Student Views on Academic Reading and its Future in the Design and Engineering Disciplines

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***Abstract* - Electronic textbooks are becoming a common educational tool, but there is little research on the student desires, which will affect the effectiveness of this tool. This paper aims to add to the current research by outlining students' reading habits in physical and electronic textbooks and identifying what students feel they need to study using future electronic textbooks. This paper describes a series of focus groups with a total of thirty design and engineering students. Findings illustrated the different ways in which these disciplines approach their academic readings and that future electronic textbooks require some discipline specific components. There were some similarities in views and ideas, such as being able to insert their own images into the textbooks and the desire for less text and more interactive components to facilitate their learning. Identifying design criteria based on discipline needs and including student input based on their task needs will assist in designing future electronic textbooks that will meet academic reading requirements.**

Keywords - focus group; electronic textbooks; academic reading; design education; engineering education.

I. INTRODUCTION

Electronic textbooks are becoming more prevalent in higher education. Still, students are not as excited about this trend as many universities. While 60% of students reported using electronic textbooks during their academic studies, with half being required to by their instructors, student preference for physical textbooks has not waned [1,2]. In fact, many studies have shown that student preferences of some components, such as search functions and long blocks of text, negatively impacted student's opinions on electronic textbooks [1,3].

While electronic textbooks are starting to evolve past simple Portable Document Format (PDF) representations of the physical text, they are in their infancy. It has been individual schools creating their own interactive electronic textbooks, which are shifting away from the textbook metaphor [4] and creating this evolution. This shift from the textbook metaphor will allow for additional materials and components, which will enhance and assist with the reading task [5]. Yet, creating this type of electronic textbook for individual courses is time consuming and impractical on a larger scale due to the number of courses offered worldwide and the ever changing course material. On the other hand, electronic textbooks coming from major publishers do not tend to use diverse components that would be more suitable for the disciplines they serve and instead use components that would be appropriate for all areas of study. Although different disciplines are known to approach their education in different ways [6], it is still in broad practice to create this type of electronic textbook. Regardless of creating electronic textbooks specifically tailored for courses or broader textbooks, there is still the challenge of selecting and creating new supplemental materials and components for this new type of electronic textbook [7].

Not only would academics and publishers find creating new content difficult, advancing technology and the use of electronic textbooks may have altered the ways in which students use textbooks. Students can now easily read in cafes or while travelling [8], moving away from the desks and tables that used to confine students. Being able to study in more locations may seem positive, but without normal study aides such as highlighters and notebooks, students may find themselves slipping from the deep reading required during revision, which allows for in-depth comprehension and recall [9] to surface reading, which provides students with a more limited understanding of the materials [10]. While some components included in current electronic textbooks seem similar to the support activities students employ during reading, they are noticeably different. For example, many students take notes in the margins of their physical textbooks to support their studying. While electronic textbooks commonly offer notation software, notes are typically not displayed on the screen and require clicking on a small icon to later revisit (see Fig. 1). This could cause the students to miss their notes or interrupt their reading process leading them to become distracted. In fact, electronic annotation software is used less often than traditional note taking done with a

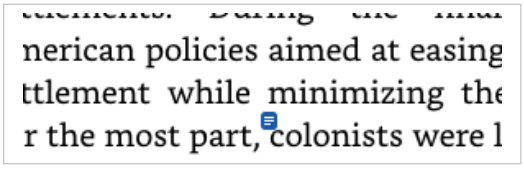


Figure 1. Example of note taken in a Kindle electronic textbook [15].

physical textbook [11]. The lack of tangibility associated with electronic textbooks also negatively affects the reading task [12]. Past research has stated that electronic textbooks should enhance current physical active reading activities while presenting an interface that is easy to use [13].

Currently, the components that are used to support academic reading are being designed for future electronic textbooks with limited understanding of the students and their habits [14]. While educators should be designing the content within electronic textbooks, students are the central user of electronic textbooks and know their own study behaviors and what additional tools they need to feel comfortable with the material. This could lead to new textbooks not being able to fully support students' study habits and not only failing the student but becoming something that is looked on with distain.

The purpose of the focus groups outlined in this paper was to identify components that are important to students during their studies from the task requirements reported by students, something that limited in the current discussion. Since each discipline has different approaches to studying and different needs, focus groups were separated based on the two disciplines studied: engineering and design. This allows for a better understanding of how these groups of students approach their studies. It also assists in identifying what type of supplemental content needs to be created and what tools need to be included to support academic reading in these different disciplines. This paper also aims to bring a deeper understanding to the data from an earlier survey released at The Hong Kong Polytechnic University [16]. It also provides insights into how students complete their academic readings in physical and electronic mediums and how they envision their future electronic textbooks based on their discipline specific needs. The rest of this paper is organized the following way. Section II describes the method employed in this paper. Section III presents the results of the focus groups. Section IV discusses the results within the literature and in a more general context. Section V presents the main conclusions and presents some future areas that should be explored.

