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RESEARCH ARTICLE

The adoption of mark-up tools in an interactive e-textbook reader

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Abstract Researchers have more often examined whether students prefer using an e-textbook over a paper textbook or whether e-textbooks provide a better resource for learning than paper textbooks, but students' adoption of mark-up tools has remained relatively unexamined. Drawing on the concept of Innovation Diffusion Theory, we used educational data mining techniques and survival analysis to examine time to adoption of highlights, notes, annotations, bookmarks, and questions in an interactive e-textbook reader. We found that the only tool that more than half of the participants used was highlighting. Students who purchased a printed copy of the textbook had longer average times to using notes and annotations. Because most of the more interactive tools were used by a relatively small number of students, regression modeling of the factors associated with tool usage was difficult. However, there was evidence that the likelihood of using the tools decreased as the semester progressed, and that students' self-reported reading behaviors and grade point average were predictive of the time to using the mark-up tools. An interaction between bookmark usage and amount of reading was positively associated with course grades, suggesting that a strategy of bookmarking with frequent reading could assist students to learn content successfully. The implications of this research are that (1) instructors may need to more directly scaffold the adoption of interactive e-textbook tools that are touted as boosts to student learning and (2) promoting adoption early, shortly after students begin reading the e-textbook, is critical for students to acclimate to using the tool.

Keywords Interactive · E-textbook · Technology adoption · Survival analysis · Diffusion theory

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Introduction

E-textbooks and digital content systems are evolving into interactive platforms that enable learners to mark-up material to help them retain information. These interactive tools are supported by reviews of research about learning with educational technology, which have found that there are greater effects for technologies that support student cognition rather than just provide information (Schmid et al. 2009; Tamim et al. 2011). For example, researchers have been able to develop supports for student learning with digital course materials, such as web-based pedagogical tools that were effective in supporting student self-regulated learning (Dabbagh and Kitsantas 2005). But learners may not recognize the opportunities to use such tools without explicit instruction in how to use them (Azevedo 2005; Winne 2010). Thus, there is a demonstrated need for instructional technologies to be developed and implemented according to the principles of sound instructional design. Indeed, educational technology has been defined as a "practice" centered on supporting student learning through "creating, using, and managing appropriate technological processes and resources" (Januszewski and Molenda 2008, p. 1).

Many e-textbooks available to learners are not "page-fidelity e-textbooks", which are generally static PDF copies of paper textbooks, but digital course materials that include more interactive tools that are designed to support student learning (Rockinson-Szapkiw et al. 2013a, p. 260). However, researchers have less often examined the adoption of the interactive tools designed to support student learning with e-textbooks. Prior research has centered largely on whether students prefer an e-textbook over a traditional textbook (e.g., Brunet et al. 2011; Jao et al. 2005; Shepperd et al. 2008; Woody et al. 2010) and whether there is a difference in learning outcomes between students who use an e-textbook and students who use a paper textbook (e.g., Brunet et al. 2011; Kim et al. 2010; Woody et al. 2010). Although e-textbook providers tout the addition of mark-up tools, such as highlights, notes, and bookmarks, as boosts to student learning, there has been little research about students' adoption of such tools. There is sufficient evidence to warrant the promotion of adopting these tools, for the effective usage of highlighting and note-taking in digital course materials can promote student learning (Ponce et al. 2012). The current study investigated the factors associated with earlier usage of the mark-up tools in an interactive e-textbook system, for presumably students must adopt these tools for there to be any learning benefit from using them. In our study, in which we examined adoption in courses across multiple disciplines, we explored whether the adoption of such tools differed according to how e-textbooks were used by instructors in different disciplines.

The research described in this article has practical significance for educators. The adoption and usage of learning tools in interactive e-textbooks are an important focus for instructors and educational technologists in higher education because they are becoming more prevalent. In lower-division science and engineering courses, for example, many institutions have adopted digital learning platforms such as the Mastering products from Pearson or LaunchPad by MacMillan. These products invariably include e-textbooks with interactive features, in addition to the quizzing and testing functions that are often attractive to instructors of large science and engineering courses. Still there is evidence that the growth of e-books has not reached its potential because readers tend prefer paper materials for sustained reading activities even if the e-book is efficient for accessing information (see Stone and Baker-Eveleth 2013).

Review of relevant literature

Post-secondary students and learning from educational technology

There has been extensive research about the effect of educational technology on learning outcomes, and reviews of research have shown that uses of technology to support cognition had, overall, greater effects than uses of technology for presentation of content (Schmid et al. 2009; Tamim et al. 2011). Examples of technologies that support student cognition are those that support students' metacognition (Azevedo 2005) or ability to regulate their learning processes (Azevedo and Hadwin 2005; Winne 2010). Such technologies can prompt learners about when to apply specific cognitive and metacognitive strategies when learning with digital course materials and provide necessary scaffolds for applying those strategies effectively.

Still, one important feature of learning with educational media and technology is the necessity of using effective instructional design, which some researchers have called technological pedagogical content knowledge (Mishra and Koehler 2006). It is vital to explore how instructional technology is integrated into learning activities in such a way that best supports student learning.

College students now encounter an array of multimedia learning tools in a variety of courses, and students are often required to use such platforms that contain homework submission systems, e-textbooks, and other self-testing features. Such systems include Pearson's Mastering series, WileyPlus, and MacMillan's LaunchPad platform that are widely used in undergraduate science and engineering fields. But one open question is how well learners adapt to using such technologies that can include a variety of multimedia features, in addition to adaptive features that are designed to support student learning by guiding them through the process of learning complex material. It can be dangerous to assume that college students are "digital natives" that will easily adopt and adapt to learning technologies that may require a significant amount of training to learn to use effectively (Hargittai 2010; Helsper and Eynon 2010; Kirschner and van Merriënboer 2013; Wang et al. 2014). After all, reviews of research about learning with media have demonstrated the affordances of technologies such as books, which provide a certain "stability" of text that is useful to learners' who are consolidating material into long-term memory (Kozma 1991, p. 184).

Although there have been a variety of studies that demonstrate the value of educational technology for learning, students' learning strategies are also an important factor in the effective usage of educational technology for learning tasks. Learners who used more effective study strategies online achieved better learning outcomes, and this suggests that students should receive instruction in how to use different annotation tools in e-textbooks. For example, the SOAR (Selection, Organization, Association, Regulation) method is effective in improving students' learning in DCM (Jairam and Kiewra 2010). Learners who used a highlighting and note-taking instructional strategy in a computer-based learning environment achieved better learning outcomes than students who received traditional instruction (Ponce et al. 2012). Learners can more effectively recall material when they receive instruction in how to monitor their learning processes online (Bannert et al. 2008). Readers in the online format reported interacting more with the text through highlighting and taking notes (Rockinson-Szapkiw et al. 2013a). Although activities such as note-taking (which are more often incorporated into e-textbooks and digital learning systems) have been shown to be beneficial to learners in print (Kiewra 1989) and with online materials (Kauffman et al. 2011), prior research about the adoption of strategies has repeatedly emphasized the need to scaffold student adoption of strategies with learning from media, including textbooks (Caverly et al. 2000).

Factors affecting students' decision to adopt e-textbooks

One kind of educational technology that is commonly found in post-secondary settings is the e-textbook. E-textbooks have increasingly become popular options in higher education as educators seek to find alternatives to paper textbooks that have become, in general, very expensive (Ji et al. 2014). And, as we mentioned in the previous section, e-textbooks are included in comprehensive digital course materials that students use to complete required homework or quiz problems. However, despite the benefit of the increased amount of mark-up tools, students may not adopt e-textbooks even if they are cheaper than paper textbooks. When examining the decision to use an e-textbook along with the ratio of price of the paper verse the price of the e-textbook, Terpend et al. (2014) found that students would most likely adopt the paper textbook if the prices were equivalent. They also found that about 10 % of students would continue to adopt the paper version even if the price were 3.5 times the e-textbook. The authors argue that this is an indication that a minority of learners may be so fervently against using an e-textbook that they are willing to pay a premium price to continue using a paper textbook.

