Improving Learning with eTextbooks

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Abstract
eTextbooks offer the potential to change the way faculty teach and students learn. One approach to providing eTextbooks enables faculty to custom tailor traditional “flat” paper textbooks from major publishers by embedding videos and annotating them with comments. We conducted a lab study in which participants read a chapter in a computer networking book either in paper form, or using an etext system with annotations and a video embedded by the faculty member teaching the course using the book. We found that participants who used the etexts scored significantly higher on a test; the effect size was medium (.55). Interestingly, participants did not recognize that they learned more and perceived that the paper book better met their learning needs.

1. Introduction

A new generation of students is arriving at universities: the Millennials – students born from in the 1990s [1, 2]. This generation of “digital natives” embraces new technologies and information sharing, and they are astute networkers [1]. But this is not just about gadgets; Millennials have fused their social lives and use of technology in ways that are new and fundamentally different. They are characterized by: a) use and fluency with multimedia; b) comfort with expressing thoughts and feelings online; c) collaboratively seeking and synthesizing information and experiences; and d) co-designing learning experiences personalized to individual needs and preferences [3, 4].

Yet when they reach college, they are greeted with paper textbooks – many pounds and many dollars’ worth of them – and approaches to learning that their grandparents would recognize. These approaches to learning do not meet their expectations and more importantly do not take advantages of current technological capabilities for digital communication, something that Millennials have come to expect and value. There is broad agreement that the move to electronic textbooks is inevitable [5-7]; whether in two years or 10 years, at some point, the paper textbook will be a relic of the past.

So one key question is how can we use technology to improve teaching and learning? In this paper, we examine the use of one etext system called Courseload which is in use at several dozen colleges and universities. Prior research using this system has found that students prefer it to paper textbooks [8, 9]. In this paper, we examine how the use of this etext system affects student learning.

2. Prior Theory and Research

There have been high expectations for leveraging technology to improve education outcomes by transforming textbooks from paper to electronic. Most initiatives have taken one of two approaches. One approach has been digitizing existing flat print books. Most publishers now offer electronic versions of their books (e.g., PDF), and several vendors have emerged to sell these (e.g., VitalSource.com, CourseSmart.com, CafeScribe.com). The Kindle and the iPad also create opportunities to deliver these flat electronic books in new hardware formats. There have been several electronic textbook initiatives aimed at increasing the implementation and deployment of these flat e-books [e.g., 10]. These projects have met with a modicum of success because they were designed to provide access to a limited set of textbooks and materials. They offer limited cost advantages, but little promise of leveraging technology to improve learning outcomes.

Other projects have focused on completely rethinking what a textbook is. These projects have redesigned the “textbook” into a multimedia learning resource [11-13]. Many of these approaches have shown learning advantages but their high cost of production make them hard to scale [14]. These approaches may be useful for large market textbooks (i.e., for freshman courses) where their cost can be amortized over many users [14], but their cost makes them unrealistic for most traditionally sized courses. These projects are grand undertakings that are not scalable; it is difficult to rapidly deploy and integrate electronic materials using this model of building new content for each new textbook.
In our work, we adopt a different approach from these two. Research on the information technology has shown that it is best to never build new systems unless there is a clear competitive advantage to be gained [15, 16]. Individuals and organizations are better off buying or re-using existing systems, even if they are not a perfect fit. Innovation research has repeatedly shown that firms that focus on producing the best technology usually fail and are beaten by firms that focus on producing cheaper technologies that are “good enough” [17]. There are more than 1 trillion pages of material on the web [18], so for all but the most esoteric subjects, useful “good enough” multimedia content already exists, albeit scattered around the web.

Thus we believe the key to providing richer, more engaging multimedia content in a scalable way is not to create “ideal” new materials independent of the students in a one-size fits all model, but rather to enable instructors to easily find and embed existing content into textbooks (and remove content) to tailor those books to the needs of their students. That is, to enable instructors to tailor their textbooks to the learning needs of their students by finding the most appropriate “good enough” resources on the Web and integrating them directly into the textbook wherever they like.

The transformative aspect of information technology is not just in the way it changes the nature of content, but how it changes the way students and instructors interact with the content and with each other. Our vision for the rapid integration and deployment of electronic texts and other materials is not grounded in the traditional approach to developing new multimedia electronic textbooks. Instead, we build on sociocultural theories of learning [19-23] to exploit the social aspects of information technology, to enable instructors and students to tailor the learning experience to their needs, to expand education beyond the classroom setting, and to take advantage of Millennials’ comfort with technology and their expectations for social interactions. Our goal is to improve learning outcomes while lowering costs and without requiring existing textbooks to be rewritten.