II. METHOD

Focus group method was chosen to uncover current and future student needs and approaches related to academic reading, and was used identify task related design criteria for future electronic textbooks [7]. The focus group method allows for internal validity, a better understanding of the phenomenon that would not be possible through methods that use quantitative analysis, and assists in understanding truly complex issues [17], which are necessary in this type of research.

A. Participants

Students were recruited from The Hong Kong Polytechnic University. There were two requirements for participation. The first, students need to be enrolled in either an undergraduate level design or engineering program. The second, the students needed to have prior experience using electronic textbooks during their academic studies. Once students volunteered for participation, they were placed into three person focus groups made up of participants only from their discipline. While the disciplines of the students remained the same, the different programs within that discipline were mixed. For example, computer science, electronic engineering, and product engineering falls within the Engineering Discipline at the university, so all of those groups of students were included in engineering focus groups. Design students' programs also varied with students from programs such as product design, communication design, and multimedia design. Overall, five focus group sessions from the design programs and five from the engineering programs were conducted. Thus a total of thirty students participated in these focus groups. After three focus group sessions, homogeneity was reached [19, 20, 21] but sessions continued for two more focus groups per discipline so that findings would be more significant. Total student participants were 16 males and 14 females aged between 18 and 23. Engineering focus groups consisted of a total of 11 males and 4 females. While design focus groups consisted of 5 males and 10 females. The increased number of males in the engineering department and increased number of females in the design department reflect the distribution of genders in these faculties with design disciplines being more female heavy and engineering being more male heavy.

B. Session Design

Each focus group session was designed to last approximately one hour. The sessions were made up of sixteen semi-structured interview questions, which were followed up with unscripted questions related to the answers. Based on the similarities between the answers, many follow-up questions were the comparable. Students also participated in two activities during the session. The first activity asked them to express how they define current electronic textbooks. The second activity asked them to envision their future electronic textbooks, without considering the limitations of current technology. In this activity, students were asked to include components they wanted in their discipline specific electronic textbooks and then asked questions about how they would interact with these new textbooks. During both activities, students were given markers and paper and allowed to complete them with little oversight from the moderator. Each session was audio taped and later transcribed. The papers from the activities were kept for analysis and examples appear later in this article.

C. Data Analysis

Once each session was transcribed, the data was coded. The codes used in this research were grounded in the data [18] and used to organize the data into recurring topics and subtopics for easier analysis, description of the results and development of theory. Some of the codes, which emerged from the data are as follows: task requirements, technical requirements, preference, technical issues, ergonomics issues, and habits.

III. RESULTS

The semi-structured interview questions investigated the habits, task requirements, and preferences of students in regards to textbooks. The questions were broken up into three segments: one on physical textbooks, the next on electronic textbooks, and finally future electronic textbooks. The same questions were used for both design and engineering focus groups, although follow up questions differed slightly based on the responses given by students. During the future electronic textbook segment, students were also asked for feedback on ranking data gained from an earlier survey [16]. Two activities were also completed by students, one during the electronic textbook segment and one at the end of the future electronic textbook section, which wrapped up the focus group sessions.

A. Physical Textbooks

The questions regarding physical textbooks mostly dealt with student habits regarding physical textbook reading. Habits and preferences are diverse for many reasons; however, trends did emerge when analyzing the full transcriptions of the focus groups. When design students were asked about the frequency of their use of physical textbooks, answers ranged from 20% to 90% of their time reading. However, these initial responses are deceiving. Students later admitted during the sessions to underestimating their use of physical textbooks because they frequently printed out the electronic versions and initially included them in their estimates of electronic textbook usage. Overall, design students' usage of electronic textbooks was much closer to the higher percentage. Most often, these students reported to completing their academic readings in the physical form while at a desk at home in the morning before lectures or late night. Other locations design students reported competing their physical academic readings were home on the sofa, while traveling, and in the classroom. The majority of design students did not wish to read while traveling. When asked to expand on this, students reported the issue of dizziness as the main cause of their decision, although they also reported a dislike of carrying heavy books or a large amount of papers influencing the decision. They reported using the textbooks as the main source of learning concepts and reported looking past the required readings to find other resources regarding the concepts.

On average, engineering students reported using physical textbooks less than 50% of their time while doing academic readings, although two participants out of 15 claimed to use them almost 80% of the time and two state that they would go out of their way to use electronic textbooks as much as possible. How often engineering students did academic reading varied from only during exam times to one hour per day in the afternoons and evenings. This large discrepancy translated into their average time spent with a physical textbook. Those who reported only reading for revision would spend upwards of five hours reading per instance over the entire day. Most often, engineering students believed that reading should be done when it was required and not necessarily to look at concepts outside of what they are taught. Engineering students placed high emphasis on quiet when completing their studies. Those that had a quiet home environment reported to working at their desks at home, while the rest believed that the school library was the ideal quiet environment to keep them away from distractions. No engineering students reported using physical textbooks while travelling. All engineering students reported that the main purpose of their academic reading was to review what they had learned during the lecture and if required reading for their homework assignments.

