

High school learners' continuance intention to use electronic textbooks: a usability study

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Abstract

E-textbooks are often considered as having several advantages over printed textbooks. However, research shows conflicting results regarding school learners' satisfaction with e-textbooks. In South Africa a particular e-book platform, EduBook for e-textbooks, is currently used in 170 schools across the country. In this study the satisfaction and continuance intention of 10 learners from a South African high school where cross-subject implementation of the EduBook platform was piloted, were considered. In this mixed method study, a control group of 7 non e-textbooks users from other schools were used to compare the findings. Guided by the adapted ECM model of Baker-Eveleth and Stone (2015), quantitative data was collected through eye tracking tests and qualitative data was collected through individual interviews and a focus group discussion. The findings confirm the influence of usability, expectations and perceived usefulness on satisfaction and continuance intention to use the e-textbook platform. In addition, it highlights post-adoption expectations created by cross-subject implementation and its influence on learners' satisfaction. The important role played by the way in which teachers use the platform is emphasised and learners provided useful suggestions on how teachers can be prepared and assisted in the use of the platform.

Keywords

e-textbooks, continuance intention, satisfaction, eye-tracking tests

1. Introduction

It is easy to list the advantages of introducing e-textbooks in South African schools. Printing textbooks are expensive and the distribution throughout the country requires a mammoth administrative effort. Textbooks are damaged easily and children are not allowed to make notes in them. E-textbooks provide a solution to all of these problems.

Today's children are 'digital natives' and hence generally comfortable with technology. It would therefore be fair to assume that they would welcome e-textbooks as a replacement for printed textbooks. There are however conflicting results in this regard. In a study conducted by Woody *et al.* (2010) involving 91 learners with an average age of 19, learners did not prefer e-textbooks to paper textbooks regardless of experience levels and age. (Woody et al., 2010) Weisberg (2011), on the other hand, reports on learners' increased receptiveness to using e-textbooks over the three years of a longitudinal study.

We are interested in how South African teenagers in particular experience e-textbooks. A number of schools in South Africa have over the past three years moved from traditional printed textbooks to a fully digital system. Currently, more than 170 schools and over 50 000 children are using the EduBook e-textbook platform developed by EduX (pseudonym) – an educational technology consultancy located in the Gauteng province. In most of these schools, the use of the EduBook platform is mandatory for both learners and teachers. Some research has already been done on the adoption of this platform. Weilbach and Matthee (2015) focused on the problems experienced by teachers while implementing the EduBook platform in their classrooms. The findings of this study emphasised the importance of understanding the 'ecology' of the school as was predicted by Olson and Sullivan in 1989, when implementing e-textbooks. The findings also show that regardless of the use of the platform being mandatory, using it to its full potential is not a given.

Sobero and Eikebrokk (2008) link the underutilisation of a system to the well-researched concept of continuance intention. Continuance intention simply refers to the continued use of technology. In a voluntary context, continuance intention transpires as a willingness (or not) to continue the use of the system. Sobero and Eikebrokk (2008) argue that although a lack of will to use the system cannot lead to discontinued usage in a mandatory environment, it may lead to dissatisfaction and underutilisation of the system or even to job dissatisfaction. Continuance intention therefore remains an important concept in technology acceptance studies, even of mandatory systems, as is the case of e-textbook implementation in schools described here.

Baker-Eveleth and Stone (2015) adapted the expectation-confirmation model (ECM) of Bhattacherjee (2001) to explain continuance intention to use e-textbooks. The adapted expectation-confirmation model of Baker-Eveleth and Stone (2015) suggest usability, perceived usefulness, expectation-confirmation and satisfaction as determinants of the continuance intention of users. The concept expectation-confirmation refers to the discrepancies (or not) between users' initial expectations of a system and its actual performance after adoption (Thong, Hong, & Tam, 2006). The factors listed by Baker-Eveleth and Stone provide a useful starting point towards the understanding of the continuance intention of e-textbook users.

In this article we report on a study that used a mixed method approach to evaluate 17 children's interaction with the EduBook e-textbook platform interface. Through eye tacking observation, individual interviews and a focus group discussion we established the children's point of view and discuss this with reference to the adapted expectation-confirmation model (ECM) of Baker-Eveleth and Stone (2015).

2. Problem statement

Educational technology is increasingly used in elementary and high schools worldwide and more specifically in South Africa. A particular e-book platform, EduBook for e-textbooks, is currently used

in 170 schools across South Africa. Although the EduBook e-textbook system is designed not to disrupt the teachers' practices, ensuring efficient use implies some adjustments. Weilbach and Matthee (2015) and Eicker and Matthee (2014) reported on the adoption issues as reported by teachers and how these changes impact the broader school environment. The first study is an example of a problematic implementation – the researchers found that the problems could not only be ascribed to usability and usefulness matters of the EduBook e-textbook platform, but also to internal political tensions in the school. Although Eicker and Matthee's study (2014) included the views of five grade 10 learners, the focus of the study was not on the learners but rather on the school environment as an activity system. Some usability and practical issues were also highlighted. This study was conducted in 2012 on a pilot roll out of the EduBook e-textbook platform. Since then, a number of updates have been released seeing improved interfaces and functionality that make the system more sophisticated. As the previous studies did not primarily focus on the view of the learners, further research is needed. Daniel and Woody (2013) and Joo, Park and Shin (2017) believe that the perceptions of learners (as important end users) regarding the use of e-textbooks are urgently needed to improve its effectiveness and use. Against this background and within this context, it is worthwhile to investigate learners' satisfaction with the EduBook e-textbook platform and their willingness to continue using the system to its full potential, i.e. their continuance intention.

The questions we address in this article are therefore:

1. How usable do learners consider the EduBook e-textbook platform to be?
2. What do learners' satisfaction and continuance intention to use e-textbooks depend on when implementing e-textbooks across subjects in high schools?
3. What role does expectations play in the overall satisfaction of the learners regarding the system?
4. What does this mean for the general continuance use of e-textbook platforms in schools?

3. Literature study

3.1 E-textbooks

E-textbooks and printed textbooks both present learning material to learners, teachers and lecturers. The main difference between these is the additional functionalities contained in an e-textbook, enabled by e-learning and e-publishing technologies. Gu *et al.* (2015) consider an e-textbook as a transition from traditional printed textbooks to electronic books, integrating multimedia and incorporating interactive functions, such as a glossary lookup, bookmarking and searching. Learners can customise their learning experience through note-taking, highlighting and generating summaries based on their own understanding, but they are also able to collaborate with each other and other learning communities through the e-textbook platform. However, not all e-textbooks are created equally and existing e-books vary between a richly enhanced interactive reading environment (such as an e-pub version) and so-called page fidelity books (which simply provides a scanned-like version of printed books, such as .pdf versions) (Lim & Hew, 2014; Rockinson- Szapkiw, Courduff, Carter, & Bennett, 2013)

The limitations of e-textbooks centre around hardware issues such as limited storage capacity on certain devices, limited battery life and limited power outlets in classrooms (Embong, Noor, Hashim, Ali, & Shaari, 2012). Furthermore, teachers and educators may lack skills in the use of e-textbooks in the classroom; learners may not find the reading pleasure that they experience when reading a traditional printed book; the reading time on a screen tends to be longer compared to that of printed text; and learners may suffer from eye fatigue when reading on screens for long time periods (Embong, Noor, Ali, Zulqarnain, & Amin, 2012; Lim & Hew, 2014; Rockinson- Szapkiw et al., 2013; Sun, Flores, & Tanguma, 2012; Van Horne, Henze, Schuh, Colvin, & Russell, 2017).