Research suggests that the more students have the opportunity to think about and apply what they are learning, the greater the positive impact on learning as measured both by self-reports and objective tests [24, 25]. Pedagogical approaches that utilize student-centered active learning strategies as opposed to traditional teacher-centered strategies have been found to encourage greater cognitive effort on the part of students that can result in increased student learning [25, 26]. Typically, this includes all subject-matter related learning activities and experiences in which students are actively thinking about and engaged in both inside and outside the classroom [27]. Experimental studies that have compared the performance of students assigned to classes taught using traditional methods and those using methods that promote active learning have found that students who are more actively involved in the learning process have higher scores on objective tests [25, 28, 29].

We believe that electronic teaching and learning can improve learning in four distinct ways.

1) Electronic devices and the pervasiveness of network access enable the use of much richer, more engaging multimedia content than the traditional paper book and enable the instructor to tailor that content to the students’ learning needs. Providing multimedia content with different types of resources in different formats can help more students succeed [30, 31] because instructors (and students) can tailor the learning experiences to better fit students’ learning needs [32]. Mayer and Moreno [33] did extensive research on multimedia learning and found that in general students remembered material better if it was presented both verbally and visually.

2) Electronic content with instructor annotations creates new opportunities for instructors to communicate with students as they experience the textbook. Instructors can annotate electronic textbooks with their comments and share those comments with their students. These comments are scaffolding that can provide guidance to students beyond the classroom setting so that they focus their efforts on important content [34]. Instructors can augment the textbook with their interpretation and views, making it easier for students to understand and interpret the content. Annotations also provide opportunities for instructors to model expert practices by making their own practices visible to students [35]. The capability for students to experience instructor advice and commentary that is integrated with the reading of the electronic textbook provides opportunities not easily possible with paper textbooks that can improve learning [34].

3) Electronic content with student annotation enhances student interest, comprehension, and critical thinking. Learning is not a passive process where students simply receive information, but an active process in which students co-construct knowledge [19]. They build upon prior knowledge and experience as they make sense of the textbook, revising their own current understanding as they encounter new ideas and information and as they test their current schema [36, 37]. Annotation of texts can make an important contribution to both the cognitive and metacognitive aspects of learning. Underlining and highlighting may assist in recall [38, 39]. More complex annotation strategies, such as summarizing, paraphrasing, finding examples, and asking questions, contribute to
metacognitive monitoring and enhance learners’ self-regulation, recall, and comprehension [38-40].

4) Electronic content with shared annotation as a social medium enables students to communicate with each other and instructors in ways that create new opportunities for active learning. Social media have been embraced by Millennials through Facebook, blogs, and Twitter. Annotation becomes a social experience when students can share those annotations and ask questions of one another and their instructors directly within the electronic textbook. When they share those annotations with other members of the class, students may feel more conceptual control [41]. This also has the potential to increase engagement and active learning by inducing discussion and participation around the intellectual content in the textbook.

This technology was tested over a three year period at Indiana University [8, 9]. Most students (60%) said they preferred the electronic textbook to a paper textbook, but this choice varied dramatically from course to course (min 36%, max 84%). Students were significantly more likely to prefer e-textbooks when the instructor actively used the e-textbook (e.g., added their own annotations); student preferences were the lowest in courses where the instructor viewed the textbook only as a reference and made no use of it when teaching. There were no gender differences. Students were more likely to prefer e-textbooks in their second and subsequent courses in which e-textbooks were used, suggesting increased satisfaction as students became more familiar with the technology.

This prior research was able to examine student reactions to using the etext system, but did not examine student learning because it did not compare a course using paper textbooks to the same one using etextbooks. So one unanswered question is whether etext technology that provides these four capabilities to faculty and students can affect student learning.

In this paper, we present the results of a controlled laboratory experiment comparing students using paper textbooks to students using this etextbook system. This is an incomplete comparison of the etextbook system because we did not examine students’ abilities to make annotations or share those annotations with others because of the short duration of the experiment. Nonetheless, we believe that the use of the etext system should improve student learning.

3. Method

3.1. Participants

There were 56 participants, drawn from a general business course taken by juniors. Four participants had taken the course using the textbook used in this study (see below), so they were eliminated from the analysis, leaving 52 participants. Approximately 58% of the participants were male. Participants were randomly assigned to treatments.