In addition to price, researchers have shown that students' prior experiences with e-textbooks as well as overall facility with technology are important factors in the decision process for adopting an e-textbook. Stone and Baker-Eveleth (2013) tried to determine why students who previously used an e-textbook would use an e-textbook in the future. They found that "perceived usefulness of e-texts" and "satisfaction with e-texts" were both directly related to students' intentions to use an e-textbook in the future. The researchers argue that one implication is that faculty who want students to not abandon using e-textbooks should assess students' attitudes toward using them (Stone and Baker-Eveleth 2013, p. 988). Students' reported frequency of reading text on a computer and looking up information while reading were associated with the decision to use an e-textbook (Woody et al. 2010). Learners were more likely to succeed in using an electronic learning platform when the assigned tasks were easy to complete given the available technology (Hyman et al. 2014).

Although e-textbooks would appear to have many advantages over paper textbooks in terms of being able to access it from any location with an Internet connection, researchers have found varying attitudes toward using e-textbooks. While some researchers have found that students preferred using an e-textbook over a paper textbook (Woody et al. 2010), others have found that students encounter difficulties in learning from e-textbooks or computer material (Ackerman and Goldsmith 2011; Daniel and Woody 2013; Noyes and Garland 2006). In one study of how well students learned from an e-textbook or a paper textbook, the students in the e-textbook group learned as much as the students who used a paper textbook, but the students learned less efficiently because they reported spending more time reading their e-textbook (Daniel and Woody 2013). Ackerman and Goldsmith (2011) found that participants assigned to the screen-reading study condition of an experiment had poorer metacognition than students who read a hardcopy text. Undergraduate students had difficulty seeking information from an e-book, treating it more like a web page and not recognizing that it had supportive features such as an index (Berg et al. 2010).

E-textbook usage and student learning outcomes

Various researchers have examined how e-books can support cognition. Students who used an e-textbook did not have significantly different learning outcomes (Rockinson-Szapkiw et al. 2013a; Shepperd et al. 2008; Woody et al. 2010). Worm (2013) conducted a study in

which nursing students were randomized into three groups that each received a different type of instruction: a simple e-book, an eCase method, and classroom instruction. Worm found students in the e-book group achieved the same gain in simple recall of knowledge than the other two groups but performed worse on a measure of complex learning. The author suggested that the e-book was just as effective as classroom instruction for lower-level learning activities.

Although there is some evidence in the literature that learning outcomes are similar, some studies suggest that students using e-textbooks are less likely to apply effective strategies or have effective metacognition (Ackerman and Goldsmith 2011; Daniel and Woody 2013). When reading on screens, learners can have more fatigue during demanding tasks (Dillon et al. 1988). In a study of 10th graders from primary schools in Norway, researchers found that students who read paper texts achieved better results on a reading comprehension tests than students who read an electronic text (Mangen et al. 2013). One important issue for the future relevance of e-textbooks in learning environments is how to ameliorate the effects of distraction due to multi-tasking in on-screen behaviors. Some research with elementary-age children has shown that interventions can be useful for promoting better information retrieval from e-books (Liang 2015), and in one study, students who used a visual cue map had a better experience with completing navigational tasks in an e-textbook (Li et al. 2013).

Research about interface and usability

An important aspect of research about e-textbook adoption has been centered on the interface or usability of an e-textbook. The interface of an e-textbook presented different functionality to users depending on the Internet browser they used, and researchers found significant usability issues with respect to using the highlighting tool (Cuillier and Dewland 2014). In a study of undergraduate students who used e-books, the researchers believed that difficulty with using an e-book interface was leading to an unwillingness to read e-books (Hernon et al. 2007). Researchers have consistently found that students may prefer using an e-textbook for short-term tasks like selected reading (Abdullah and Gibb 2008a) or the ability to find information easily in an index (Abdullah and Gibb 2008b).

One strand of research about the interfaces of e-textbooks has been how different platforms could affect the usability of an e-textbook or the ways in which a learner interacts with the interface. In a study of the OpenDSA digital platform for learning computer science, students did not often use tablet devices to access the system (Fouh et al. 2014). In a study of faculty and graduate student usage of e-books, researchers reported that users were more concerned with the usability of the e-book rather than the extra multimedia (Cassidy et al. 2012). Orientation to using e-books is essential to helping users adjust to interfaces and use them effectively (Berg et al. 2010).

Students' adoption of mark-up tools in e-textbooks

Although e-textbooks often include mark-up tools that enable note-taking, highlighting, bookmarking, and other features for organizing content, researchers have not often explored the adoption of these tools that are designed to support student learning. There is little research about the outcomes of training students to use special mark-up features in e-textbooks. Indeed, prior research suggests that to use a textbook effectively, students need to develop skills, not only in effective reading, but also on how to mark-up a textbook in ways that support learning (for a review, see Caverly et al. 2000). Researchers have

specifically examined how effective textbook reading strategies include techniques for preparing the text for later review. Caverly et al. (2000) reported that a variety of studies of textbook reading strategies have shown that underlining (highlighting) may not be helpful with material that is more demanding or places a greater cognitive load on the reader.

Bookmarking is a mark-up strategy that is supported by theories of learning and metacognition. Effective learners are able to regulate their learning processes and not only make plans for learning abut also determine how best to learn with the available tools (Azevedo and Hadwin 2005; Winne and Hadwin 1998). Students reported how using tools such as searching and bookmarking supported their learning (Kissinger 2013). Teaching strategies like bookmarking in an online e-textbook may be critical for promoting effective recall of information.

In a case study of how an instructor used an interactive e-textbook system, Cuillier and Dewland (2014) found that one of the most popular features among students was the notes that were added to the e-textbook system. However, despite the fact that students appeared to appreciate having access to instructor's annotations, they still did not believe that the e-textbook was superior to using a traditional textbook. Cuillier and Dewland (2014) found that most students in the end-of-semester survey indicated that they would prefer to use a traditional textbook. And more than half of the students in the course disagreed with the statement "By using the e-textbook instead of a traditional textbook, I did better in this class."

As summarized above, much of the research has centered more specifically on preference and the overall impact of e-textbook usage on learning outcomes. It is vital to examine students' usage these e-textbook tools in more detail to learn about how students adopt them and when. Indeed, if such tools are important indicators of students' engagement with online content, then earlier adoption may be a vital component of students using an essential learning tool throughout the academic term. The added value of an e-textbook is the potential for students to use an array of tools that help them to consolidate new information in digital texts, and we hypothesize that early adoption of such tools in the semester would be essential for creating a habit of successful annotation of an e-textbook.

Conceptual framework

The conceptual framework for this study is Innovation Diffusion Theory (IDT), which has been shown to be an effective lens for the analysis of how users take up a certain innovation (Rogers 1995). This framework was appropriate for our analysis because this e-textbook system was new to the university during the time frame of this study. Rogers (1995) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 12). The adoption of an innovation, according to this framework, is a process of obtaining information about the information until the reasons for adopting outweigh the uncertainty that an individual has about an innovation. But this framework also stresses the examination of factors related to non-adoption of a technology, which was important for this study as other researchers have found that learners cite problems with studying on screen (Mangen et al. 2013; Mizrachi 2015; Noyes and Garland 2005, 2006; Woody et al. 2010), and students who use an e-textbook course may not utilize the mark-up tools (Cuillier and Dewland 2014). This framework was also particularly suitable because diffusion scholars frequently investigate the differences between early adopters and late adopters (Rogers 1995). Other researchers have adopted this framework to investigate the adoption of technology innovations. For example, Hardgrave et al. (2003) found that an

organizational mandate to implement a specific methodology for software developers was not enough to ensure the adoption of the innovation.