On the contrary, the advantages of e-textbooks are numerous and include, inter alia, the ability to store huge amounts of materials in one place; a lighter burden to carry; a complete keyword searchability (Nicholas & Lewis, 2011); a fun-learning experience due to additional features; and the possibility to monitor the development of learners closely and appropriately (Embong, Noor, Ali, et al., 2012). According to Sun *et al.* (2012) the additional features provided by e-textbooks contribute to the perceptions learners have of the helpfulness of an e-textbook with regard to its resourcefulness, usability and the degree to which they find it interesting and playful (enjoyable).

3.2 Continuance intention

In an attempt to address the lack of focus in Information Systems (IS) research on the long-term viability of information systems, Bhattacharjee (2001) proposed a model to explain continuance intentions of IS users. He drew on existing consumer behaviour literature that explains consumers' intention to continue usage of services or to repurchase products. His proposed model, the expectation-confirmation model (ECM) is based on the expectation-confirmation theory (ECT) from the marketing literature. ECT states that consumers' intention to repurchase a product is based on their satisfaction of prior use of that product (Bhattacharjee, 2001, p. 353). User satisfaction, in turn, is determined by the discrepancies (or not) between users' initial expectations of a product and the performance of the product. Bhattacharjee argues that continuance intention of IT users follows a similar pattern and subsequently proposes that a user's intention to continue the use of IT depends on three variables: 1) the user's satisfaction with the technology, 2) the extent of a user's confirmation of expectations and 3) post-adoption expectations. His model departs from the ECT in that it focuses to a large extent on post-adoption expectations which he frames as perceived usefulness of the information system (Thong et al., 2006). This focus is justified since, as argued by Battacherjee, expectations of information systems might change over time and with continued use. He believes that pre-acceptance variables are covered by the confirmation and satisfaction constructs.

Since 2001, the ECM model has been adapted in several ways and to different contexts by a number of researchers (Chen, 2007; Lin, Wu, & Tsai, 2005; Mouakket, 2015). Thong, Hong and Tam (2006) incorporated the constructs perceived enjoyment and perceived ease of use and point out that the nature of the information technology “can be an important boundary condition” (p. 799) in explaining continuance intentions. The ECM model has also been adapted for and applied in educational contexts. Constructs that were added or investigated in studies on continuance usage of e-learning systems include social and academic integration (Tan & Shao, 2015), social presence and computer self-efficacy (Hayashi, Chen, Ryan, & Wu, 2004), learning process and course design (Chow & Shi, 2014), and perceived quality and perceived usability (Roca, Chiu, & Martínez, 2006). Of interest to this article are the studies using and extending the ECM to account for continuance intention to use e-textbooks, discussed in the next section.

3.3 Continuance intention to use e-textbooks

In 2013, Stone and Baker-Eveleth applied the ECM model of Bhattacharjee (2001) to determine the factors influencing university learners to continue the use of e-textbooks after initial adoption. The study confirmed the applicability of the ECM model to e-textbook use: learners’ e-textbook continuance intention is directly influenced by their satisfaction with e-textbooks and the perceived usefulness of e-textbooks. Perceived usefulness and satisfaction are influenced by the pre- and post-adoption expectations of the e-textbooks.

In a recent study, Joo, Park and Shin (2017) investigated the influence of perceived enjoyment on the continuance intention of school children to use e-textbooks. Their findings confirm the relationships proposed by the ECM model (perceived usefulness and satisfaction significantly influence continuance intention), but show no significant influence of perceived enjoyment on continuance intention. The authors ascribe this surprising finding to the learning context of e-textbooks: e-textbooks are not used

for entertainment but for learning. This implies that instructional strategies are needed to motivate learners to engage with the e-textbooks (Joo et al., 2017).

Baker-Eveleth and Stone continued their work in 2015 on continuance intentions of university learners to use e-textbooks by proposing an adapted ECM model (Baker-Eveleth & Stone, 2015) that includes the usability construct. They postulate and verify that the usability of the e-textbook will have an influence on satisfaction, perceived usefulness, confirmation of expectations and consequently on continuance intention. In addition, the authors consider antecedents of usability as effectiveness (improved performance of a task), efficiency (quick completion of a task), engagement (a positive attitude towards the task) and ease of learning (easy to learn how to use the system). The adapted ECM model for continuance usage of e-textbooks is given in Figure i.

Insert Figure i here

The results from this study confirm those implied by the ECM. However, two insignificant paths were identified amongst the newly added constructs: from engagement and ease of learning to usability, respectively. Baker-Eveleth and Stone (2015) explain these findings by referring to the specific population's familiarity with e-textbooks – since learners know the e-textbook, their engagement with it and its ease of learning do not significantly influence perceived usability. The authors interpret their findings by highlighting the role of the instructor in the choice of an e-textbook: the book should be effective (i.e. aid learners' studying) and efficient (allow speedy loading and displaying of information). In addition, instructors should use e-textbooks in a way which learners perceive as useful.

All previous studies using ECM can be considered quantitative studies where data collected through surveys are in the form of self-reported beliefs and affects. In this way the measurement instrument for the construct usability in the Baker-Eveleth and Stone study, consist of two statements: 1) I find e-

textbooks easy to use 2) I find it easy to do what I want using an e-textbook. The more nuanced aspects of usability are captured in the antecedents of usability (proposed in this model) as effectiveness (with learners having to rate statements like - I am pleased with how e-textbooks facilitate my studying), efficiency (e.g. the e-textbook loads quickly), engagement (e.g. I have found using an e-textbook to be interesting) and ease of learning (e.g. the e-textbook provides adequate feedback when I perform a task).

Self-reported measures are not the only way to determine usability. There are more objective ways such as through observation and eye-tracking (Djamasbi, 2014). Researchers also often point out the limitation of the measurement instruments used in quantitative studies. Although construct validity is checked, the question remains whether the full nuance of the construct can be captured using a few closed questions. Studies exist where theoretical models constructed and validated through quantitative means are used for qualitative research. One example is Ifenthaler and Schweinbenz (2013) who use the UTAUT (unified theory of acceptance and use of technology) to conduct a qualitative study on teachers' acceptance of Tablet-PCs in classroom instruction. They motivate this approach by providing detailed, rich data relating to the constructs.