3.2. Task

Participants read the first chapter in a data communications and networking textbook used in the business school’s networking course and took a quiz on the material. This course is taken by juniors and seniors and has used etextbooks for three years. The six participants scoring the highest grade on the quiz received $50 (three from each treatment).

3.3. Treatments

Half the participants (27) were given paper photocopies of the chapter. The other half (25) used the etext software on a desktop computer to read the same chapter. The chapter used in this study contained the same 13 annotations that the instructor teaching the business school’s networking course provided to his class when teaching the course. Most annotations identified which sections were important and not important, but one annotation contained a link to a four minute YouTube video produced by Cisco Systems for use in their Networking Academy. This video explained how the five layers of the Internet Networking Model work together to move messages across the Internet.

3.4. Dependent Variables

There were three dependent variables. The first was the score on a quiz, used to measure participant’s learning performance. There were 24 multiple choice questions and one open-ended question designed to test deeper understanding worth three points, for a total possible score of 27 points. All questions were taken from the Instructor’s Manual that accompanies the textbook. The remaining two dependent variables were participants’ perceptions measured using five-point Likert scale questions on a post-session questionnaire. They were: ease of use (5 questions, alpha=.75), and met learning needs (5 questions, alpha=.86). See the Appendix for the items.

3.5. Control Variables

We asked subjects their GPA. There were no differences in mean self-reported GPA between treatments and it was not significantly related to any dependent variable, so it was omitted from the analyses. There were no differences in the proportion of genders
between treatments and gender was not significantly related to any dependent variable, so it was omitted from the analyses. Likewise there were no differences in the proportion of those who had and had not used the etext system in a prior course. This too was not related to any dependent variable and omitted from the analyses.

3.6. Procedures

Participants first read the chapter either on paper or via an etext for 35 minutes. Participants in the etext treatment received instruction on how to use the software prior to reading the chapter. Participants then had 15 minutes to do the quiz. Finally, participants answered post-session questionnaires.

4. Results

Table 1 presents the results. Participants using the etext performed significantly better than those using paper textbooks (F(1,50)=4.14, p=.047). The effect size is .55, which Cohen calls a “medium” sized effect.

Interestingly, participants perceived paper textbooks to better meet their learning needs (F(1,50)=5.42, p=.024). The effect size was medium (.70). There were no differences in the perceptions of ease of use (F(1,50)=2.69, p=.107).

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<tr>
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<th>Paper Textbook</th>
<th>eTextbook</th>
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<tr>
<td>Quiz Score</td>
<td>12.96</td>
<td>15.44</td>
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<tr>
<td>Mean</td>
<td>3.76</td>
<td>3.29</td>
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<td>STD</td>
<td>.66</td>
<td>.78</td>
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<tr>
<td>Met Learning Needs</td>
<td>3.99</td>
<td>3.67</td>
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<tr>
<td>Ease of Use</td>
<td>3.99</td>
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Table 1. Means and Standard Deviations

5. Discussion

The use of the etext with annotations (instructor commentary and one multimedia learning video) improved participants’ learning, but, they perceived the etext to be worse at meeting their learning needs. This is an interesting split outcome, with participants not immediately recognizing the value from using etexts.

First and foremost, it is encouraging that even a brief use of this etext system that tested only two of the four possible contributions to learning (instructor annotations and multimedia) had an impact on student learning. The pattern of learning was consistent for both the multiple choice questions and the open ended question, with those using the etext system performing better on both types of questions (means of 14.04 vs. 12.41, and 1.40 vs. 0.56, respectively).

However, participants did not recognize these learning effects. They perceived that the etext system was not as effective at meeting their learning needs as the paper textbook. There are at least two plausible explanations for this finding. First, the software enables students to highlight and make their own annotations in the book. In this study, we did not show students how to highlight or take notes, so none did. In contrast, we noticed that about a third the students using paper textbooks made some notes on the paper copies, although most of this was underlining (i.e., highlighting). It is possible that that the lack of highlighting and annotating resulting the lower opinions of the etext software.

An alternative explanation is that it takes time for participants to effectively use any new technology after it is initially adopted; there is a learning curve [42, 43]. When individuals adopt a new technology, they must change their work processes (learning processes in our case), so initial performance and satisfaction after the introduction of a new technology often drop as individuals adapt their old work processes to effectively use the technology. Over time, performance and satisfaction gradually improve as “practice makes perfect” [43, p. 753]. Thus measuring performance and perceptions the first time new technology is employed may lead one to conclude that its use impairs performance and satisfaction, when in fact improved performance and satisfaction may only emerge after the user has employed it over time and moved down the learning curve [44, 45].

