

THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

COLLEGE OF INFORMATION SCIENCES AND TECHNOLOGY

UNDERSTANDING RATIONALE FOR SELECTION OF ELECTRONIC VERSUS
PHYSICAL TEXTBOOKS BY COLLEGE STUDENTS

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SPRING 2015

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Information Sciences and Technology
with honors in Information Sciences and Technology

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ABSTRACT

This survey study will examine the utilization and effectiveness of note-taking tools in college students using electronic document readers and touch-enabled devices. Prior research has been limited in scope and detail and prompted a need for further research. Earlier information suggests that price and convenience are motivating factors for device and title purchase, but make few claims about utilization of note-taking tools. The primary objective of this study is to gain insight into students' rationale when selecting the electronic medium for their textbooks as well as the effect that this selection has on their understanding. Surveys will be used to gather information and will serve as the primary form of data collection. Chi-square, Yates' correction, and Fisher's exact test will all serve as statistical measures to analyze the data.

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ACKNOWLEDGEMENTS

Over the past four years, the development of this research and support has been enormous from a variety of sources. In particular, the following have all been instrumental to me by providing mental, moral, and technical support.

Dr. Steven Haynes, for his commitment and dedication as my honors advisor and professor.

Dr. Erika Poole, for her assistance in preparing me through usability testing coursework and for her editorial and professorial help as a reader.

Dr. Luke Zhang, for his instruction in research methods and development of the foundation with which this research was first conceived and conducted.

My family, for their support and guidance throughout the journey, culminating in this project.

Chapter 1

Introduction

In the past decade, electronic textbooks have become increasingly visible in the student textbook marketplace. A number of studies have been conducted in an attempt to ascertain the benefits and utility of these electronic textbooks. In particular, with rising tuition and textbook expenses, one of the primary motivators that drives students to digital textbooks is the decreased cost (Nicholas & Lewis, 2011). A number of studies have found that despite benefits such as decreased cost, as well as dictionary and search functionality, a majority of students still prefer physical textbooks (Gregory, 2008) and any prior familiarity with the electronic medium failed to influence the student (Woody, Daniel, & Baker, 2010).

This research seeks to gain a deeper understanding of college student's rationale when selecting a physical or digital edition of a textbook. This thesis seeks to gain an understanding through an analysis of prior literature and research as well as studies conducted throughout the 2014-2015 school year.

The State of Electronic Textbooks in 2015

In 2015, Electronic materials have become increasingly prevalent, with various formats both openly available and rights-protected coming onto the market. These formats are viewable on personal computers or microcomputer devices, such as tablet computers or dedicated E-readers, such as those produced by Amazon or Barnes and Noble (Behler, 2009). With the influx of technology surrounding these devices and their use, textbook publishers have seen that a market exists for offering their materials digitally. Prior research discusses the possibility for print and digital mediums to coexist, as discussed by Cox (2004) and Gregory (2008). The primary considerations users have stated for their electronic textbook usage are functionality and price (Nicholas & Lewis, 2011).

Functionality refers to the features and elements of an electronic textbook that enhance and improve the experience of reading an electronic material. Williams, Slade, & Dwivedi (2014) conducted a study with a 5-point Likert scale and determined that to increase e-reader use, companies should “focus on emphasizing the usefulness and ease of use of the device.” This feedback is in line with the 2009 assertion by L. Moore’s doctoral dissertation which stated, “current ebook readers do not adequately address the functional or interaction needs of leisure readers” and elaborated on the current functional deficiencies of technologies at that time. As of 2014, these problems continue to exist, as “e-readers...lack strong search and navigation topologies” (Hyman, Moser, & Segala). Given this understanding, the primary expectation is that many people have found the advertised functions to fail to meet requirements and have thus felt less inclined to use an electronic medium for reading because it fails to cleanly deliver this functionality.