In investigating the continuance intention of school learners to use the EduBook e-textbook platform, this research is guided by the adapted ECM of Baker-Eveleth and Stone (2015) and uses a mixed method approach: the usability of the e-textbooks is measured by using observation through eye-tracking, whereas all other constructs are investigated through qualitative data collected using individual interviews and a focus group.

4. Research design: a case study

The research took the form of a case study – an in-depth examination of a real-life instance of the entity being studied (Lazar, Feng, & Hochheiser, 2017). A case study is often implemented as an

investigation in context using multiple data sources and it may have an emphasis on qualitative analysis (Lazar et al., 2017). All of these apply to our study. The case investigated was the EduBook e-textbook platform used in some South African schools to replace printed textbooks with e-textbooks.

A South African ICT education company (EduX) offers e-learning opportunities to South African schools. One of these opportunities includes the offering of the electronic versions of printed textbooks in e-pub or .pdf format. Learners can download the EduBook e-textbook platform as an application from the Google Play Store/App Store/Windows Play Store; they register their school and grade and accordingly select the assigned e-textbooks to be downloaded. They are able to create notes, sketches and highlights within an e-textbook and can automatically generate a summary of all their annotations. This summary can be saved as a .pdf document for them to print. All data related to the e-textbook is automatically saved onto the school's server as well as in the cloud. Constant connectivity to the Internet is not required. The learner will open each e-textbook once to register it for offline use. The only time the learner has to re-connect to the server using the Wi-Fi system at school is when additional resources were added to the e-textbook by the teacher, and for backup purposes.

The teachers can add resources to the e-textbooks through a web interface which presents them with an exact replica of the textbooks used by the learners. Content is added through a drag and drop feature positioning the link to the resource in the margin of the book next to the relevant content (see Figure ii). The EduBook e-textbook platform used by the learners is supported for IOS and Android.

Insert figure ii here

The goal was to determine whether learners experience problems with the EduBook e-textbook platform and with the e-textbooks they use within the system. The usability of the platform's interface

with one e-textbook was considered, as well as the general experience with using the system. The particular e-textbook used in the study is in e-pub format.

An eye-tracking evaluation of the system and e-textbook was conducted at School A – a private urban school – through an eye tracking experiment, followed by individual interviews and then a focus group interview with all participants. At the time of the study, the system had been in use at the school for almost one year. It was a pilot project and was only implemented for grade 11 learners. We duplicated the eye-tracking experiment and interviews in our university’s usability lab with a control group consisting of children who had never before been exposed to the system. Our participants therefore included novice and experienced users of the system.

4.1 The participants

The usability test involved 17 participants. Ten School A learners made up the experimental group – six boys and four girls, all in grade 11 (i.e. ages 16 or 17). The control group consisted of seven learners – six girls and one boy – from other high schools who do not use the EduBook e-textbook system. The control group’s ages ranged from 15 to 17 years. **Error! Reference source not found.** contains a summary of the groups’ demographics.

Insert table i here

A teacher at School A was appointed by the school to act as facilitator and contact person. She recruited the participants for this study by sending information letters and consent forms to all Grade 11 learners’ parents. It was thus a form of self-selection sampling. The control group was a convenient sample recruited by word of mouth through parents known to the researchers.

All the participants have regular access to computers and smartphones at school and at home and are comfortable users of technology.

5. Data collection and analysis: eye-tracking

Eye tracking is a technique to record eye movements while a person is looking at a stimulus. The continuous movements of people's eyes are called saccades. Fixations follow saccades and are moments in which the eye is static to focus on a specific point. The capturing of saccades and fixation points can provide information on interface areas where people tend to focus, as well as those to which no attention was given i.e. which were ignored.

In South Africa, most people use Android phones or tablets (Writer, 2017). According to the contact teacher at School A, the majority of the users use Android tablets. A Samsung 10-inch tablet was therefore used for the eye tracking study. Figure and

Figure iv show the setup at School A and the Informatics Design Labs respectively.

Insert Figure iii and Figure iv here

A Tobii X120 mobile eye tracker was used to record the users' eye movement while performing the tasks described below. Figure v shows the Tobii mobile device stand with scene camera (top) and eye tracker (bottom) mounted. With the Tobii Pro Studio software the data was exported in the form of gaze videos and gaze plots. These are graphical representations of the gaze data, superimposed on screen recordings captured during interaction. For each task, the number of fixations and the task duration were obtained from the eye tracking recordings.

Insert figure v here

After each eye-tracking session, we conducted a post-session interview during which participants could describe their experience with the EduBook e-textbook platform. The interview schedule appears in Appendix A. At School A we ended with a focus group interview with the ten participants. All the interviews were recorded and transcribed.

5.1 The tasks

Participants performed a set of tasks on one e-textbook available on the EduBook e-textbooks platform. The tasks represent the typical functionality one would expect in e-textbooks including searching for specific sections, highlighting text, creating summaries, adding annotations and opening resources added by educators. The tasks are listed in Table ii.

Insert table ii here

5.2 Data analysis

Eye tracking data was exported and analysed with the Tobii Pro Studio software. This included qualitative data in the form of gaze videos/graphs, as well as quantitative metrics such as task completion times and number of fixations. Qualitative analysis of each participant's video was done within the Tobii Pro Studio's Replay tab where we added log entries to indicate the beginning and end of each of the tasks the participant performed. These logs were then used to identify sections of the videos to export as gaze videos and gaze plots (i.e. fixation graphs). Figure vi shows examples of gaze plots, where the circles indicate fixations (points of gaze) and the lines the saccades (eye movement between the fixations). These gaze plots are overlaid onto the video images captured by the scene camera from above.

Insert figure vi here

Gaze videos and gaze plots were analysed per task. For each task we watched all seventeen video segments, making notes of interaction patterns, usability problems that emerged and positive aspects of the interaction.

The quantitative data (fixation count and completion times) were transferred to an Excel spreadsheet that contains a separate sheet for each task. Each row represents a user and there are columns for the descriptive statistics as well as qualitative descriptions of user actions, problems experienced and positive observations.

5.3 Validity and reliability

In the quantitative part of the research (eye-tracking tests), the researchers took some measures to ensure the validity and reliability of the research instrument. Validity refers to the extent to which the instrument measures what it is supposed to measure whereas reliability refers to the consistency of the measurement (O'Dwyer & Bernauer, 2014). Eye-tracking provides an objective measure of the users' attention on interface elements (Duchowski, 2017). Each eye-tracking test starts with the calibration of the instrument to the individual's eye. In addition, quantitative data in the form of fixation counts and completion times were complemented by gaze plots and gaze videos. The gaze plots were confirmed through the analysis of the gaze videos, as well as the interviews (discussed in the next section), ensuring valid results.