Investigation into the task requirements of academic reading in a physical textbook was undertaken as a part of these focus groups. Students were questioned about what types of supporting activities they did during physical textbook reading to help them comprehend and engage with the material. Design students reported different supporting activities such as summarizing important points from the text into lists, highlighting, and searching for more information by keywords. These students make notes in the margins of the text, or if on a separate piece of paper, they attach it to the original text. They reported to using the margins of the text when the book was their own, whereas if it was a library book, they would use post-its or other paper. Most students reported that their notetaking was more visual in nature and included things like sketches and timelines. When searching for more information or other resources regarding the concepts, students reported using Google. Similarly, engineering students reported taking notes in the margins, underlining, highlighting, looking over drafts from class, and looking up definitions in the dictionary. Engineering students also reported doing practice exercises, something that based on the requirements of their discipline were novel.

Students also reported some ergonomics issues and other considerations when deciding to use physical textbooks. Both groups of students reported that physical textbooks are very difficult to carry around and hold in their hands. The expense of physical textbooks when compared to electronic textbooks was also a recurring topic. Yet, they believe that physical textbooks are not only much more convenient to take notes in, but they also support the more visual type of notetaking (see Fig. 2) that they require, which then assists in their comprehension and recall of the material. In addition, students reported the impression that they were reading more deeply and remembered the information more easily because they avoided distractions afforded by electronic devices, such as the constant connection to the Internet. There was also a sense of accomplishment when it came to finishing physical page.

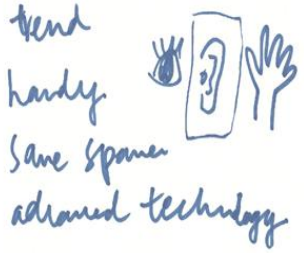


Figure 2. Example of visual notes that a design student made.

B. Electronic Textbooks

1) Definition

Before answering questions similar to those asked during the physical textbook segment, each focus group was asked to complete an activity in which they defined the term electronic textbook. The five Design student focus groups defined electronic textbooks in the following ways:

1. "A tool for learning without physical barriers. It contains lots of text, with additional elements including pictures, audio, and video."
2. "A gadget that allows us to learn wherever we are."
3. "A portable smart device, which is eco-friendly and able to store varied books with internet support."
4. "A digital content that allows easy access by different media and can be easily modified and shared."
5. "Allows a user to read through electronic devices (examples: computer, tablet, & phone), which provides more interactions and information by images, notes, which is more interesting, attractive, and convenient than traditional printed textbooks."

While the definitions themselves vary, they give insight into what the students view as the most important aspects of electronic textbooks. Students placed emphasis on the portability and diversity of the devices. The components of the aspects of the textbook itself is more limited and described simply as books or text with a few other aspects defined.

During this process, they also highlighted several components as important to their current electronic textbooks such as text, animations, images, video, dictionaries, and infographics. Text was considered especially vital to the electronic textbook as students felt that without text, the textbook loses its main purpose. They also highlighted some ways that electronic textbooks have enriched their learning experience such as facilitating communication, increased mobility, and increased interaction between the reader and the text.

The five Engineering student focus groups defined electronic textbooks in the following ways:

1. "A portable device, which includes all notes or text, video, and pictures into one appliance. It is cheap, environmentally friendly, and convenient when comparing to the physical textbook."
2. "A textbook, which does not print out on paper physically, but can be viewed and edited via electronic device like computer, phone, tablet. It has basic features as physical textbook and advanced features such as video, audio, tests, and animation."
3. "A softcopy that provides us useful content academically."
4. "A textbook in a soft copy version. It's the same as a physical textbook."
5. "A non-physical reading material, displayed by electronic devices. The reading experience depends on the user interface of the software."

Once again, definitions differed between groups, but similarities emerged. The groups believed that the electronic textbook was very similar to its physical counterpart, however many groups defined it as including additional advanced features as well.

Engineering students placed value on the electronic textbook's ability to search for keywords and additional components such as animations, video, and images that help facilitate their learning. They believe that the main purpose of electronic textbooks is to help students revise concepts they've learned in the classroom.

2) Usage

The questions regarding electronic textbooks mostly dealt with student habits regarding electronic textbook reading. Overall, design students reported that they spent significantly less time reading in electronic textbooks. When students did report reading in electronic textbooks frequently, they qualified that they were doing a physical reading from the electronic form. This happened most often when the readings were more than just a few pages. More flexibility was reported when reading with electronic textbooks, yet design students still reported reading most often in the classroom at their desk during the lecture. The reason they reported doing so was so that they may better understand the concepts that the professor is discussing. They reported that the average time they spend with an electronic textbook at times increases to usage during the entire day if they are working on a project. The majority of the time they access electronic textbooks they will use laptops, but if they had access to tablets they would do the reading on that device. They will use the phone if they need to do a short reading and they feel the convenience outweighs the limitations such as discomfort during reading and dizziness. They reported the preference for laptops was to avoid eye fatigue and also that when they wanted to save pages or chapters; there is more storage space in their computers than on their phones. Engineering students reported that they spent on average less than half of their time reading in electronic textbooks at home or while travelling in the afternoon and evenings. The increase in reported reading during traveling was because of the convenience electronic textbooks afford. The students access their electronic textbooks on laptop computers most of the time with only a few tablet owners reporting reading on that device. Phones were considered an extreme option and only used while travelling or when absolutely necessary for revision immediately before an exam.