With regard to pricing, the issue can be approached both as a publisher of content and also as a consumer of content. Although Gallagher (2002) noted that at the time, “leading publishers have seen little traction with e-textbook offerings a few years ago because of the high technology cost,” the truth is that the biggest influence in the increase in e-textbook consumption is related to price. Connaway & Wicht (2007) touch on the issue that some feel that e-books should cost the same amount as a typical textbook, but in many cases of multi-user licensing, this has been shown to not be the case. This primarily affects publishers and “distributors” such as libraries at universities and in major cities, where multi-user licenses are required in order to lend copies of electronic texts to many users simultaneously.

Looking at individual consumers highlights the importance of price point, with many researchers indicating the value of a book’s sticker price. Rockinson-Szapkiw, Couduff, & Bennett (2013a) indicated that 63.2% of e-book users in their study indicated price as a reason to choose them. A finding from two years prior suggested that “if an e-textbook were just \$25 less than a print version, 75% of the students would select it” (Nicholas & Lewis, 2011) and four years prior, these researchers had examined a small group and found that within the group, all of the first-time e-book purchasers made the decision based on

price (2007). These statistics have indicated that for a significant period of time, price has been the guiding factor in individual consumers' decisions to purchase digital content, and there is no evidence to suggest a widespread change in the near future.

Chapter 2

Literature Review

Organizational Structure of Literature Results

The structure for organizing literature broke the discovered material into the following subcategories:

1. Background information and prior research
2. Preference for Electronic Materials
3. Inhibitors to adoption of digital technologies
4. Comprehension parity
5. Other Psychological benefits

Literature Search Process

In order to conduct the literature review, several databases were used for primary source discovery. These included the Penn State Digital Library catalog, the ACM digital library, and Google Scholar's directory of published articles and papers. Generally, the searches began with keyword searches that would then branch out, based on similar citations or papers from similar publications. The keywords that were most successful at collecting content included:

- e-textbook
- e-book
- electronic book
- e-reader

Key Themes of Discovery

Background information and prior research

This theme area was chosen to allow for a strong foundation of background information on the topic of electronic textbooks and also to help provide context for why this research has value.

Key themes included:

1. Demographic trends with regard to e-book adoption. This extended to various world populations and age demographics influencing who were more likely to adopt this technology.
 - a. This paper addressed the current trend of certain Asian populations to be leading the way in mobile learning technologies (Hyman et al., 2014)
 - b. This paper addressed the trend of younger, high-income people to be disposed towards utilizing e-book technologies (Jung et al., 2012)
 - c. This paper addressed the concept of “superusers” with regards to e-books and some of the defining demographics for that subgroup (Nicholas et al., 2010)
2. Coexistence with textbooks in a setting such as an academic library or a textbook-based learning environment.
 - a. This paper noted the continued niche for both print and digital mediums (Gregory, 2008)
 - b. This paper addressed the presence of digital and physical mediums within the context of a library (Cox, 2004)

Preference of Electronic Materials

This theme area exists to create and develop an understanding for why students prefer electronic textbooks as a medium over physical print textbooks.

Key themes are:

1. Functionality and the key areas that users seek when opting to use digital resources.
 - a. This paper addressed the intentions of various users when considering when and how to use e-readers, and examined the functional criteria users considered (Williams et al., 2014).
 - b. This paper addressed the primary theme of functionality in e-reader usage through a study of e-book consumption in the leisure setting (Moore, 2009).
 - c. This paper addressed the requirements set forth between fiction and textbook consumption on e-readers, focusing on key areas of functionality required by users (Malama et al., 2005).
2. Price as a determining factor when selecting which medium of a book to purchase or use.

In addition, looking at purchasing habits for this type of material.