Unfortunately, the amount of assistance rendered to the novice group who struggled to use the system, limits the validity of the data. Despite this, we found that all learners (from both groups) struggled with the same tasks – from where certain conclusions regarding usability could be made (see section 8.1).

6. Data collection and analysis: interviews

Recordings of the post-test interviews and the focus group interviews were transcribed and analysed to supplement the results of the usability evaluation. The interviews were semi-structured and loosely based on the constructs represented in the adapted ECM. The purpose of this study is not to falsify or validate the identified relationships of the ECM but rather to use the constructs as a way to structure our understanding of the perceptions and experiences of learners regarding the usability of the e-textbook system.

Examples of questions include: do you like using the e-textbook system? Does it make learning easier? Do you prefer the hard copy textbook to the e-book? How can the system be improved? What are

the advantages of having this system? Do you know all the functionalities we tested? Do you intend using these in future?

6.1 Trustworthiness of findings

The term trustworthiness is used to describe the validity and reliability in qualitative research (O'Dwyer & Bernauer, 2014). In the qualitative part of the research (interviews and focus group), the trustworthiness of the findings were ensured by 1) having more than one researcher present during the individual interviews, 2) having fellow researchers cross-checking the code and the findings, 3) checking the findings of individual interviews using a focus group interview with all the learners from the experimental group, and 4) using the gaze plot diagrams to confirm some of the findings from the interviews – providing some form of triangulation (Shenton, 2004). Furthermore, the transcripts of the interviews were checked thoroughly and the codes used to transcribe the interviews were used in a consistent manner (Cohen, Manion, & Morrison, 2011; Creswell, 2014).

7. Ethical considerations

Ethical clearance to conduct the research was granted by the Ethics committee of the Faculty of Engineering, Built Environment and IT at the University of Pretoria. School A granted consent to conduct the experiment and the interviews on their premises during school hours. A teacher was appointed to facilitate the process from their side. Parents of all participating learners signed consent forms that gave us permission to record eye tracking data, videos and audio of the interviews.

8. Results

8.1 Usability

Experimental vs. control group

There were notable differences between the results of the two groups which could be misleading if not seen in the respective contexts of the two groups. The experimental group had been using the EduBook for e-textbooks in school for 12 months, while the control group had never seen the application before. Although the experimental group were often provided with some help, the control group needed help on almost every task. Where the task completion times of the two groups are presented together in a graph, the reader should note that the difference between their results is often not meaningful because of how they were facilitated during the tasks. However, what was interesting was that the two groups struggled mostly with the same tasks and found the same things easy or intuitive.

Task completion times

Table iii provides an overview of the average, median, maximum and minimum completion times per task. The information of the two groups was separated.

Insert table iii here

The median was found to be a more accurate reflection of the completion times within the groups than the averages, because the averages are skewed by outliers. Figure summarises the medians for the two groups across all tasks. Adding the annotation took both groups the longest to complete. For the experimental group the next most time-consuming task was finding a posted resource, then generating a summary of red highlights and finding all book resources. For the control group, the second most time-consuming task was highlighting blue and green, finding a posted resource and then finding search items.

Insert figure vii here

Where the control group completed a task quicker (e.g. 'Summary of Red') it means that they were given instructions to complete the task by the facilitators as they were struggling with the task and would probably not have been able to complete the task successfully on their own.

The difference between the minimum and maximum completion times can also be a meaningful metric. Low minimum completion times indicate the potential ease with which a task could be completed and high maximum completion times may point to usability problems. Comparing the maximum and minimum completion times for the experimental group shows large differences between the slowest and the fastest participants (see Figure). Here the differences were often explained by the fact that some of the participants had used the specific functionality before, while others had never attempted to use it.

Results emerging from the qualitative analysis of all the gaze videos support the above descriptive statistics.

Usability problems

Overall, the following usability problems emerged from the objective data:

- 1) *Finding the table of contents (ToC)* – in the experimental group, seven participants went straight to the ToC icon. In the control group three participants went straight to the ToC icon, three tried to reveal the ToC through a sliding action and one repeatedly clicked on a three-dot icon in the top right. The control group’s behaviour shows that the action required to open the table of contents is not intuitive. The experimental group knew where to go because they had done this many times before. The ToC can be made more easily detectable by replacing the existing icon with an icon that maps more clearly to its function.
- 2) *Finding and using the search box* – the minimum time to find the search box in both groups was zero seconds, as two participants found it immediately. Interestingly, the control group participant who took the longest, found it in less than four seconds while the experimental group student who took the longest spent 28.38 seconds. This participant was an outlier and we concluded that users located the search box easy enough. However, using the search box caused problems. When given the task to search for “creativity”, all experimental group participants

typed the word in the search box and then half of them tapped the keyboard's return key and the others tapped the magnifying glass (sometimes repeatedly) or the back key on the keyboard. Those who tapped the return key then tried the magnifying glass. The same happened with the control group. Six of them first used the return key and then tapped the magnifying glass or the back key. Only one experimental group participant scrolled down without help. This indicates a severe usability problem. Because nothing visible happens after the search term was entered, users believed their action was unsuccessful and that they had to try something else. What they actually needed to do is to scroll down in the ToC to see where the found term had been highlighted. This is a highly ineffective response to a search action. The search function can be improved by automatically scrolling down to where the first occurrence of the search term is located. If a search term is not found, appropriate feedback needs to be given to the user. Also, the found terms are currently only highlighted using bold face which is not clearly detectable – they should stand out clearly in the ToC. Being able to search is an important advantage of e-books over printed books. This functionality should therefore be exploited optimally.

- 3) *Creating a summary of all red highlights* – most of the experimental group participants knew that they had to tap the three-dot icon in the top right to get to the Summary page. However, few realised that they first had to go to the chapter which had red highlights and then go to Summary in order to create a summary of only the red highlighted text. Eventually some realised they had to go to the red highlights and others received help from the facilitator as they really struggled to get it done. One user opened the red highlights and pressed down on the red part trying to bring up a pop-up menu from where she could create the summary. All the control group participants needed help with this task. This is why the results show that they completed the task quicker than the experimental group. The users found the Generate summary menu option relatively easy. The problem was that when they were on the summary page, they could not request a summary of red highlights if they were not in the chapter with the red highlights.