Investigation into the task requirements of academic reading in an electronic textbook was undertaken as a part of these focus groups. Students were questioned about what types of supporting activities they completed during their electronic textbook reading to help facilitate their comprehension of the material. Design students reported using highlighting tools, music to help them focus, and Microsoft Word or the comment function to take notes. While design students reported taking notes while reading electronic

textbooks, they reported taking less notes than when using physical textbooks. Reasons for the limited notetaking were reported as difficulties with the annotation components and the fact that the components do not support the more visual types of notes, which they feel better facilitate their learning than text only notes. Engineering students reported using built in encyclopedia functions, dictionaries, search functions, highlighting, and screen capture functions most often. When they did take notes, they reported to either hand writing them or putting them in a separate Word document because they would not refer back to the textbook later. Several students stated that they do not take any notes when they move to an electronic textbook because of the inconvenience caused by the medium.

Even though students were not explicitly asked about physical and cognitive ergonomics issues related to electronic textbooks, both engineering students and design students brought this subject up. Both groups cited eye fatigue as a major concern associated with the use of electronic textbooks, so students prefer regulating electronic textbook usage to very short readings. One student described the situation succinctly, "If I need to read a long article, for example 20 pages, I would print it out instead of looking at the monitor. But if I only read for just one or two pages, I then will just read it on the monitor." The eye fatigue would, in turn, caused what students described as dizziness or issues reading the text closely. Many students reported skipping lines while reading or reading the content that was only based on the exact concept they need to understand and not complete the full reading. Design students also discussed how they would rather print long readings instead of viewing them online to facilitate their learning, believing that the addition of too many components may destroy their creativity. While engineering students stressed electronic textbooks were easier to carry and allowed for more mobility when completing their readings. They also reported to printing any long electronic readings they may have to complete.

Students also reported several technical issues and other aspects, which influence their interaction with electronic textbooks. Design students repeatedly reported the battery on their mobile devices as negatively impacting their academic reading. They also reported the time it takes to scroll through the text as a hindrance to their reading. Finally, they complained about the small size of the text and described how it made reading more difficult. Both groups of students also discussed how the ease of sharing and downloading electronic textbooks facilitated their learning. Also the usage of electronic textbooks allowed them to avoid the inconvenience of going to the library, identifying the call number, finding the book, waiting in lines, and then carrying it with them, which was a common complaint for both groups of design and engineering students. Accessing the texts online minimized the time it took for students to be able to begin their readings. The ability to quickly and easily go from one text to another was another reported convenience to electronic textbooks. In line with this, students reported that it was easier to identify new resources based on keyword searching. When they were able to identify a core concept they needed to learn, they would type it into the library website or Google to find more resources that referenced that concept. And while students discussed their dislike of reading electronic textbooks on their phones, they reported the positive affect on their time management. Students stated that using electronic textbooks on their smartphones allowed them to read in bed, read when they had spare time while waiting for friends, or read while stuck in unexpected traffic. In addition, students reported that the ability to take digital notes makes them less likely to lose said notes. Some students reported taking pictures of their physical notes to avoid this, while other students only took screenshots of pages or sections of the textbook that they though would be valuable to them later. Students also discussed how cost, mobility, and environmental friendliness made using electronic textbooks more desirable.

While many of these technical advances were reported to have a positive influence on academic reading and resulted in some positive perceptions, students reported many issues. When taking notes, students felt that typing instead of writing made it more difficult to remember and digest the concepts they needed to learn. Engineering students also wished for the ability to draw or write manually in their electronic textbooks, but reported that the current technology that allows these actions are buggy and slow making them unusable. The search functions that students found exceptionally helpful, they also reported as harmful to their reading. Students from both disciplines stated that they missed information when they tried to quickly complete their readings to avoid eye fatigue by searching for and only reading the sentences regarding the required concepts. Both groups of students felt that this negatively impacted their understanding of the material as a whole and put them at a disadvantage. Another major issue that came up with every student regarding electronic textbooks was distractions. Notifications from social media and messaging applications were reported as a major issue, which hindered focus during their academic reading sessions. Students also found that they lost time and focus when searching for keywords they found within their books online; they reported finding themselves playing online games or watching hours of YouTube videos simply by switching to their browser.