- a. This paper focused involved a comparative study of why students elected to use certain mediums for the textbooks in university, and highlighted student concerns about price (Riockinson-Szapkiw et al., 2013a)
- b. This paper directly discussed the criteria used by college students when determining which medium to use for their textbooks (Nicholas & Lewis, 2011)
- c. This cited paper examines a small-scale study of undergraduates which revealed purchasing habits for electronic textbooks (Nicholas & Lewis, 2007)

Inhibitors to digital technologies

This theme area is dedicated to understanding the key inhibitors to digital technology adoption and usage. The key themes are:

1. Distractions that can occur as a result of the use of technology for reading
 - a. This paper addressed the understanding usage intent and actual usage of mobile learning agents (Hyman et al., 2014)

b. This paper was a comparison of performance between electronic and printed texts, discussing the variance in student learning and also covering issues such as distractions that could occur (Daniel & Woody, 2013)

c. This survey addressed why university students were electing to use electronic textbooks and their benefits and drawbacks (Levine-Clark, 2006)

2. Cost as a prohibitive factor that prevents and stifles adoption of technology that would be useful for growth and development

a. This paper focused on understanding what market environment conditions will be beneficial for emerging technologies. In specific, a note is made with regards to electronic textbook adoption (Jin & Li, 2012)

b. This research discussed user satisfaction and concerns with eBook readers, making a note of the drawbacks discussed (Richardson & Mahmood, 2012)

c. This survey examined e-reader adoption amongst college students and attempted to gain an understanding of rationale behind purchasing a device (Foasberg, 2011)

d. This paper analyzed the criteria used to determine which medium to use in a college student's life. (Nicholas & Lewis, 2011)

e. This cited work discussed rationale behind why digital publishers have suffered in recent years (Gallagher, 2002)

3. Access restrictions and complex licensing policies that confuse readers and undermine the shared and flexible nature of the digital medium.

a. This paper sought to address the reason why e-books are not as widely spread in the public and academic library settings today (Slater, 2010)

b. This paper examines some of the major barriers to the e-book revolution and examines academic libraries' inability to transition fast enough (Connaway & Wicht, 2007)

Comprehension Parity

To understand the preference, this theme area establishes the equality of results when looking at the various mediums.

Key themes are:

1. Course grade equality and the statistical backing behind each medium for academic success.
 - a. This paper directly investigated the correlation between cognitive learning and student success (through grades) when using an electronic medium for textbooks (Rockinson-Szapkiw et al., 2013a)
 - b. This cited work involved understanding benefits and drawbacks of electronic textbooks (Shepperd et al., 2008)
2. Learning Outcomes and Comprehension equality when examining qualitative data for each medium. While not directly measured for academic success, this is a significant metric for raw language understanding.
 - a. This paper was a comparison of performance between electronic and printed texts, discussing the variance in student learning (Daniel & Woody, 2013)
 - b. This paper directly investigated the correlation between cognitive learning and student success (through grades) when using an electronic medium for textbooks (Rockinson-Szapkiw et al., 2013a)
 - c. This doctoral dissertation examined whether electronic books would influence comprehension or motivation of students (Wells, 2012)
 - d. This paper compared the use of various font sizes and page layouts to enhance reading comprehension and performance (through speed) (Tsai et al., 2011)
 - e. This doctoral dissertation focused on understanding the readability and reading comprehension of various small-screen devices (Baker, 2010)

f. This paper discussed students' preference and satisfaction with electronic textbooks, calling out explicitly the equality in performance (Woody et al., 2010)

Other Psychological Benefits

This theme area exists to explore the psychological benefits that using and preferring digital technologies can bring.

Key themes are:

1. Satisfaction with a digital technology as a reading tool or aid.
 - a. This paper examined the motivation for students to become repeat users of e-texts as well as the factors that lead to reader satisfaction (Stone & Baker-Eveleth, 2013)
 - b. This paper studied the influence of navigational aids on student satisfaction with electronic reading assignments (Sung & Mayer, 2012)
2. Ease of use and Usability of a digital technology for reading and knowledge consumption.
 - a. This paper addressed the use and effectiveness of visual design guidelines for interactive digital text in areas including usability (Jin, 2013)
 - b. This paper examined the importance and value of adequate legibility and usability in e-reader design (Siegenthaler et al., 2010)
 - c. This paper addressed the concept of expectations about usability in e-reader usage through a study of e-book consumption in the leisure setting (Moore, 2009)
3. Confidence in self, both as a reader and in comprehension ventures.
 - a. This study examined English as a Foreign Language students' perceptions of an e-book reading program (Huang, 2013)