Other researchers have used the technology-acceptance model (TAM) to examine the factors associated with a subject's intention to use a certain technology (Davis 1989, 1993) and the adoption of evidence-based teaching practices (Lund and Stains 2015). The TAM posits that perceived ease of use and perceived usefulness are associated with likelihood to adopt a specific technology. Researchers have used this framework to examine the factors associated with faculty members' uptake of instructional technologies (e.g., Buchanan et al. 2013). For our study, we specifically examined learners' prior attitudes toward using e-textbooks and the ways in which they read paper textbooks to help us understand the likelihood of adopting certain tools in the interactive textbook.

We also draw upon the literature of organizational change—particularly within STEM education—to frame our analysis of the introduction of an innovation and its effect upon the faculty members and students who were the first to experience it. In general, effective change strategies are those that involve careful programs designed to change the beliefs of individuals over a period of time, while at the same time recognizing and addressing the situational factors that mediate a person's ability to change (Henderson et al. 2011). In an examination of successful change strategies in higher education in STEM, researchers found that promoting successful change in education involves the collaboration of faculty to develop reflective teachers (Henderson et al. 2010). Thus, the literature on successful organizational change is complementary to IDT in that sustained adoption of innovations depends on effective communication strategies and frameworks to promote adoption after the "innovators" have carried out their adoption.

Method

Research questions

Our research study about the time to adopting interactive e-textbook features was guided by the following research questions: What are the factors associated with time to students' first use of the mark-up tools in an interactive e-textbook? What is the relationship between frequency of tool usage and final course grades? We selected time to first usage because the time that students begin using mark-up tools in an e-textbook is important for the establishment of a procedure for learning from the e-textbook. E-textbook vendors often emphasize the value of special mark-up tools that enable students to mark up their e-textbooks and share those annotations with others, but we are not aware of an in-depth exploration of the factors that may facilitate that adoption of e-textbook tools earlier in the academic term.

Participants

Courses

This IRB-approved research study was conducted in conjunction with a pilot project involving e-textbooks at a major school in the Midwest. The data we collected were part of another study that examined how students reported using e-textbooks and paper textbooks for their learning. As part of the pilot project, the students received a free e-textbook for the duration of the semester. All students were granted access to the e-textbook through the university's course management system, so all students who were part of the study had free

access to the e-textbook for their courses. At the beginning of the semester, a graduate student from the office of academic technologies visited each course to provide students with a brief tutorial about how to access the e-textbook and use the mark-up features. The researchers received permission from participants to collect the measures of their e-textbook usage directly from the company that provided the e-textbooks to the different courses that were included in the pilot. It was a pre-condition for participating in the study that the instructors assign at least one half of the e-textbook to their students.

We collected all records of students' reading and usage of the mark-up tools. The reading data were necessary for this analysis, for it determined when students began accessing their e-textbook and when they stopped accessing it.

Instructors

To learn about the context of students' usage of their e-textbooks, we conducted semi-structured interviews with the eight instructors who were part of the research study. This research method was appropriate for we wanted to learn about how instructors planned to integrate the e-textbook into the design of their courses; qualitative research methods are appropriate for understanding how people perceive a phenomenon and how they make sense of it in their everyday lives (Merriam 1998). The pseudonyms of the instructors and the basic course information are included in Table 1. One semi-structured interview occurred at the beginning of the semester, and one occurred at the end of the semester. The purpose of the interviews was to learn about whether the instructors had taught with an e-textbook before, how they planned to use the e-textbook in the course, and their overall impression of the e-textbook system after the course. All interviews were transcribed.

We analyzed the interview transcripts by reading all of them and taking notes about how instructors described their usage of the e-textbook. We then categorized the different kinds of usage of the e-textbook and used this information to augment the quantitative data for the survival analysis.

Students

Table 2 includes the demographic characteristics of the 274 students who had read their e-textbooks. These students (who were primarily undergraduate students) were recruited from eight courses that used an e-textbook in the common, interactive e-reader that was tested in the pilot project. These courses comprised social sciences, business, and education.

Table 1 Instructors' disciplines and prior usage of e-textbooks

Instructor	Discipline	Prior e-textbook usage	Students	Tool usage required
Brown	Education	No	22	Yes
Roberts	Humanities	No	17	No
Martin	Humanities	Yes	8	No
Crawford	Business	No	49	No
Simpson	Social science	No	31	No
Little	Social science	No	22	No
Neill	Education	No	72	No
Powers	Business	No	53	No

Table 2 Summary characteristics of e-textbook readers (N = 274)

	n	Mean	SD
Age	255	21.62	2.26
Cumulative GPA	254	3.28	0.28
ACT composite	204	24.97	3.43
Gender			
Females	169		
Males	88		
Year			
Graduate	8		
Senior	162		
Junior	75		
Sophomore	8		
First-year	1		
Non-degree	3		

In our analysis of the data about who read the e-textbook, which was provided by the e-textbook vendor and which will be fully described in the methods, we determined that not all students read their e-textbooks and that some who read their e-textbooks had dropped their course or taken an incomplete. There were records for reading for 274 of the 287 students in the study. Thus, thirteen students did not read their e-textbooks. Of these thirteen students, six had dropped their courses, but seven had remained in the course and received a grade (so our assumption was that these students used a resource other than their e-textbook). We excluded these thirteen students from the survival analysis because they never read their e-textbooks and therefore did not have the opportunity to use the interactive tools. In addition, two of the 274 students who had read their e-textbooks received an incomplete in their courses, and one student who read the e-textbook withdrew from the course. We included these three students in the study because they did read their e-textbooks and had the opportunity to use the tools.

This resulted in a data set of 274 observations for students who had read their e-textbook. However, nine students were enrolled in two classes, and one student was enrolled in three classes. We decided to keep these duplicate records in the data set because their inclusion did not excessively violate the assumption of independence that is required for survival analysis methods (Hosmer et al. 1999). We calculated the survival curves and produced the survival estimates for both groups of students: students who participated in the study once and students who participated in the study more than once. We found that there was no significant difference between the two group's median time to final date of reading, $X^2 = 0.0058$, $p < .94$. Thus, we were reasonably confident that the students who were in the study more than once were not reading their e-textbooks for longer or shorter durations than the students who were not duplicates in the study.

Collection of demographic data and baseline information about textbook usage

We collected from the university's registrar demographic information (gender, year in school, and race and ethnicity), measures of prior learning (cumulative GPA and ACT composite and sub-test scores), and students' final course grades.

Table 3 Means on questions about textbook reading behavior

	n	Mean	SD
Asking self questions while reading	268	3.37	0.85
Looking up unfamiliar terms	268	3.38	1.06
Re-reading material	267	3.84	0.93
Skipping material	266	3.34	0.95
Relating reading to current knowledge	268	3.88	0.82
Discussing reading with others	268	2.87	0.92

We adapted items from the Reading Behavior Questionnaire (RBQ; Soifer et al. 1990) and administered them as part of a survey to determine students' perceptions of how they typically use e-textbooks. Our rationale for using this instrument is that it has been applied in other contexts to analyze adults' reading behavior (see Scales and Rhee 2001). The survey was administered at the time of subject recruitment in their classes. The RBQ were Likert-type items in a five-point frequency scale (1 = "Never"… 5 = "Always") and the summary statistics are included in Table 3.

Collection and organization of analytics data from e-textbook system

Data reduction: reading data

The e-textbook vendor provided a data set with all records of students' reading the e-textbook as well as ancillary material that a few of the instructors had uploaded into the e-textbook system. According to the e-textbook vendor, a page was counted as "read" when it was viewed for at least 10 s in the e-textbook system. Each observation in the data set included a timestamp and page number of the page that was read in the e-textbook. The data set included 76,217 observations of reading behavior for students in the e-textbook system. Because the emphasis of our study was to determine the factors associated with the time to adopting certain features in the e-textbook, we removed the observations for the ancillary material (e.g., articles not included in the e-textbook) that was uploaded in the system by two of eight instructors, which resulted in a data set of 75,748 observations for reading behaviors in the e-textbook.