- 4) *Highlighting specific parts of the text blue or green* – in a previous task the participants had to highlight a specific part of the text in red and only one out of each group struggled a bit with this. We conclude that the highlight function is easy to use. However, when they had to highlight different sections of the page in two different colours, problems emerged. They would select the colour blue and highlight the text. To find the text to highlight in green they needed to scroll. When they did this without deselecting the pen first, ‘scrolling’ would paint the parts where they touched, blue. When this happened most of them realised that they had to first deselect the pen, then scroll, then select the pen and the colour green, and then highlight the green parts. Most of the participants in both groups experienced this problem, but they also easily corrected it using either the Undo button or the Eraser tool. It is useful that they could easily fix the error, but the fact that almost all of them required this corrective action means the highlight function could be designed more effectively.
- 5) *Creating a PDF of a summary* – four of the ten experimental group users completed this task without any problems. All the others struggled, not realising the printer icon is the route to create a .pdf file. Since most users will create a .pdf rather than send the document to the printer, the printer icon could be changed to a button that says ‘Create PDF or Print’. Three of the five control group participants who did this task completed it easily.
- 6) *Creating a free-hand annotation* – to add an annotation one has to press down on the text for the annotation option to appear. Seven of the experimental group participants pressed down on the white space on the page expecting the option to appear. (It turned out that they are iOS users and it works in that way on an iPad.) Five of the experimental group participants (including some who first tried to press down on the white space) tried the Pen tool without success. All seven of the control group participants tried the pen tool at some point in this task. They all required assistance to complete the task, since they had no idea that they had to press down on a word to do this. The fact that all the novice users and some of the experienced users regarded

the pen icon as a mechanism to get to the annotations suggests that the designers can consider making this an alternative or the main route to add annotations.

- 7) *Finding a resource added by a teacher* – To find a resource one has to go to the position in the text that is associated with the specific resource. The resource will then be visible next to that in the Resources panel. If the user then scrolls sideways, it will become completely visible and can be opened. Only three of the experimental group participants could successfully locate the resource. All the control group participants required guidance with this task. In both groups, participants tapped on the Resources heading and the refresh icon in an attempt to make the resource visible.
- 8) *Finding all the resources associated with the book* – three of the ten experimental group participants knew they had to leave the book to find a list of all the resources. The rest struggled a lot and needed help. All the control group participants had to be guided through this task. Their actions clearly showed that they could find no clue in the interface where to locate all the resources at once.

Using the ECM to understand usability

According to the adapted ECM suggested by Baker-Eveleth and Stone (2015) the four antecedents of usability of e-textbooks are effectiveness, efficiency, engagement, and ease of learning. Effectiveness refers to the improved performance of a task, efficiency to the quick completion of a task, engagement relates to the positive attitude towards a task, whereas ease of learning refers to how easy it is for a user to learn how to use the system. How usable did learners find the EduBook e-textbook platform and associated e-textbook? The results of the interviews show that the learners appreciated the highlighting, note taking and search facilities. However, the results of the objective usability

evaluation indicate that the usability of the EduBook e-textbook platform is lacking. The search function does not make the search results visible, giving the user the impression that the search was not executed and thus hampers effectiveness. With regard to efficiency, the fact that users can create a summary of the highlighted sections only if they activate the function from within that specific chapter, slows down the process. If they could choose the chapter(s) to summarise from within the Generate summary section it would be more efficient. During the interviews, learners pointed out that they are used to the highlighting functionality in .pdf or MS Word documents where one can simultaneously highlight and scroll up or down. The e-textbook allows one to do both, but not at the same time. Learners mentioned the inefficiency of note taking: it has to be done through the annotation facility – writing on the book itself is not possible. Ease of learning is not achieved in most of the functionalities, as is evident from the numerous tasks where novices and some experienced users needed continuous guidance. The most prominent cases where this was lacking are: finding the specific resources which were added to a chapter; finding all the resources added to the book; and creating an annotation associated with a part of the text. Learners from both groups expressed the need for more in-depth training.

We cannot relate the results of the eye-tracking usability evaluation to the antecedent of engagement, since a person's attitude is a subjective characteristic that can only be investigated from the user's own point of view. However, we could find some indication about students' attitudes towards e-textbooks from the interviews. Some learners from the experimental user group expressed their dissatisfaction with studying from an e-textbook – they mentioned the difficulty of flipping through pages and switching from one window to another (*"Yeah exactly! It's a lot harder when if I'm on one page and have to go to another then you have to scroll all the way up – if I could just keep my hand there – flip back, have a look, flip my hand back, keep going*). The same learners also expressed a negative attitude towards e-textbooks. Other learners in the experimental group were more comfortable with technology and seemed to have adjusted the use of the system to their learning

needs (by for example adding a keyboard to their tablet, or using a laptop or phone rather than a tablet).

Each of the remaining constructs in the adapted ECM (Baker-Eveleth & Stone, 2015) will consequently be discussed with reference to findings from the interviews:

8.2 Satisfaction

According to the adapted ECM, perceived usefulness and expectation-confirmation patterns influence overall satisfaction. Results from the analysis of the interview data directed by these constructs are given below:

Perceived usefulness

According to Bhattacherjee (2001), post-adoption expectation-confirmation is reflected in perceived usefulness. With the use of the EduBook e-textbook system came new expectations which were confirmed, e.g. learners expected learning resources to be consolidated through the system, they expected access to information, and they expected lighter backpacks. These functionalities were perceived as useful. However, learners now expected teachers to use the system consistently, which did not happen (*“No there are definitely a few teachers that don't use it at all - which is a little annoying because the whole point is to have less books and then you sometimes still need to carry it around”*). In addition, they found different e-textbooks to have different layouts which lessened the perceived usefulness of the system (*“My Bio and Business books are actually really good. My CAT textbook is another story – some of the examples or screenshots of what the activity should look like, is blurry”*; *“You can only write on .pdf books, not on e-pubs.”*).

Expectation-confirmation

The data from the interviews were analysed to determine pre-adoption confirmed and disconfirmed expectations from both groups. The pre-adoption expectations were inferred from the remarks of the

experimental group since the learners were not pertinently asked what they were. These expectations are given in Table iv.

Insert Table iv here

The control group's learners expected that teachers will not use the system or accept it (*"Our teachers are relatively old and not used to technology"*); some indicated that they will themselves find it difficult to study from an e-textbook; that there will be more distractions in the classroom should e-textbooks be implemented (learners will play games on their tablets); that they would have lighter backpacks; and that teachers would first need extensive training on the use of e-textbooks. Learners in the control group also mentioned that they do not trust the technology and that they fear that they might lose their notes. Interesting to note is that this fear was reversed under the experimental group as these learners mentioned that they prefer electronic notes above printed notes, as they were worried that they could lose the latter. The control group also had unrealistic expectations regarding the technology which include that teachers will find it easier to mark homework and that the teacher will be able to "control" all the devices from his/her laptop. It was clear that they already expected the e-textbooks to have at least the same functionalities as a printed book.

8.4 Continuance intentions

Although the use of this system is mandatory for the control group, we considered the learners' willingness to try out the functionalities to which they were exposed in the eye-tracking test as an indication of their continuance intentions to make use of the system. Almost all learners mentioned that they were willing to try out the functionalities in future. Whether this is a true indication of their willingness to do so, is another matter. However, in the focus group discussion, the users had a number of suggestions regarding the improved use/uptake of the system. Keep in mind that these learners had only one more year of school left. They mentioned ways to improve the teachers' uptake of the system; they suggested that the devices used should be standardised; and that e-textbooks should be implemented from the start of high school (see Table v).