C. Future Electronic Textbooks

The future of electronic textbooks was investigated in many ways. Overall, design students reported that they would be more likely to use electronic textbooks if they were more interactive. They also desire more features such as accurate text to speech, improved bookmarks that used a sentence or word to mark a place, manipulatable images, and improved responses from the technology when attempting to select or highlight text. Design students also reported a desire for improved text displays, which would reduce eye fatigue, such as e-ink technology or the ability to select the colors and contrast between text and background based on individual preference. Engineering students also agreed that they would be more likely to use electronic textbooks that were more interactive. They believed that this type of electronic textbook would facilitate their learning, speed up their work progress, and make them more efficient students. They wanted less text and more components such as 3D and manipulatable pictures

and videos to help illuminate the concepts. The majority of the groups suggested ways of doing this that are not feasible with the current technology available commercially. Frequently both disciplines requested holographs or projection systems for the images so that they would be able to interact with them in what they described as a more interesting or detailed way. These students also placed large emphasis on better annotation tools. They felt that a more natural input for annotation would help facilitate their learning of the materials and if they could write with their finger or a pen and have the information be recorded within the electronic textbook that it would be ideal for their learning experience. Both disciplines thought that electronic textbooks would be improved by shorter blocks of text. Some students even believed that simple summaries of the main concept would assist them during their academic readings.

When students were presented with information regarding the answers from the previous survey, design students agreed that the top five components chosen were appropriate (see Table I). They believed that text was more vital to the learning experience than students in the survey rated it, but agreed that the readings they have to read are diverse and that a lot of it seems unimportant to them, which could have influenced the ranking. Students reported that multimedia ranking first was understandable based on their discipline but thought that the importance of the information from the text should not be subverted. Design students also reported that the findings of the undesirable components from the survey were valid (see Table II).

TABLE I. COMPONENTS DESIRED BY STUDENTS

Rank	Desired Components	
	Design Students	***Engineering Students***
1	Multimedia	Text
2	Bookmarks	Highlighting Tool
3	Highlighting	Multimedia
4	Text	Bookmarks
5	Translation, Dictionary, and Encyclopedia	Annotation

While students liked the idea of speech to text in their electronic textbooks, they eventually decided that the benefits of the tool were not appropriate for electronic textbooks because the note taking required for academic reading requires more thought than afforded by speech to text tools. Only one group felt that link to experts for answers to questions should be included in electronic textbooks. These students felt that this tool could combat the limited amount of time they have with their course tutors. The other four design focus groups did not believe this component was necessary at all. Engineering students thought survey respondents had overestimated the importance of text and underestimated components such as 3D images. The student participants felt that these were the core features that should be included in future electronic textbooks and that they are in line with the traditional conventions that are already in place. They believed that this type of response was because respondents chose components they were more familiar with and could envision. Other than that, students believed the other components chosen as desirable and undesirable were valid. They especially agreed with the inclusion of a time management system as an undesirable component as they felt it would cause added unnecessary pressure to their reading experience.

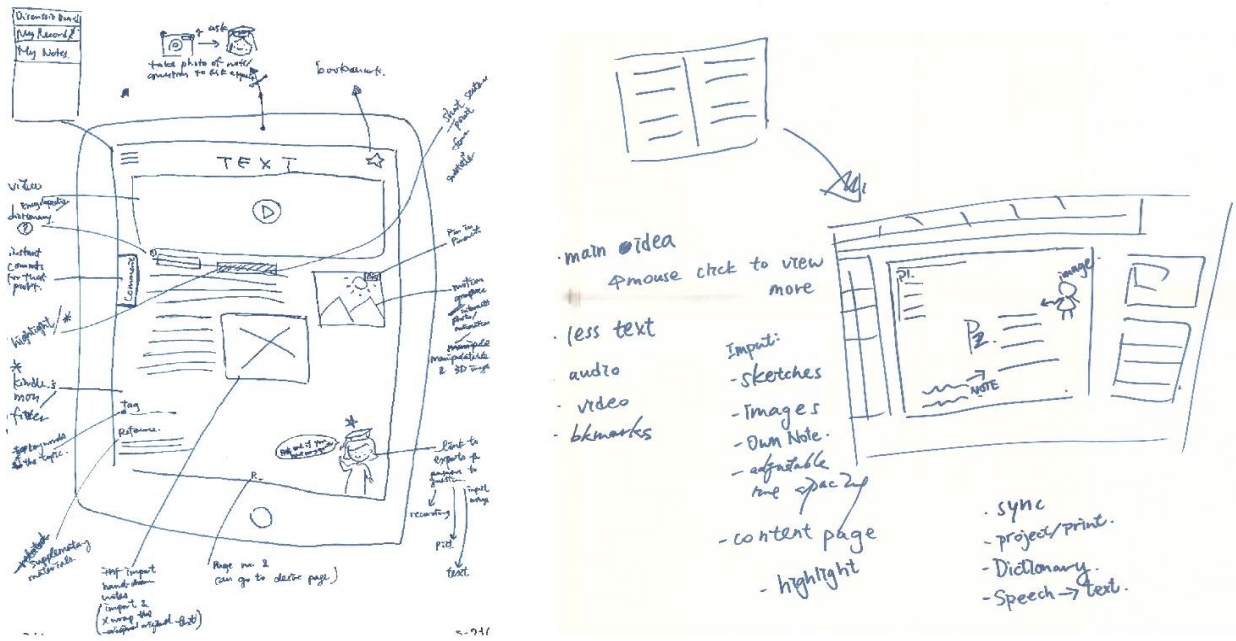
TABLE II. COMPONENTS UNDESIRED BY STUDENTS