- b. This study examined struggling readers at the secondary school level who utilized e-readers to build confidence and develop reading comprehension skills (Lettenmaier, 2013)
- c. This study addressed the academic success of students when utilizing electronic textbooks as well as the mental states of those students (Rockinson-Szapkiw et al., 2013a)
- d. This study addressed the concept of using e-textbooks to motivate students to read and become more self-reliant when reading (Rockinson-Szapkiw et al., 2013b)
- e. This doctoral dissertation addressed the mental understanding of a novice to a technology and reading comprehension in this context (Baker, 2010)

Literature Summary and Value of Research

In summary, e-reader technologies have existed for some time. Over the past two decades, there have been numerous advances to help mitigate impediments, however, there is still a lower adoption rate than experts had predicted. Students are fairly consistent when it comes to preferring electronic materials, citing consistent reasons like increased functionality and potential cost savings when they examine e-readers. The drawbacks, however, are the distractions that come with connected technology use, as well as increased upfront cost and confusing access and licensing policies. Overall, these inhibitors seem to be deterring many potential e-book consumers, but the trends over time show that e-book consumption is on the rise and students are drawing significant benefits from the technology.

Although through numerous papers, the empirical evidence has shown that both course grades and basic comprehension remain statistically similar across the electronic and print mediums, electronic textbooks are still succeeding for many readers. There is significant evidence that demonstrates a marked psychological improvement when utilizing electronic reading materials, signifying value in the adoption of the technology, especially when considering struggling or foreign demographics. This psychological improvement means that in some cases, even though objective metrics are equal, students feel more

accomplished or more successful when using an electronic textbook. These gains cannot be discounted, and merit further research at the least.

Finally, there is a “paucity of peer-reviewed, research-based articles” in this area, and additional research, especially which seeks to be peer-reviewed and grounded in research, must be completed in order to prevent an overall draught from preventing future advancement in this field of study (Richardson & Mahmood, 2012). The research question proposed in this paper will further and supplement research which has been completed prior, and will provide further information for future researchers to build off of.

To this end, further academic research in this realm will provide an increased understanding of students’ disposition towards electronic materials. Faculty and educators find their assignments competing for attention with other technological consumption, and providing students with a medium that they believe in will maximize their chance for success.

Chapter 3

Preliminary Research

All pilot study information and results are provided from Honors Option Research Pilot Study (Freda, 2014a) with consent of the author. Summary and interpretation are provided from IST 489H Research Assessment (Freda, 2014b) with consent of the author.

In order to understand the reasons behind students' decisions and assess whether or not students are deriving mental benefits from their selection of a given textbook type, an initial pilot study was conducted in the Spring of 2014 to ascertain basic information that was utilized to refine and iterate on the research process and methodology. The basis for this pilot study was to analyze and gain a basic understanding of how students perceive reading in the digital and physical mediums.

The primary research question for this pilot study was with regard to students' perceived and actual preferences. Students claim they prefer a specific medium, but does their rationale hold up when those students are completing work, or is it a mental deception? This study sought to examine this question in the context of article-length (approximately 20 pages or less) reading assignments, common to the University setting, and frequently used to convey information in case studies.

Research question:

At this point in revision, the Research Question is, "Are college students utilizing electronic textbooks for more effective reading than conventional textbooks?" It involves a few elements – the first examining a specific population and its usage of a technology, the second analyzing a specific method of understanding, and the third examining two comparative mediums for that technology. This research carries value not only to students seeking to find better ways to understand material, but also to educators

in terms of providing content as well as manufacturers and producers of textbooks and electronic reading devices who may see financial value in improving or redesigning processes around the results.