Insert Table v here.

9. Discussion

The results of the objective eye tracking usability evaluation, as well as the interviews, indicate that more can be done to improve the usability of the EduBook e-textbook platform. The ineffectiveness and inefficiency of the search, highlighting and note taking facilities were observed during the eye-tracking study and confirmed during the interviews. Despite these, learners still appreciated the e-textbook functionalities and especially the consolidation of all their learning resources. From the usability study, the researchers came up with a number of suggestions on how to improve the usability of the platform and presented these in a report to the management and developers of the platform.

It is clear that confirmation of expectations (both pre and post adoption) influenced the learners' satisfaction with the platform. Both groups, whether consciously or not, expected the e-textbooks to have at least the same functionality as printed books, e.g. they complained about the inefficiency of switching between tasks on the platform, as well as 'flipping' through pages. Some said explicitly that they cannot study from electronic text. Once the system was implemented, it created expectations: learners expected the same user experience across different teachers/subjects, textbooks, e-textbook formats and devices. This expectation was not met in some cases which influenced the perceived usefulness of and satisfaction with the system. On the other hand, learners with a positive attitude towards technology and skills to adjust the system to their own needs, seemed to embrace the positive affordances of the platform and were willing to explore other functionalities.

The focus group discussion with the experienced users revealed interesting perspectives. Learners emphasised the importance of the role played by teachers on their (the learners') satisfaction with the system. Their suggestions reveal an empathy with the teachers: teachers should not be forced to use the system; we would like to help the teachers with the system; and teachers should know before they are appointed what will be expected from them regarding the use of e-textbooks in the

classroom. They also recommended the standardisation of devices and phased implementation starting with the grade 8 learners (the first year of high school).

The study contributes to research on e-textbook implementation in schools by examining a large-scale implementation across different subjects. Although no in-depth study was done on the differences between the e-textbooks across the different subjects (as recommended by Joo *et al.* (2017)), there are indications that the difference between the quality and layout of the textbooks play a role in user satisfaction. Joo *et al.* (2017) also suggest that one should consider the role played by self-efficacy and technology experience on user satisfaction and continuance intention. Our study confirms that these relationships are worth investigating.

10. Conclusion

This study focused on the implementation of e-textbooks across subjects in a high school. Both quantitative data (eye-tracking results) and qualitative data (from interviews and a focus group discussion) were collected to investigate learners' satisfaction and continuance intention. The results from this study indicate that where e-textbooks are implemented across subjects in high schools, learners' satisfaction and continuance intention to use the platform, depend to a large extent on 1) the usability of the system; 2) the extent of their expectations that it should work like a printed book; 3) the extent of their expectations that teachers should use it in a similar and consistent way; 4) the extent of their expectations that the functionality and format of the e-textbooks should be consistent between different subjects; 5) the learners' skills regarding adjusting to the system or to their own needs (e.g. rather use a computer, adding a keyboard, etc.); and 6) the learner's attitude towards technology – self-efficacy (some loved it, others think they are not digital enough).

The small sample and the way in which the sample was selected, limit the generalizability of the study. However, we believe that this study provides a good starting point for further research on

the topic of the use of e-textbooks in schools. We also consider the mixed method approach to contribute towards the credibility of the study.

In conclusion, the factors influencing the continuance intention of learners to use e-textbooks have been considered and confirmed in several studies. The research presented in this paper contributes to these findings by confirming these factors using eye-tracking data and in-depth qualitative interviews. In addition, it highlights the expectations created by cross-subject implementation. In this regard, similar to Joo *et al.* (2017), Gu *et al.* (2015) and Stone and Baker-Eveleth (2013), we believe that future research should clearly focus on how the use of e-textbooks influence the learning process. Stone and Baker-Eveleth suggest the consideration of perceived student learning and study time as factors influencing learners' satisfaction with e-textbooks. Although not the focus of this paper, our study shows that perceived student learning will be influenced by learner characteristics (including self-efficacy and attitude towards technology) and the way in which the teacher uses the e-textbook in class. To complement self-reported measures, in-depth empirical studies are needed on educational aspects of e-textbooks, such as e-texts and retention; the effective pedagogical designs of e-textbooks; the integration of flash cards and assessments; the suitability of e-textbooks for certain subjects; and the incorporation of learning analytics.

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Figure i: Adapted ECM model of Baker-Eveleth and Stone (2015)

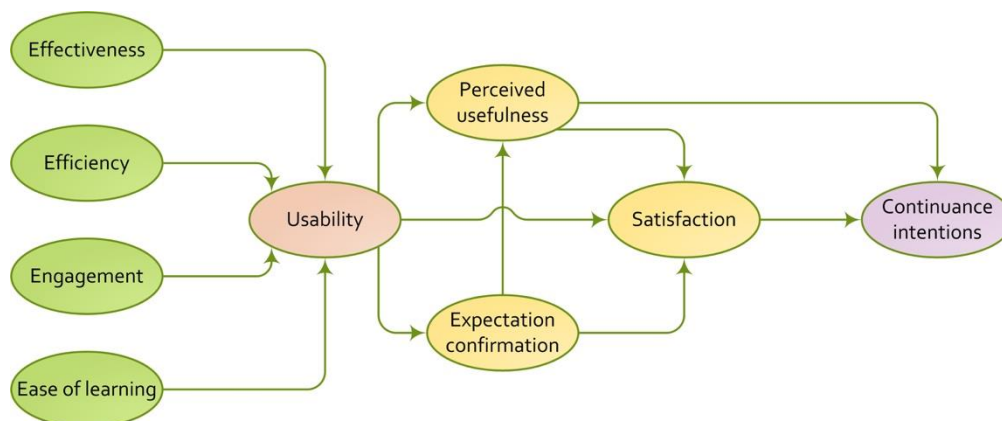


Figure ii: An example of an e-textbook on the EduBook e-textbook platform showing the annotations and added resources in the right margin