Rank	Undesired Components	
	Design Students	***Engineering Students***
1	Hide Unimportant Aspects	Hide Unimportant Aspects
2	Speech to Text	Time Management System
3	Time Management System	Speech to Text
4	Link to Experts	Text to Speech
5	Text to Speech	Project or Print Annotations

After this general information was gathered, students were asked to complete the final activity in which they were given free rein to create the perfect representation of an electronic textbook for their discipline. As this was without the constraints of current technology, many of the solutions students presented would not be fully functional at this time. Design students produced results that were more visual in nature. The majority of focus groups provided sketches of their visions of future electronic textbooks, keeping notes on functionality and features surrounding the sketch while the other groups provided more descriptions on the functions with sketches supporting those (see Fig. 3).

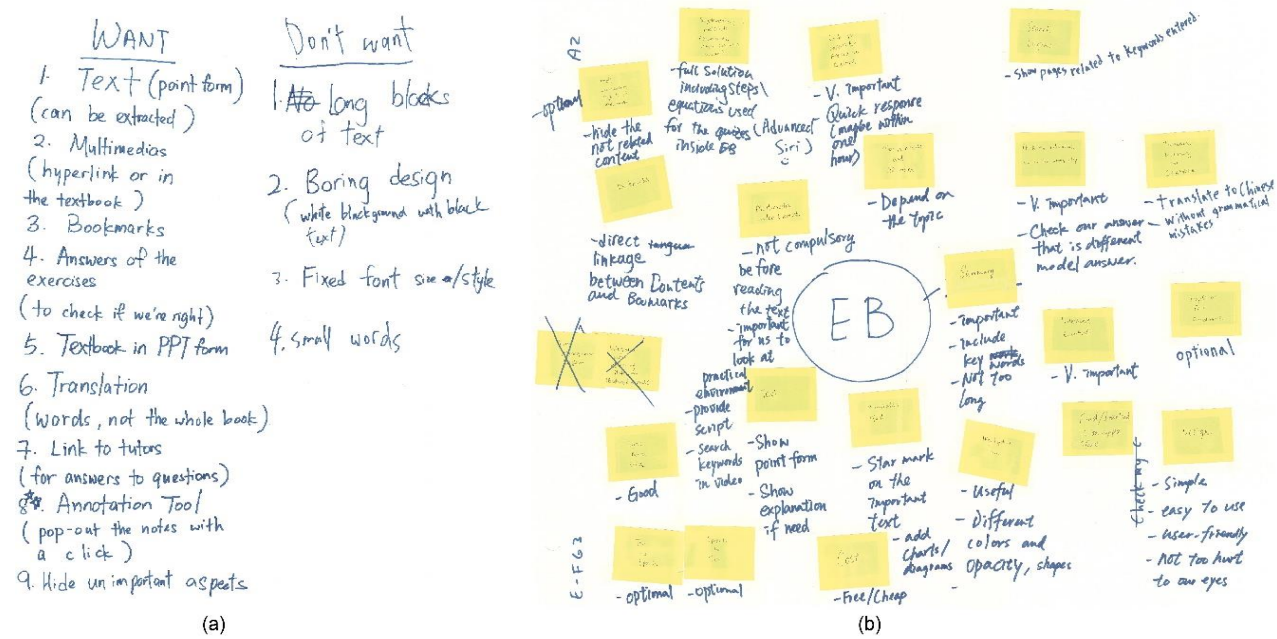
Their electronic textbooks often took inspiration from applications such as Adobe Illustrator's interface and included the ability to add notes or photos directly inline, shorten forms of the text with emphasis on important concepts rather than of paragraphs, adjustable line spacing and text size, a table of contents, video, audio, adjustable images, bookmarks, the ability to synchronize across devices, translations, a dictionary, and an encyclopedia. They felt that highlighting and annotation tools would no longer hold as much importance future electronic textbook because there would be much less text but still included them. Yet, both groups of students felt they were still vital to the learning experience and included them. They did stipulate that the current rigid structure of these two components were no longer acceptable. Highlighting needed to be more free form and easier for students to accomplish, whereas annotation tools needed to have a better physical input. Typing notes into the annotation tool was considered to be a hindrance in learning the material. Students felt that handwriting better suited their notetaking styles. They reported that this type of notetaking would allow them to draw their own pictures or create lists in bullet point forms to better recall and comprehend the materials. Students also often built in the ability to hide unimportant content automatically by extending the text by clicking on the bullet

point text. Many similar components appeared in the engineering future electronic textbook, yet the representation all groups of engineering students chose to convey their textbook was a list form (see Fig. 4). This electronic textbook also relied on less text, but included some discipline specific aspects like interactive equations.