Organization of mark-up data for e-textbooks

We collected all measures of usage of mark-up tools from the e-textbook vendor, which was an initial dataset with 29,638 observations of mark-up activity for the learners. To ensure that the data set was appropriate for our analysis, we conducted a thorough examination of the data to ensure that it only contained information about valid interactions with the e-textbook system. We classified the mark-up tools as highlights, notes, annotations, bookmarks, and questions. Table 4 includes the description of each tool.

In the process of cleaning the data set for analysis, we discovered a small number of duplicate records in the mark-up data. We found that certain highlights appeared more than once and verified that the exact same passage was included in both records. This may have been related to the fact that the timestamps in the data set included the time of the mark-up activity. For example, we found two duplicate instances of an 805-word highlighted section in the e-textbook system. The only difference in the two records was that the second

Table 4 Description of mark-up tools

Mark-up tool	Description
Highlight	Learner may use a highlighting tool to select and apply a color to text
Note	Learner may add text to a section of the e-textbook and view the note
Annotation	A note that is added to section of highlighted text
Bookmark	A placeholder that the learner could apply for easy access to the page
Question	A note that can be submitted to the instructor in the e-textbook

record had a time stamp of 1 m after the first one. We used SAS 9.4 to identify and remove 298 duplicate observations. We also excluded 76 notes without text in them. After making these deletions, we had a data set of 29,292 observations.

We also developed a procedure to account for the fact that some early usage of the e-textbook could be learners "testing" out the system. An analysis of whether certain mark-ups were deleted supported this decision. (The data set of mark-up behavior included a variable indicating whether the bookmark, annotation, note, highlight, or question was eventually deleted by the user, but there was no timestamp indicating when the deletion occurred.) Based on our analysis of when deleted mark-ups were created, we dropped the mark-up usage that occurred prior to week 2 of the semester. Our analysis showed that 19 % of the deleted highlights were created before week 2. In addition, 60 % of annotations and 40 % of the notes that were deleted were created before week 2. These are higher percentages that we would expect if there were no learning curve or a period of trying out the mark-up tools in the e-textbook system. After we removed these 3359 observations, our final data set included 25,933 observations from which to calculate the statistics related to time to first usage of each specific mark-up tool after the first week of the semester.

We included a procedure in which a colleague, who was not a member of the research team, received the full set of analytics for each course in the research study. He calculated, for each course, the mean and standard deviation of the number of total pages read (online and offline). This enabled us to determine whether the usage patterns of our research participants were significantly different from the entire population of the course. Under the assumption that both groups would have the same standard of deviation, we conducted independent samples t-tests to examine whether any means of tool usage were significantly different and did not detect any evidence of differences between our sample of students and the population of students in the eight courses that were part of the research study.

Preparation of data for survival analysis

Derivation of censoring and duration variables

We used survival analysis for this analysis because our primary research question was centered on determining the factors associated with earlier adoption of the mark-up tools in an interactive e-textbook system. Time-to-event analyses are more commonly used in educational research to examine educational attainment (e.g., Bahr 2009; Ishitani 2006, 2008) and teacher attrition (Kelly 2010). Ishitani (2008) argued that while it was important to study the factors associated with students' departure from postsecondary institutions, an understanding of the time of departure was essential to exploring and testing interventions that could facilitate students' integration in college.

The time to adoption of such tools is of great importance to instructors who provide students with educational technology that is designed to help them with their learning. With access to students' records of reading and marking-up their e-textbook, we were able to determine the 1) the time period between students' first and last date of reading their e-textbook and 2) whether a student used any of the five mark-up tools during that period.

We provide a brief example of a more conventional usage of time-to-event usage from biomedical research to define the terms origin, event, period of watching, and censored observation. We then will relate these terms to our own study. The Worcester Heart Attack Study (WHAS) was a study in which the goal was to examine variables and trends associated with how long people survive after having a myocardial infarction (Hosmer et al. 1999). In the WHAS the origin was the date of admission to the hospital. In our case the origin was the day that the student first accessed the e-textbook. For the entire period of the study, the WHAS investigators then "watched" each subject until the subject died or was lost to follow up. For our study, we observed students from the first reading date until the first usage of each tool or until the end of the semester. In WHAS, subjects who died were coded as having experienced the event of interest, and in our study students who used a tool were coded as having experienced the event. In WHAS, subjects who were lost to follow up or who were alive at the last date of follow up for the study were coded as censored observations because the researchers did not know if the subjects had died or not. And in our study, students who never used a tool during the period of observation were coded as censored observations. Table 5 is a description of how our usage of survival analysis compares to the terminology in the example of the WHAS study.

We selected the first date of reading the e-textbook to be the origin because this date represented the first time a student began using the e-textbook. The median date of first reading was August 22, 2012 (3 days after the beginning of the academic term), but the range of this variable was 126 days. Because students varied as to when they began reading their e-textbook, we derived a variable that represented the number of days between the beginning of the semester (August 19, 2012) and the date the student began reading the e-textbook. This variable allowed us to investigate in the regression model whether students with later entry times also had longer times to using the mark-up tools in the e-textbook system. We selected the end of the period of "watching" to be December 7, 2012, which was the last day of the last week of classes.

Survival analysis procedures require a variable that denotes whether or not an event occurred and another variable that indicates the length of time between the origin and the

Table 5 Description of terminology for survival analysis

	WHAS	Our Study
Origin	Day subject was admitted to hospital	Day that subject began reading e-textbook
How time is measured	Days	Days
Event of Interest	Death	First usage of mark-up tool
Period of "watching"	From date of admission until death or final date of follow up	From date of first reading until usage of mark-up tool or end of semester
Censored observation	Subject who is lost to follow up or is alive at last day of study	Subject who does not use mark-up tool before the earliest of last date of reading OR final day of semester

occurrence of an event or the time until censoring. The calculation of the duration variables differed depending on the coding of the censoring variable, which denoted whether the student had the event of interest (i.e., the use of a specific mark-up tool). For students who used a tool, the duration variable was the length (in days) between the first date of reading and the first usage of the tool after week 1. For those who did not use a tool, the duration variable was the length (in days) between the first date of reading and the last date of reading (or December 7, 2012 if the last date of reading was after).

Analysis of time-to-event data

After deriving the censoring variables and duration from first date of reading to the first date of using a mark-up tool, we estimated the survival functions for each mark-up behavior to compute the median time to first use of each tool and whether significant differences existed among the survival functions for each class in the study. We used the log-rank test in a statistical procedure in SAS 9.4 to estimate the Kaplan–Meier curves for each course, and we included a Tukey procedure for a test of multiple comparisons to assess the between-class differences among the different estimated survival curves.

For the regression procedures involving time-to event data, we used parametric regression models to estimate the coefficients of variables that were associated with longer survival times (i.e., longer times to using a specific tool). Each model was first tested to determine if an exponential distribution, a basic parametric model that is appropriate under the assumption of a constant likelihood of tool adoption over time (Allison 2012). We calculated the Lagrange Multiplier Statistic using PROC LIFEREG in SAS 9.4, and found that only the model for the question tool had a p value of .45. Thus, we did not have enough evidence to reject the exponential model as an appropriate fit. The other models had a reasonably good fit under the Weibull distribution, which allows for a non-constant hazard. This was appropriate given that our first analysis suggested that usage of tools drops off quickly after a period of about a month. We computed generalized R^2 for each model based on the log likelihoods of the null model (without any covariates) and of the full model. This is not like the statistic (the proportion of variance explained) for linear models with a normally distributed outcome variable, but it is a measure of the strength of the relationship between the predictors and outcome (Allison 2012; Hosmer et al. 1999). We converted the parameter estimates to the log-hazard scale so that we could calculate hazard ratios (HR) that were simpler to interpret.

