups have > 25 subjects), the MANOVA robust to violations of the assumptions of normality (Diekhoff, 1992). Thus, a non-parametric alternative was not considered. The assumption of the homogeneity of variance-covariance was not tenable based on the results of the Box’s test, $M = 270.51$, $F(10, 156877.79) = 26.66$, $p = .00$. The results of Levene’s test of equality of error provided evidence that the assumption of homogeneity of variance across groups was not tenable for any of the dependent variables. Thus, a more conservative alpha level of .025 was set (Tachnick & Fidell, 2007). Additionally, Pillai’s trace was used as the reported statistic as it is a more robust when assumptions are violated (Tachnick & Fidell, 2007).

Results on the MANOVA yielded that statistically significant differences existed between the two groups on the combined dependent variables, Pillai’s Trace = .07, $F(8, 538) = 4.56$, $p < .01$, partial $\eta^2 = .03$. The observed power was high at .99. When results for the dependent variables were considered separately, using a Bonferroni adjusted alpha level of .005, affective learning and psychomotor learning between groups were found statistically significantly, $F(2,539) = 9.75$, $p < .01$, partial $\eta^2 = .04$, power = .98; $F(2,539) = 12.88$, $p < .01$, partial $\eta^2 = .

<table>
<thead>
<tr>
<th>Variables</th>
<th>Affective Learning</th>
<th>Psychomotor Learning</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Learning</td>
<td>.31**</td>
<td>34**</td>
<td>.07</td>
</tr>
<tr>
<td>Affective Learning</td>
<td>-</td>
<td>.40**</td>
<td>.25**</td>
</tr>
<tr>
<td>Psychomotor Learning</td>
<td>-</td>
<td>-</td>
<td>.37**</td>
</tr>
</tbody>
</table>

**p < 0.01

Variables

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<td>.37**</td>
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.05, power = .99, respectively. The mean scores indicated that students who used e-textbooks for their education courses had significantly higher perceived affective learning and psychomotor learning than student who choose to use traditional print textbooks. Grades and cognitive learning did not reach statistical significance, $F (2,539) = 19.80, p = .02$, partial $\eta^2 = .01$, power = .67 and $F (2,539) = 1.12, p = .328$, partial $\eta^2 = .01$, power = .25, respectively. Students’ choice and use of textbook format did not significantly influence their perceived learning or grades.

**Discussion**

As textbook publishers increase availability of electronic versions of textbooks and students become familiar with e-books and handheld devices, a dramatic increase in student selection of e-textbooks is expected (Smith & Curuso, 2010). This study is amongst the first to address efficacy of electronic textbooks during a semester long course, including users accessing the e-textbook via mobile devices. Moreover, this study is significant as it addresses traditional and online students’ use of e-textbooks at the undergraduate, graduate, and doctoral levels in higher education. Findings suggest students select electronic textbooks due to cost and portability, yet four out of five students overwhelmingly continue to prefer print textbooks due to familiarity with print versions and the ability to highlight text, “dog-ear” pages, and take notes. Students’ reports of reading techniques yielded comparable percentages for reading word for word and skimming, and there was no significant difference in course study time based on selected text version. However, actual self-reporting of student use of the two formats indicates the e-textbooks uses actually interacted with the text to a greater degree though the use of electronic features such as highlighting and note taking. This may account for the higher impact on perceived affective learning and psychomotor learning for e-textbook users. Nevertheless,
findings suggest students’ choice and use of textbook format did not influence their grades or cognitive learning in their residential and online courses.

This study seeks to add to the body of research concerning efficacy and e-textbooks at the higher education level. The small number of minority participants limits this study. The researchers suggest future studies in the areas of e-textbook efficacy should continue to examine student performance, student perceived learning, student populations at the graduate and post-graduate levels, and efficacy related to minority populations using e-textbooks. As student use of e-textbooks increases, more relevant research is needed to verify their reliability as educational tools.
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