(a) (b)

Figure 3. Two examples of the future electronic textbook by Design Students.



(a) (b)

Figure 4. Two examples of the future electronic textbook by Engineering Students.

IV. DISCUSSION

This section discusses the findings from the focus group sessions as a whole and in relation to past literature.

A. Student Usage

Student usage of physical and electronic textbooks differed in both disciplines in all aspects of use. However, both disciplines of students felt that current electronic textbooks did not meet their needs as well as the physical textbooks did. They described usage of electronic textbooks as something that was encouraged by peers, faculty, or necessitated by circumstance. Faculty support of the use of electronic textbooks for their courses has been found to generally increase student usage of electronic textbooks [22]. The mobility offered to students by electronic textbooks do change where and when they do their studies, something that students did describe as a convenience that outweighed many of the limitations of electronic textbooks. In line with previous studies, even with this ease of downloading and mobility, students still reported that they preferred physical textbooks [2]. In addition, even with the increase mobility, students tended to access their electronic textbooks on the more cumbersome technology that is harder to use while mobile, which is in line with previous literature that found that users of stationary computers such as desktops were more likely to have experienced reading with an electronic textbook [22]. Similar to what past research has uncovered about this phenomenon, students reported not wanting to read long blocks of text in an electronic textbook [3] and that feelings of nostalgia [23] make it difficult for them to adapting to the new medium. Nearly all of the focus group participants reported that they would print out long readings, rather than printing them on the screen. If printing of the materials was not a function that was built into the electronic textbook, students would go so far as to find a work around. Students discussed going out of their way to find copies of the textbooks that lacked Digital Rights Management (DRM) restrictions and even to taking screenshots of the pages and later printing them. Printing out pages from electronic textbooks allows for students to continue to experience the four affordances of spatial flexibility, manipulability, tangibility, and tailorability, which students are nostalgic about in regard to print textbooks [12].

Supporting activities also changed for many students. They found themselves taking notes less, several going so far as to report no longer engaging in any supporting activities, and, as past research has found, they were becoming frustrated with built in functions such as bookmarking, highlighting, and annotation tools [11]. Repeatedly, students reported taking notes in the physical form was easier and allowed them to see their notes with the concepts, which later assisted in revising the material. Those that took electronic notes would do so in a Word document so that they may include outside material along with their summaries of important concepts, such as pictures or links to other reference material. They then reported that they would not go back to the textbook where their notes could be taken in context of the larger material.

In addition to the change in supporting activities, the addition of the inherent distractions during reading of electronic textbooks is a serious issue that needs to be addressed. Students stressed that certain components added to enhance electronic textbooks or the simple act of switching to a browser to search for a keyword adds time on to the total reading experience and that past research has informed us will interrupt their deep reading and overall comprehension of the materials [24]. By investigating current use of both types of textbooks, the differences in usage, issues that may arise and understanding the reasoning behind the usage design recommendations, such as shortening blocks of text and finding opportunities to incorporate aspects reminiscent of the four affordances, such as the ability to see notes on the page instead of hidden within an icon, can be made for future electronic textbooks. Also this type of comparative investigation allows for an understanding of technical and ergonomic issues, which emerge from the shift in mediums that can then be designed to avoid.

B. Future Textbooks

Student preference for design attributes of electronic textbooks was similar in both disciplines of design and engineering, yet several components differed. Overall, all students agreed that text should be limited to the most important information presented in a shortened paragraph or bullet point form. More information could then be accessed through hovering over the text or similar interaction. Students also felt that creating textbooks that were more interactive would facilitate their learning and allow them to truly understand and engage with the material. Based on student responses, making this type of change would rectify the shift in reading style away from what scholars identify as surface reading back to deep reading [9, 10], which past research has proven necessary for succeeding academically. While these reported changes may make electronic textbooks more appropriate for the type of reading required, previously reported interaction may have been influenced by current ideas of electronic textbooks like the students in the focus groups reported with the past survey results [16]. In addition, student enthusiasm for these components may later wane, but previous studies show that should do little to the effectiveness of the components [25].

Because of the issues associated with students' dislike of long blocks of text and subsequent effect on reading quality, it is recommended that designers incorporate short blocks of text [26] with extended information hidden. The loss of information in long form can be supplemented with components such as multimedia or other engaging components. Although limiting the text may make the information easier to students to digest and read, changes still need to be made regarding the supporting tasks. The common request for electronic textbooks to include a more natural input method for notetaking, which would be closer to handwriting has been already implemented in some e-reading applications such as Evernote (see Fig. 5), this technology is still reported to be cumbersome and not available in many of the applications students use during their academic reading. Based on student feedback during the focus group sessions,

more advanced and user friendly versions of this component would be well received and assist in encouraging students to use electronic textbooks. Many of the students also reported desiring a stylus to take notes. While this may make taking notes more reminiscent of taking notes with physical pen and paper, it may create additional complications, which were not previously present in electronic textbooks. Examples of this would be creating a situation where the stylus has to be replaced when a student misplaces them, causing an additional expense or making taking notes when completing academic reading whilst traveling more difficult than it was previously reported.