Regression modeling of final grades

To examine the association of mark-up tool usage and final grades in the course, we built linear mixed models with a random effect for the course—the random effect accounted for the variance due to students being clustered in courses. We used a natural log transformation of "unique pages read" because the raw variable was right skewed, and we transformed the tool usage into a categorical variable. We first put cumulative GPA in the model to account for students' academic achievement, and then added the transformed variable of pages read and the variable for tool usage. We tested one linear mixed model for each tool, and we examined the residuals of the models to determine whether we were violating the assumptions of mixed-model linear regression. The model met the convergence criteria, and the mean of the residuals was very near to 0 (0.03), and less than 5 % of the standardized residuals had a z score of 2 or greater. We used RStudio to create a plot that illustrated the fixed effects of the model (R Core Team 2014).

Table 6 Median time (in days) to first usage of tool

Tool	Median	Events	Censored observations
Question***	Undefined	19	253
Highlighting	28	138	134
Note	Undefined	75	197
Annotation**	Undefined	57	215
Bookmark*	Undefined	90	182

Test of equality over strata: * $p < .05$, ** $p < .001$, *** $p < .0001$

Results

Table 6 shows the median time to first use of a mark-up tool and the results of the test of equality over the strata variable, which was the variable that we used to denote the different courses that participated in the study. Only one tool, the highlighting tool, had a median time to first usage because it was the only tool that at least 50 % of the subjects had used. However, the other tools have undefined medians because they were used by less than half of the students. There were significant differences among the estimated survival curves for the question, annotation, and bookmark tools.

One education course, taught by an instructor with the pseudonym Professor Brown, had a median time to first use of the question tool that was different from all of the other courses included in this study. Figure 1 is the Kaplan–Meier curve that shows the difference in survival time for Professor Brown's students versus all other students in the study. We combined the other courses because our multiple comparisons with a Tukey

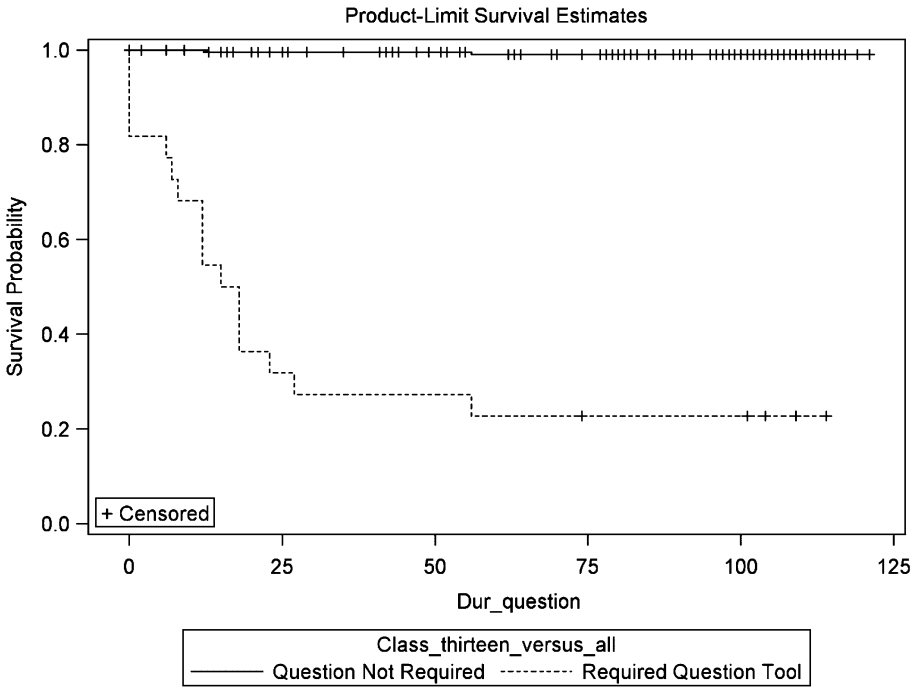

Fig. 1 Kaplan-Meier curve for time (in days) to first use of question tool

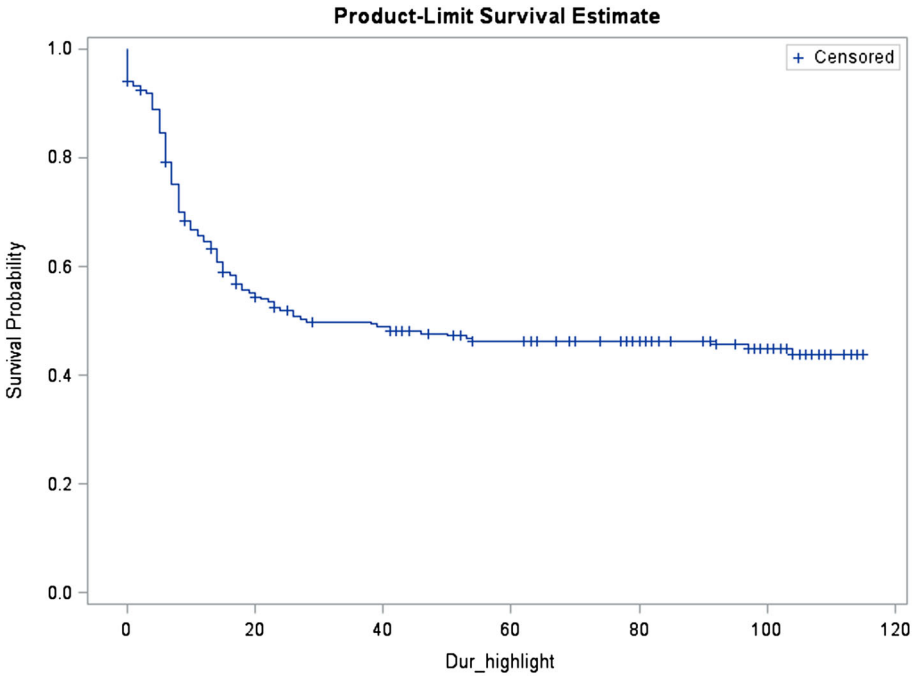

Fig. 2 Kaplan-Meier curve for time (in days) to first use of highlight tool

adjustment showed that only Professor Brown's class had a different survival curve—no other courses were different from each other at the alpha .05 level.

An analysis of the interviews with faculty members in the study showed that this professor had integrated the use of the question tool into the students' assignments. In an analysis of instructor adoption of e-textbooks (Van Horne et al., in progress), we reported that most of the instructors adopted the e-textbook for students to use as a free substitute for a paper textbook. But Professor Brown purposefully assigned her students to use the question tool for regular assignments in which they were supposed to submit "critical points" in the e-textbook.

The fact that most of the medians of time to first use of specific tools were undefined is instructive. First, it suggests that highlighting was the most commonly used tool. Under the assumptions of independence, the median time to first use of the highlighting tools was 28 days (approximately a month) after first time reading the e-textbook. Figure 2 shows the Kaplan–Meier curve for the time to first usage of the highlighting tool. Even though we dropped the usage of the e-textbook that occurred in the first week to account for students testing the system, this result still suggests that most students are not immediately highlighting their e-textbook after the beginning of the semester.