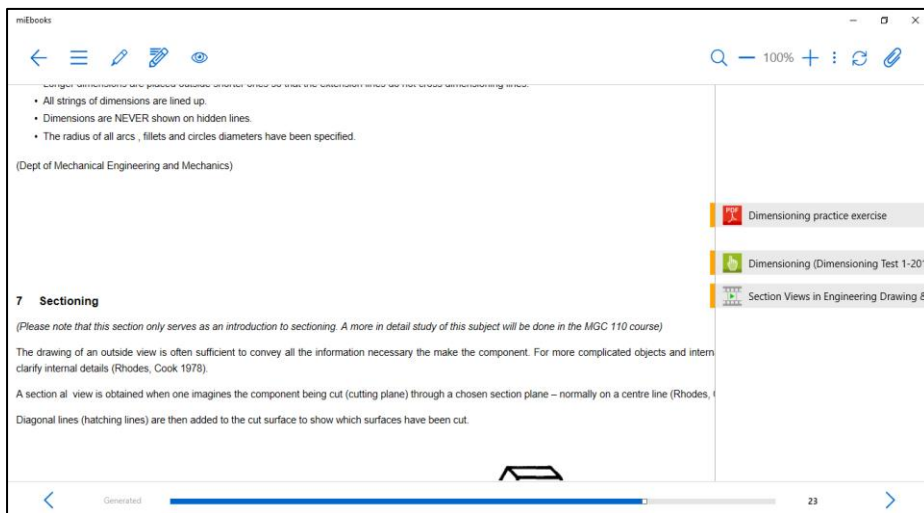


Figure iii: School A setup



Figure iv: Usability lab setup



Figure v: Tobii mobile device stand with scene camera and Tobii X120 eye tracker

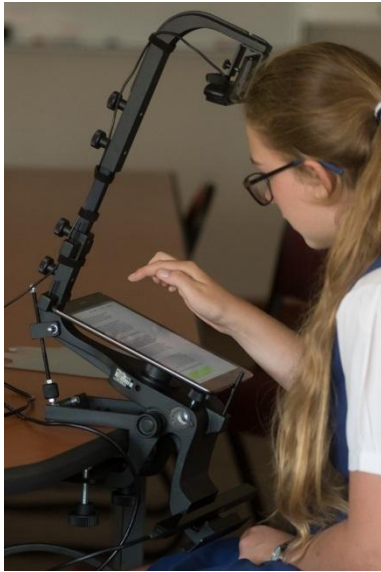


Figure vi: Examples of gaze plots showing the fixations and saccades overlaid on an interface scene

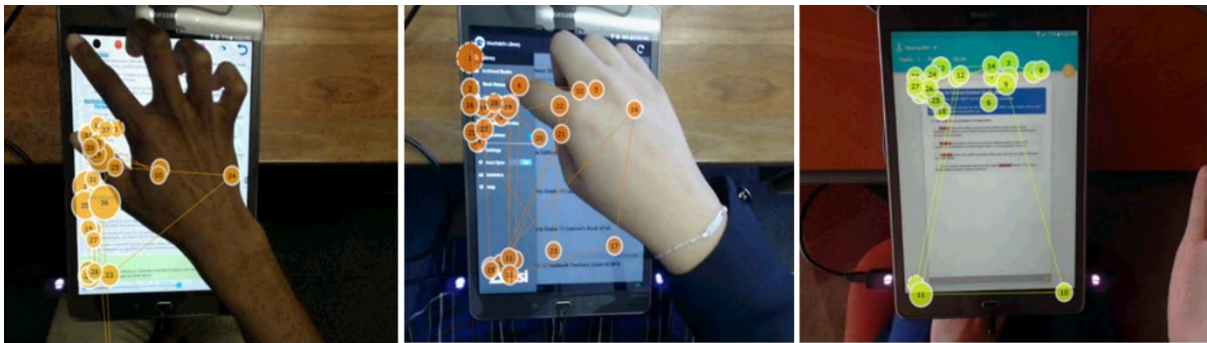


Figure vii: Median task completion times

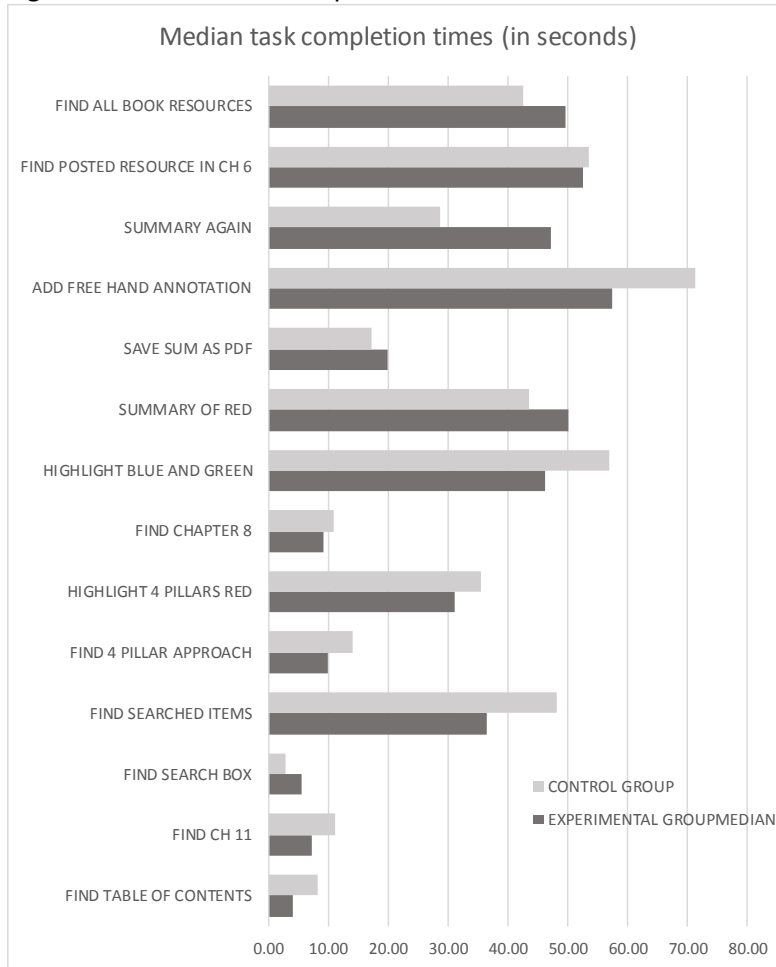


Table i: Demographics of Experimental Groups used in the study

	Experimental group	Control group
Date:	2 and 3 November 2016	26 January 2017
Number of learners:	10	7
Female:	4	6
Male:	6	1
Age:	All learners 16 – 17 years old	15 years old: 5; 16 years old: 1; 17 years old: 1
Devices used by learners to access the EduBook e-textbook platform and e-textbook:	6 iPads; 3 Samsung tablets; 1 iPhone	n/a as users have never used the platform or e-textbook 4 of the learners did not own tablets

Table ii: Tasks performed using the EduBook e-textbook platform and e-textbook

	Task	Interface Evaluated	
		EduBook e-textbook platform	e-textbook
1	Search for the eTextbook “Consumer Business Studies Grade 11” and OPEN it	x	
2	Use the Table of Contents to go to Chapter 11 (Marketing)		x
3	Use the search facility to search for the word “creativity” and go to the first section you find on it.		x
4	Highlight the key concepts of the four pillar approach to creativity in red.		x
5	Use the Table of Contents to go to Chapter 8, Section 1.2 on The stages of team development. Highlight the heading “Stages of team development” in green and the different stages in blue.		x
6	Generate a summary of all your red highlights and download it as .pdf		x