This study measured performance and satisfaction after only 35 minutes of use while participants were still adapting to the new technology. There was an immediate performance improvement, but satisfaction was lower. Prior research has shown that satisfaction with etexts is higher the longer students use it; students who used the system two semesters were more satisfied than those who only used it for one semester [8, 9]. Both of these studies examined courses in which the instructor (not the students) chose whether or not to use etexts. The decision to use etexts for one semester or two semesters was not up to the student, and thus is independent of the students’ opinions of the etext system. Thus we believe that the lower satisfaction observed in this study reflects an initial drop in satisfaction which is typical following the introduction of a new technology as students adapt their learning to the new system.

Thus we conclude that student satisfaction is likely to drop immediately after the introduction of etext software because students must adapt their learning styles to the new processes enabled by the technology.
The short length of the experiment precludes any comment about how satisfaction might change over time, although past research suggests that students will be at least as satisfied (if not more satisfied) with etexts as paper textbooks over the long run [8, 9].

Although this study suffers from the usual limitations of laboratory research, we believe it has two implications for future research and practice. First and foremost, since the provision of a modest number of instructor annotations and one multimedia instructional video embedded in the text improved student learning, we encourage instructors to adopt this style of teaching.

This study used both instructor annotations and one video, because this is how this chapter is normally taught during the class on this topic. As a result we are unable to determine which had more impact — annotations or multimedia. More research is needed to understand how students respond to both types of additions to the textbook and how this impacts their learning. It may be both are equally important, or that one is more important than the other for certain students.

There is probably some ideal number of annotations and videos for any given piece of content. One might expect a declining marginal benefit for both. This suggests that good practice would be to include a modest number of annotations and videos, depending upon the nature of the content and the availability of videos on the Web. This too is a topic for future research; we would hypothesize that too few would provide limited learning value, but the provision of too many could overwhelm students and begin to degrade learning. But we need empirical evidence and guidelines for practice.

Second, students perceived that the etext software did not meet their learning needs as well as paper textbooks. This may be because we did not show students how to highlight and annotate using the etext software or because user satisfaction often drops after the adoption of new technology as they adapt their processes to it. Both explanations are plausible. Future research is needed to better understand which is the primary explanation for this initial drop in user perceptions.

5. References


Regardless of which explanation is the best, we believe there are two implications for instructors using etext software. First, instructors should help students adapt their study processes to the new technology. The focus here is beyond showing students how to use the software. This is a necessary but not sufficient first step. The goal is to help students change their study processes to take advantage of what the etext software can provide. This means 1) reading instructor annotations and using the multimedia resources instructors make available; 2) making their own highlights and annotations; and 3) sharing those highlights and annotations with other students and reading other students’ annotations to better make meaning of what the text has to say. By taking advantage of the etext software’s capabilities, students can engage more with the text, and learn more as a result.

Second, instructors should be prepared for an initial stage of dissatisfaction with the etext software. Change is never easy and changing study habits to encourage students to engage with text materials is likely to prompt some initial drop in satisfaction. Once this initial change process is past and students engage more with their texts, satisfaction is likely to increase, as past research on the semester long use of etexts shows [8, 9]. However, some short term discomfort is to be expected.

Etexts have the potential to change the way faculty and students teach and learn. Past research has shown that students prefer paper textbooks to etexts when the etext are simply digital reproductions of the paper textbook (i.e., PDFs). However, past research also shows that students prefer etexts to paper texts when instructors annotate the text and embed multimedia resources from the Web into the text and when students highlight and annotate the text and share those with others. This study shows that a modest number of instructor annotations and multimedia video can improve student learning. Taken together, we believe these results are encouraging for the future of learning, as it inevitably goes digital.

Generation, EDUCAUSE Publishers, Boulder CO, 2005
[6] Knowledge@Wharton, "Electronic Textbooks? You Bet", Forbes.com, (March 5), 2010,


Appendix – Questionnaire Items

Ease of Use
It was easy to use the textbook.
This textbook was easier to read than other textbooks I have used.
The textbook was clear.
I was comfortable using the textbook.
This textbook was more difficult to read than other textbooks I have used. (Reversed)

Met Learning Needs
My learning needs were met by the textbook.
Using the textbook was effective for learning the material.
The textbook was compatible with the way I learn.
The textbook gave me the freedom to learn the way I want.
I was able to learn efficiently using the textbook.