Regression modeling of time to using the mark-up features

The computation of the estimates of the Kaplan–Meier curves indicated that for all tools except the highlighting tool the median time to first usage was undefined. Although Kaplan–Meier estimates are useful for examining the general distribution of how long an

Table 7 Estimates for AFT Regression Models

	Annotation	Bookmark	Highlight	Note	Question
Intercept	19.19 (3.71)	12.37 (2.20)	5.77 (0.67)	7.87 (0.93)	4.21 (0.30)
Days between date of first reading and first day of term			0.09*** (0.02)	0.08* (0.04)	−0.06* (0.03)
Has not purchased paper (reference: purchased paper)	−2.10* (0.92)			−1.84* (0.90)	
Reading behavior questionnaire items					
Frequency of re-reading			−0.33* (0.16)		
Frequency of relating reading to things you know		−0.65** (0.23)			
Frequency of asking self questions while reading	−0.83* (0.31)				
Cumulative GPA	−1.83* (0.77)	−1.05* (0.53)			
Subject (Education vs. Science)	−2.32** (0.93)				
Subject (Humanities vs. Science)	−2.37† (1.29)				
Subject (Business vs. Science)		−1.07† (0.55)			
Course (Professor Brown vs. All Others)					5.57**** (0.84)
Scale parameter	1.63	1.61	1.65	1.87	1.00
AIC	395.78	554.40	708.80	521.91	91.52
Generalized R^2	.12	.11	.11	.04	.27

Standard errors in parentheses

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

event takes to occur, they are not appropriate for the modeling the associations that certain variables have with the likelihood[1] of an event occurring at a point in time. Thus, although this process provides an overview of the survival curve, it does not adequately account for within-subject factors that may also be associated. Thus, here we present the findings of the regression modeling, and the parameter estimates for the parametric Weibull models are included in Table 7.

Time to using the annotation feature

The annotation feature is a note used in combination with a highlighted section of text. We found that whether a student purchased a paper textbook, self-reported frequency of asking questions while reading, cumulative GPA, and the subject of the course were significant predictors of time to using the annotation tool. Compared with the science courses (the

[1] Although "hazard" is a technical term in survival analysis that is used when referring to the chance of an event occurring at a point in time, we will use the term "likelihood" in place of "hazard" to help the reader understand the findings in the following sections. But we will use "hazard ratio" (or its abbreviation "HR") when we discussing how the covariates are related to the odds of an event occurring at a point in time.

baseline course subject in the regression model), in which the usage of the mark-up features was not required, courses in education had a hazard ratio of 10.18, 95 % CI [1.70, 60.94], which reflects the much greater likelihood of a student in the education course using this specific mark-up tool. In Professor Brown's education course, students may have been much more likely to annotate their e-textbook to keep track of their ideas and be prepared to submit questions to their instructor. Students' self-reported frequency of asking themselves questions while reading was also predictive of the likelihood of using the highlighting tool. There was also a marginal effect for the Humanities courses, for which annotating may have been important for preparing for discussions. A one-point increase in the RBQ item about frequency of asking yourself questions while reading a textbook was associated with an 129 % increase in the likelihood of using the annotation tool, HR = 2.29, 95 % CI [1.23, 4.22]. A one-point increase in cumulative GPA was associated with a much greater likelihood (more than 500 %) of using the annotation tool, HR = 6.23, 95 % CI [1.37, 28.22].

Time to using the bookmarking tool

We found evidence that the time to using the bookmark feature was statistically significantly associated with cumulative GPA and self-reported frequency of relating reading in a textbook to current knowledge. In addition, we found a marginal effect for the business subject. The shape of the scale parameter (1.61) also suggested that the hazard decreases at an increasing rate, which again is supportive of the observation that students are more likely to start engaging in this mark-up behavior (if they do at all) toward the beginning of the semester. Figure 3 illustrates that, after 25 days, very few students used the bookmarking tool for the first time, suggesting that students are not likely to begin using new tools later in the semester—they may make decisions about tool usage relatively early in the term.

There was a significant association between time to first use of the bookmarking tool and the self-reported frequency of relating reading in a textbook to current knowledge. A one-point increase in this RBQ item was associated with a 92 % increase in the likelihood of using the bookmarking tool, HR = 1.92, 95 % CI [1.21, 3.00]. And students with higher cumulative GPAs also had faster times to using the bookmarking tool, HR = 2.86, 95 % CI [1.01, 8.17]. The bookmarking tool may have been useful for keeping track of important passages in the e-textbook because only one page was visible at a time in the e-reader.

The marginal effect for business courses could be related to the content type of the e-textbooks and how the courses were structured. Through the interviews with one business professor, we learned that the students solved problems in the course, and the instructor posted notes for students with information about practice problems (personal interview, December 20, 2012). Students in business may have used bookmarking more to keep track of pages with problems or notes from the professor, especially since it was difficult to see several pages at once in the e-textbook.

Time to using the highlight tool

Time to highlighting was associated with delayed reading time and students' prior usage of paper textbooks. For every one-day increase in the time a student delayed reading his or her e-textbook, there was a 9 % reduction in the likelihood of using the highlighting tool, HR = .91, 95 % CI [.87, .96]. For a point-increase in the frequency of re-reading, there was a 39 % increase in the likelihood of using the highlight tool, HR = 1.39, 95 % CI

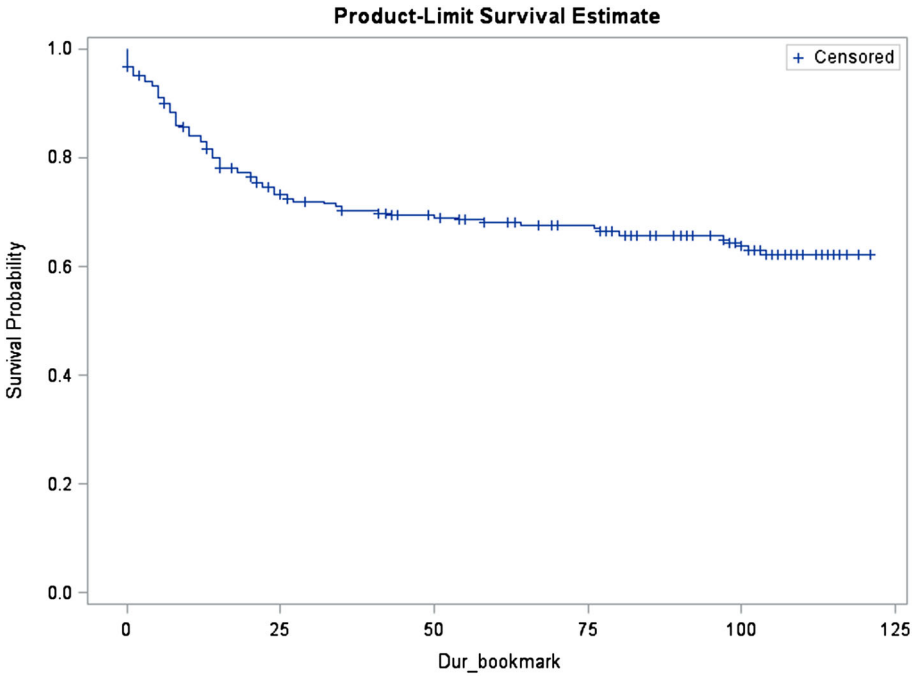

Fig. 3 Kaplan-Meier curve for time (in days) to first bookmark tool

[1.01, 1.92]. In addition the scale parameter of 1.65 suggests that the likelihood of using the highlighting tool decreases more rapidly. We did not detect a difference between the survival curves of the different course subjects for the time to using the highlight feature ($p < .33$).

Time to using the note feature

All other things being equal, students who did not purchase the paper textbook had 6 times the likelihood of making a note in the e-textbook, HR = 6.30, 95 % CI [1.08, 36.60]. This was an important finding because it suggests that important information about students' plans to engage in the e-textbook can be predicted by their decisions at the beginning of the term to adopt a paper textbook. There was also an effect for the time to starting reading after the first day of classes. After controlling for other factors, we found that an increase in 1 day in the variable representing time of first date of reading was associated with an 8 % decrease in the likelihood of making a note in the e-textbook system, HR = 0.92, 95 % CI [0.86, 0.995]. We did not detect a difference in the survival curves of the different classes for the time to first note ($p < .44$).