7	Add a free hand annotation to Porter’s Five Forces reminding yourself of its importance (Chapter 1, Section 3)		x
8	Generate a summary of all your green and blue highlights, as well as your free hand annotation and download it as .pdf		x
9	Find the following resource in section 6 of chapter 7: “Grade 11 Ethics Activity”	x	x
10	Find a list of all the resources pushed by your teacher to this e-textbook.	x	

Table iii: Task completion times in seconds

TASKS	EXPERIMENTAL GROUP				CONTROL GROUP			
	AVERAGE	MEDIAN	MAX	MIN	AVERAGE	MEDIAN	MAX	MIN
Find table of contents	4.49	4.15	7.24	2.23	12.57	8.28	36.18	1.38
Find chapter 11	8.70	7.27	22.49	3.75	13.52	11.02	23.14	8.25
Find search box	10.26	5.58	28.38	0.00	2.42	2.93	3.72	0.00
Find searched items	43.27	36.46	77.48	10.94	55.57	48.22	84.16	36.92
Find 4 pillar approach	13.11	9.84	47.26	1.33	22.43	14.08	45.82	10.01
Highlight 4 pillars red	34.68	31.12	67.94	12.81	39.78	35.59	72.97	18.73
Find chapter 8	11.71	9.28	26.91	4.04	12.78	10.92	26.54	4.62
Highlight blue and green	47.73	46.27	59.38	31.02	53.51	56.97	71.75	35.18
Summary of red	55.09	50.07	120.39	28.87	59.07	43.62	118.19	30.84
Save sum as pdf	19.16	19.88	37.12	3.51	14.89	17.14	22.24	1.21
Add free hand annotation	59.07	57.35	84.20	28.72	75.73	71.41	112.82	51.50
Summary again	50.24	47.27	85.28	26.73	28.99	28.65	35.89	22.78
Find posted resource in chapter 6	59.03	52.58	97.09	19.36	54.37	53.42	75.37	32.69
Find all book resources	64.70	49.61	182.77	21.58	45.27	42.67	64.08	30.47
All tasks	494.03	485.13	720.21	350.81	540.24	518.33	658.15	446.69

Table iv: Pre-adoption confirmed and disconfirmed expectations of the experimental group

Experimental group: Pre-adoption confirmed expectations	
Expect older teachers to be more reluctant to adopt the technology	<i>“...because if they’ve been teaching... you know some of our teachers are quite old, and they’ve been teaching like this for about 20 years . They don’t want to do that because that’s how they teach and that’s how they get the best out of their learners.”</i>

<p>Consolidated resources</p>	<p><i>“Like more variety – it’s accessible because sometimes you have to get back to your teacher because you’re missing something from the notes.”</i></p> <p><i>“I think it would be easier if they moved to the e-textbooks - like now in my Maths book I have pages and pages of revision notes, where if we used our tablets it could just be there. Then I could just click on it and use it from there.”</i></p>
<p>Lighter backpacks</p>	<p><i>“I just like it because it’s lighter it’s not as heavy – it’s not so many books.”</i></p>
<p>Mobility</p>	<p><i>“...if I have drums after school – its half an hour’s drive from school – I can use my online textbooks and I can go online and I can do it there and I can study and go through my notes.”</i></p>
<p align="center">Experimental group: Pre-adoption disconfirmed expectations</p>	
<p>Expect e-books to have at least the same functionalities as printed books</p>	<p><i>On note taking:</i></p> <p><i>“I actually enjoy the printed book because my note-taking is easier – I can write, I can highlight, I feel like when it comes to highlighting on my e-book you can highlight so far then you have to stop and then scroll and go up to keep highlighting.”</i></p> <p><i>“Somehow enable it so you can actually write on the question page. So you can like edit it and not have to side note it. I want to be able to write it under the question.”</i></p> <p><i>“...so you can circle something as if it was your printed page.”</i></p> <p><i>“...it’s a lot harder when if I’m on one page and have to go to another then you have to scroll all the way up – if I could just keep my hand there – flip back, have a look, flip my hand back keep going. So the scrolling up and down is quite frustrating.”</i></p>
<p>Expect the e-book highlighting functionality to be the same as that of other electronic applications such as MSWord, .pdf editors, etc.</p>	<p><i>“When you search it doesn’t bring it to right under the search bar. So if you search for it, it sort of highlights it in a very light blue and then you have to go and look for it in the search results. [Interviewer: “...for example if you search in a MSWord document?”] “...Yes.”</i></p>

<p>Expect teachers who teach to be slow to adopt the system, but expect them to teach to the best of their ability.</p>	<p><i>“...because if they’ve been teaching... you know some of our teachers are quite old, and they’ve been teaching like this for about 20 years. They don’t want to do that because that’s how they teach and that’s how they get the best out of their learners. So changing how they do that [how teachers teach], it’s going to hamper the way we learn and the way they teach. So you actually don’t want them to use it...”</i></p> <p><i>“No, because even though you teach them, they are still going to be slow. My mom knows how to use her phone but she still takes about 45 minutes to type a message. (laughs) So, like it’s the same thing – you can’t expect them to do it.”</i></p>
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Table v: Suggestions of the Focus Group on Continuance Intention

Code	Quotes
Improving teachers’ adoption of the system	
<p>They need support</p>	<p><i>“But the teachers also need proper support because our... teacher can’t put past exam papers on the EduBook platform for us because no-one can help him.”</i></p>
<p>Let us help them</p>	<p><i>“And we could not help him because we do not know that stuff – that side of it ... so in a way that’s also now hampering our education.”</i></p>
<p>They should not be forced to do it</p>	<p><i>“It’s not about convincing the teachers to do it, it’s just about encouraging them to do it. If it doesn’t happen, it doesn’t happen.”</i></p> <p><i>“But we also all know that if we were forced to do a sport which we don’t want to do then we will never do it to our full ability, because we don’t want to. So, ...”</i></p>
<p>Inform teachers before they are appointed about the use of the system</p>	<p><i>“When schools are looking for teachers and teachers are applying for jobs, then you can start by saying there’s a requirement that you need to know about... we’re gonna be working all online. Then you’re not gonna attract so many teachers cause not all teachers teach the same way.”</i></p>
Standardise devices	
<p>Regulate content on devices</p>	<p><i>“There are too many distractions. They should rather provide us with our own school devices, where we aren’t able to get stuff like games...”</i></p>

Enable equal access	<i>“Yes, they kind of try to give us a setting we should have – but it didn’t help - like it’s very expensive to buy an advanced tablet... like some of us have iPads and stuff ...and then others have the Nova ones and they work really slow – so it’s very difficult to keep up with the teacher’s pace if the teacher is working quickly and you have a slow tablet.”</i>
Implementation suggestion	
Start from beginning of high school	<i>“I think it’s good that you guys are talking to us about it ... If you can implement it straight from high school where you can choose your subjects ... then by the time they get to matric, they’re gonna be strong... you’re gonna have a higher success rate.”</i>