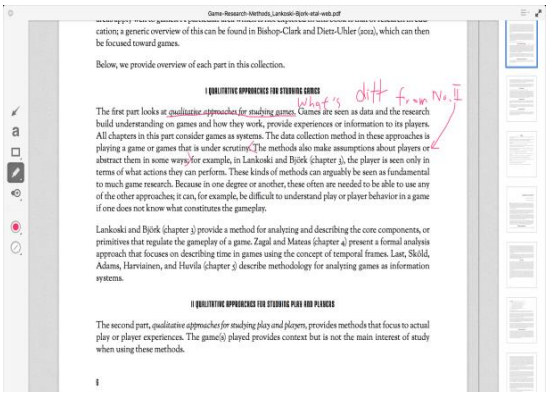


Figure 5. Example of notes taken in an electronic text in Evernote.

C. Comparison of Disciplines

While there were many similarities in responses on the components and format in which future electronic textbooks were presented from both engineering students and design students, there were some fundamental differences. One of these differences was highlighted during the second activity in which it became apparent that while similar requirements may be requested, the ways in which students think and interact with each other and academic materials are different. Design students felt comfortable creating a visual representation of what they thought their perfect discipline specific future electronic textbook was and worked together from the start to create their ultimate proposal, each of them adding to the proposed textbook as they saw fit. This can be associated with the nature of design being undertaken as a team project, especially as taught at this university. On the contrary, engineering students presented their answers in a list form and instead of compromising and discussing opinions during the creation process, waited until after their individual lists were made to try and unify their answers. They also requested that one student write the final list and would only switch designated writers if they felt they did not support the inclusion of a component as strongly as another student. This could be attributed to the often solitary nature of engineering projects, at least in the early stages of work.

When examining the differences in component inclusion, the discipline requirements become apparent. While both groups of students wanted to be able to add their own photos to the text inline or with obvious icons to remind them of their inclusion and have text represented in bullet form, engineering students did not feel that taking their own notes were absolutely necessary in the new textbook and questioned the requirement for inclusion of this tool, though including it later in their final recommendations. When asked about their hesitance surrounding the inclusion of the component, they stated that the information was now in point form and they no longer needed to take notes but could still see value in the inclusion of the component. On the contrary, design students felt no hesitance surrounding the component and still wanted to take their own notes, indicating that this was a requirement based on the interdisciplinary and creative aspects of the design process. Engineering students also requested the component interactive equations to be included in their future textbook, which is consistent with a discipline that requires the use of equations in their work over those that do not, such as design.

Based on the educational requirements of both disciplines of students, it is important to ensure that components change based on the needs of the students and the concepts that the electronic textbook is trying to convey to their readers. Researchers have called for this in the past, requesting that textbooks are coherent and the content is tailored to the reader groups who will be using them [27]. This concept should be extended to the components that will be used in electronic textbooks. Hartley proposed in the past that "changing the way we write textbooks is one way in which we can make a major improvement in the quality of instruction" and proposed that electronic textbooks could do this with different examples for different readers [27]. This already accepted idea, can be extended from the content design and into the technical design. Some educators are already calling for digital textbooks, which bring together different types of content such as multimedia and text to create an electronic textbook that will be more interactive [28], which is echoed in the responses of the student participants in the focus groups.

V. Conclusion and Future Work

Overall, students believe that future electronic textbooks need to be improved to become more interactive to facilitate their learning and help them fully engage with the material. Some examples of changes that both engineering and design students believed would be beneficial to their academic reading process were 3D and manipulatable images, multimedia related to the concepts, and better annotation tools, which allow them to add more than just textual notes related to the topic. Also, students from both disciplines were not averse to changes in textbooks, which are currently outside of commercial technical capabilities such as holographic images. Although, students can agree on these components, when comparing two similar disciplines that share many fundamental characteristics with differences in approaches, it becomes apparent that we need to adopt an approach to textbook design that tailors electronic textbooks to meet discipline specific needs.

From the findings of these focus group sessions, some design criteria can be identified for future electronic

textbooks. The future electronic textbooks need to become more interactive, discipline specific, and with less text. Also, discipline specific components are vital, such as interactive equations in engineering textbooks, to better facilitate the understanding of their work and engaging with the material.

While design recommendations such as these have important applications to industry and academia, more research should be conducted to truly verify the practical validity and educational repercussions of the components suggested. The educational perspective should also be investigated to understand the use of electronic textbooks as a teaching aid. This perspective is best investigated on an individual basis because of the changing opinions on appropriate classroom instruction techniques of the individual instructors.

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