Time to using the question feature

Recall that Professor Brown's course had markedly different usage of the question tool behavior when compared to all other courses in the study. The only significant predictor in the model predicting time to using the question tool was the binary variable for the courses.

Table 8 Parameter estimates for fixed effects of model predicting final grade

Variable	Estimate	SE	t	*p*
Intercept	1.19	0.98	1.21	0.2673
Cumulative GPA (centered)	0.93	0.1	8.99	<.0001
Natural log of total pages read	0.04	0.03	1.94	0.17
Bookmarks (≥5)	−2.81	0.85	−3.29	0.001
Bookmarks (2–4)	0.89	0.77	1.16	0.25
Bookmarks (1)	0.13	0.5	0.26	0.79
Bookmarks (0)	–	–	–	–
Log Total Pages Read*Bookmarks (≥5)	0.44	0.15	2.99	0.003
Log Total Pages Read*Bookmarks (2–4)	−0.16	0.14	−1.16	0.25
Log Total Pages Read*Bookmarks (1)	−0.03	0.09	−0.33	0.74
Log Total Pages Read*Bookmarks (0)	–	–	–	–

The hazard ratio of 632.7 is almost meaningless from the standpoint of interpretation because Professor Brown's class was the only one in which students were required to communicate with the question tool, which is why this mark-up tool was modeled on the level of Professor Brown versus all other courses (rather than on the level of course subject). The descriptive results, described in Fig. 1, show that all other courses had practically no usage of the question tool.

Effect of tool usage on final grades

After controlling for students' grade point average, we found that number of bookmarks and its interaction with a natural log transformation of number of pages read was a significant predictor of learning outcomes in the form of final grade. This association may be related to the ability of the bookmarking tool to help students navigate e-textbooks and more easily access information. The parameter estimates for the fixed effects this model are included in Table 8. Our mixed-effects linear model did show that it was essential to incorporate a random intercept due to the intra-class correlation because the covariance parameter estimates showed a significant random intercept for course ($p < .05$). Figure 4 is a depiction of the effect of the interaction of bookmarking and reading on final grade in the course. For students in the greatest category of bookmarking usage (5 or more bookmarks), the more that they read their e-textbook, the greater, on average, their final grade.

Discussion

Adoption of mark-up tools in an interactive e-textbook platform

To summarize the main findings, we found that students' adoption of mark-up tools in an e-textbook was associated with how students reported typically reading a textbook, how early they accessed their e-textbook for the course, whether they had purchased a paper textbook, their cumulative GPA, and differences between courses. In our study, price was not a barrier to adopting the e-textbook because the e-textbook was free, so these results are from a case in which all students were able to access and use the e-textbook. In

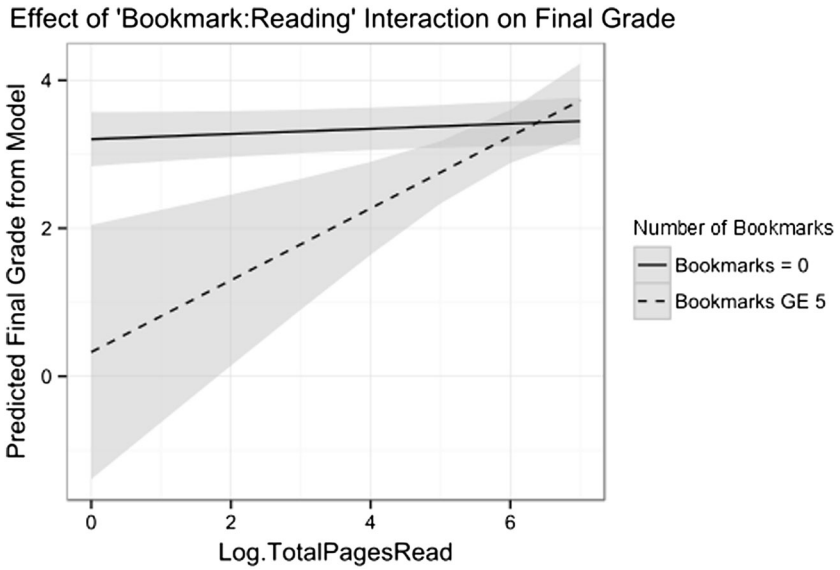

Fig. 4 Effect of "Bookmark:Reading" interaction on final grade (fixed effects)

addition, the courses that were part of this study were from education, the humanities, and social sciences, so our results are from a study of e-textbook usage in different disciplines.

We believe this research contributes important findings for the study of how college students use the interactive features of e-textbooks in their learning activities. Whereas almost all of the students had read their e-textbooks, the usage of most of the interactive tools was not common. The highlight tool was used by the most students, and it was the easiest tool for students to use for it did not require the addition of text to the system. Prior research has demonstrated that highlighting is the most frequent behavior in studying (Caverly et al. 2000). In contrast to the use of the highlighting feature, the median times to using the other mark-up tools were undefined, indicating that most students never used the tool. This research supports the findings of another researcher who found that students rarely used the interactive tools in the e-textbook platform (Cuillier and Dewland 2014). And it also complements the research of Berg et al. (2010) who found that students who accessed an e-book did not have the conception that the e-book could be used like a print book and were, therefore, not likely to take advantage of some features (such as the index) in the e-book. Indeed, more recent work involving eighth graders who used a COMPASS e-textbook showed that the ability to navigate the e-textbook was not associated with reading ability, suggesting that ability to navigate is a separate skill (Sullivan and Puntambekar 2015).

One feature of this e-textbook pilot was that students received some introductory training on how to use the basic highlighting, annotation, bookmark, and note-taking tools. And yet, the adoption of the question tool in Professor Brown's class was entirely due to her requirement that students use that tool. We suggest that introductory training may not be sufficient for promoting the adoption of the tools that enable students to interact with the content of their e-textbooks. Indeed, prior work on how innovations spread through a community has emphasized the importance of change agents and peer-to-peer networks that enable potential adopters to learn about how a new technology may benefit them (see

Rogers 1995). In this case, we may see what can be called two-stage adoption, which is characterized by a majority of users who adopt the basic usage (that is, reading the e-textbook) but a more significant second stage involves deeper interaction with the technology. Thus, addressing the teaching practices within specific disciplines when assisting instructors to teach with e-textbooks can help ensure that the adoption of mark-up tools is situated appropriately (Henderson et al. 2011). With respect to e-textbooks, instructional technologists may need to consider communication strategies or course-based interventions that are likely to be persuasive to learners. For example, training for students could emphasize an introductory unit in which students are required to use the mark-up tools so that they can develop a familiarity with them. An additional communication strategy could be in the form of a "think-aloud" protocol in which an instructor or instructional technologist demonstrates effective usage of mark-up tools while narrating the decision process for using each tool.

One key finding of this study was that purchasing a paper version of the e-textbook was associated with a reduced likelihood of using the note feature in the e-textbook. Thus, instructors who adopt e-textbooks may find it beneficial to determine whether there is a traditional-textbook version of the e-textbook and how many students purchase it. This could have consequences for instructors who want students to leverage the electronic resources in the e-textbook. If an instructor expects students to post and share notes in the e-textbook—a common feature of e-textbooks nowadays—there may need to be focused attention on how to scaffold students' adoption of these tools.

This study also suggests that only asking students whether they have used e-textbooks previously may not suffice for determining whether students will use the learning tools in a new e-textbook. In our study, 23 % of the participants had reported using an e-textbook previously at the university. But in our regression models, prior e-textbook usage did not enter at the alpha .05 level of significance. We suggest that instructors and instructional technologists must go further than only assessing whether students have prior experience; rather, they should determine students' typical reading behaviors and design interventions based on how students report that they interact with their textbooks (or with e-textbooks they have previously used). Our findings that certain measures of reading behaviors was predictive of time to adopting mark-up tools is significant for those who are seeking to facilitate the adoption of e-textbooks in their courses. According to Rogers (1995), an "authority innovation-decision" is a process by which a person or group of persons can mandate adoption, which is akin to what happened with the question tool in Professor Brown's course. One important question for further inquiry would be whether these students, who were mandated to use this tool in their course, continue to use this tool (or a similar one) when usage is not required.

Importantly, increased usage of the bookmarking tool, coupled with more total reading, was predictive of students' final grades after controlling for prior learning. Such a reading strategy may be very useful in an age in which students need to develop strategies for effectively accessing and learning information in e-textbooks. But our research shows that most students did not use the bookmarking tool, so educators must scaffold the adoption of useful tools in order to receive the benefits of using them.

Implications for instruction with interactive e-textbooks

This research supports the notion that learners, the so-called "digital natives," may need scaffolding for the adoption of mark-up tools in an interactive e-textbook. To be specific, as part of the course learners may need to carry out several activities in which they are

provided structured guidance on effective note-taking, bookmarking, and annotating in an interactive e-textbook. An advance organizer could include not only information about e-textbook content, but a checklist or other information on how the learner can use mark-up tools effectively (Morrison et al. 2013). Such scaffolds—implemented early in a term—could help promote familiarity the tools and knowledge about how to use them effectively. Our research complements findings by Helsper and Eynon (2010), who questioned the empirical evidence that supports the notion that facility with learning technologies can be explained by "generation" alone. This finding has also been supported by various researchers (e.g., Hargittai 2010; Kirschner and van Merriënboer 2013; Wang et al. 2014). The one course in which students adopted the question tool was a course in which the use of the tool was required by an education professor who wanted to promote dialogic communication. Thus, the importance of the instructor is paramount for widening adoption of interactive e-textbook tools that may promote dialogic communication among students. Otherwise, learners may not understand the purpose of these tools.

Instructors often have access to analytic information in the form of dashboards that present summaries about learners' behavior in an e-textbook system. Since this particular system counted a page as read after only 10 s, it is possible that instructors could receive an inflated estimate of how much reading activity is occurring. A typical textbook page can likely only be skimmed in 10 s. Thus, instructors need to properly understand what is being counted and what it may actually mean, as it could be very different from an initial assumption. Instructors should be cautious of how databases "measure" usage and how this relates to adoption or interaction with the materials.

In our study, we found that one of the courses that adopted the question tool—and in which students had much faster times to adopting the tool—was an education course. The professor in this course had specifically wanted to facilitate dialogic interaction among students, and, in addition, wanted students—many of whom would be future educators—to interact with the tools and have the experience of using an e-textbook. Our work, therefore, supports the findings of Hora and Holden (2013) who argued that the adoption of instructional technology is associated with the context of the instructor's discipline and that of Mishra and Koehler (2006), who call for technology adoption to be in support of the best strategies for teaching in a specific content domain.

One important strength of this study was that we studied the adoption of educational technology in a set of courses that used the same interactive, e-textbook reader. The finding that frequent bookmarking coupled with reading the e-textbook was associated with an increase in course grade is instructive for several reasons. First, it is aligned with recent reviews of research on learning with educational technology in which scholars found that technologies that better support cognition have better effects on outcomes (Schmid et al. 2009; Tamim et al. 2011). Bookmarking in this environments could provide an effective support for cognition and self-regulated learning in an environment in which finding information could be challenging for learners (Winne 2010).

Importantly, increased usage of the bookmarking tool, coupled with more total reading, was predictive of students' final grades after controlling for prior learning. Such a reading strategy may be very useful in an age in which students need to develop strategies for effectively accessing and learning information in e-textbooks. There is an existing research about self-regulated learning and how it supports cognition (Pintrich and Zusho 2002). Learners that have skills in self regulation are able to focus their behaviors and motivation toward the goal of improving their outcomes (Pintrich 1999). Learners who used an e-textbook were more likely to use self-regulated learning strategies that learners who opted to use a traditional textbook (Rockinson-Szapkiw et al. 2013b). In addition,

bookmarking can support learning in an e-textbook by assisting students with segmenting their activities in the e-textbook by enabling them to more deliberately and easily access relevant material.

This research does suggest that learning with tools in interactive e-textbook platforms should be taught from an early age. This complements the findings of Sullivan and Puntambekar (2015), who suggested that instructors should facilitate students' ability to reflect and plan navigational strategies when using e-textbooks. Indeed there is a growing body of research that emphasizes the distinction between instructional strategies that support reading comprehension and those that support strategies for effective navigation (see Salmerón and García 2011). Indeed it may be vital to not only provide instruction on how to use specific tools (which is usually just a "point-and-click" exercise") but also to use these tools within the context of reading and navigating an e-textbook. For selecting the correct tool and using it appropriately during reading is more important than knowing how to use a tool in an abstract way that is separate from the meaning-making process.

Another implication of this research is for the development and marketing of interactive tools for learners who are adopting e-textbooks or similar digital learning platforms. The experiences of students in these platforms should be communicated to the companies that develop the platforms. Companies may find it beneficial to suggest specific strategies and scaffolding to promote the adoption of these tools if indeed they do promote learning. In addition, better communication with instructors about the necessity to scaffold students' adoption of such tools could help to ensure that instructors put in place the proper support for students who are learning to learn with these tools. Instructors are often not able to determine the rate of adoption of mark-up tools or other interactive tools to support learning in e-textbooks, and instructors could be more informed about how to design their learning activities if they had better information about how adoption and usage of specific learning tools was associated with successful learning outcomes.

Limitations

This study was important to conduct in a natural educational setting for we were able to examine how e-textbooks were used in actual educational settings. One limitation of this study is, naturally, that the study was conducted with a convenience sample of students who had access to free interactive e-textbook. For that reason, we were unable to design an experiment in which we could test the effectiveness of different interventions designed to promote adoption of mark-up tools. We also did not have a procedure for norming the Reading Behavior Questionnaire, so it could be that the results from using that method are not reliable. But the Questionnaire items are taken from a published study about reading behavior, so we believed it was appropriate for this analysis.

One limitation was that we did not collect data about students' prior usage of mark-up tools in an e-textbook or paper textbook; we only collected data about whether students had previously used an e-textbook in a college course. Although we did not detect any relationships between the times to first usage of the mark-up tools and whether students used an e-textbook before, we may have benefited from asking students who had used an e-textbook before whether they had adopted mark-up tools or just used the e-textbook for reading.

Another limitation was the amount of censored observations in all of the analyses. A preponderance of censored observations can contribute to problems with model fit, and there was some evidence from our analyses that the Weibull distribution may not have provided an adequate fit, for the generalized R^2 values were relatively low. However, the

estimates in the models were statistically significant and were interpretable, so we still believe that the parametric survival models were informative and useful for this analysis.

Conclusion

The study of the time to first usage of the mark-up tools in an e-textbook system can be understood in terms of the broader context of e-textbook adoption in higher education. The time to adoption of such tools is of great importance to instructors who provide students with educational technology that is designed to help them with their learning. On one side, there are intricate e-textbook systems that afford learners a variety of options for annotating their e-textbooks and sharing e-textbooks with others. But educators and educational technology companies may be incorrectly assuming that students will adopt these e-textbook tools on their own. On the other side, there are e-textbooks that are plain substitutes for traditional e-textbooks (such as the free e-textbooks that are sometimes found in MOOCs). And students may access these plain e-textbooks for the information they need to complete the task at hand. Our conclusions from this study would suggest that it is vital to do more than just provide learners with an interactive e-textbook that boosts learning through the adoption of mark-up tools—we must examine the rate of adoption and provide interventions that address obstacles to effective adoption.

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