Methodology

Participants

The participants in this study are college students from the Pennsylvania State University's IST 331 course. The majority of students in this course are 3rd-year students who are members of the College of Information Science and Technology. In exchange for participation in this research, students were provided with one in-class extra credit point. In total, eight students participated in the pilot study.

Experimental Design

To conduct this study, a method was developed to create a scenario where students could be presented with reading materials and could provide feedback on different technologies. Participants were selected from the IST 331 Section 001 and were compensated with in-class extra credit for participating in the study. Students were informed that this study was to study the various ways in which electronic reading technologies differed from physical mediums. In order to minimize the risk of the participants biasing results, participants were informed that the basis of the study was to analyze data through the comprehension questions. This decision was made to ensure that students were focused on an end goal of answering questions and were able to be candid regarding the technology and features that they preferred and utilized. In addition, the researcher observed the students from a distance to allow for the best simulation of individual, independent work without time or proximity pressure from the researcher. These

decisions were made in an attempt to minimize any behavioral modification due to observation, referred to as the “Hawthorne Effect” (Landsberger, 1958).

Equipment

- Microsoft Surface Pro 256 GB Touchscreen Computer
- Google Drive Form for participant data entry
- #2 Mechanical Pencil
- Blue Pen
- Black Pen
- Highlighter
- Printed Survey
- Printed copy of article #1, “Coach K: A Matter of the Heart”
- Printed copy of article #2, “Cultural Intelligence”
- Digital copy of article #1, “Coach K: A Matter of the Heart”
- Digital copy of article #2, “Cultural Intelligence”

Procedure

The protocol for participants using a digital medium were as follows:

1. Interviewer reviews procedure and obtains verbal consent
2. Participant is given Surface Tablet Computer and instructions on use
3. Participant answers pre-survey questions on the tablet
4. Participant reads passage one and answers comprehension questions on the tablet
5. Participant reads passage two and answers comprehension questions on the tablet

6. Participant answers post-survey questions on the tablet

The protocol for participants using a physical medium were as follows:

1. Interviewer reviews procedure and obtains verbal consent
2. Participant is given printed copies of the survey, question packet, and both reading passages
3. Participant answers pre-survey questions
4. Participant reads passage one and answers comprehension questions
5. Participant reads passage two and answers comprehension questions
6. Participant answers post-survey questions

The online version of the survey can be found online at <http://bit.ly/1hSyqi4>.

Results

With a sample size of $N = 8$, the results of this study will have small statistical power, but will still offer some insight into the potential discoveries that can come from further research.

Enjoying Reading

The mean enjoyment level participants listed for reading was 3.875, with minimum 2 and maximum 5 on a 5-point Likert Scale. Related data includes that participants answered that they read an average of less 45 minutes per day outside of class assignments and 75% of respondents indicated that they had read between 0 and 4 books in the previous year outside of class.

Using Electronic textbooks

Only 1 participant had never used an electronic medium for textbooks before, but all but one participant indicated that they used this medium for 5 or fewer hours per week. 75% of participants indicated that they would prefer a physical medium over electronic, and reasons for preferring electronic textbooks were limited to “Price to obtain”, “Convenience to obtain”, and “Ease of carrying/transporting”.

After completing the reading, half of the respondents who had a preference of medium indicated that they would prefer the digital and half indicated they would prefer the physical medium. 37.5% of respondents switched their preferred medium of choice, but no trend between medium switching (A -> B or vice-versa) was present.

The mean ease of reading on the provided medium was 2.667 for electronic and 3.5 for physical, with only 1 participant rating the difficulty of reading on the medium above average. The text size received a mean rating of 2.75 with 1 indicating that text was too small, although the mean rating for the physical medium was 3.

The most frequently requested function that students believed would help them was a “Search Function”, with 75% of participants indicating that this feature would be one they would use.

Conclusion

Enjoying Reading

The results from participants’ mean enjoyment level correlates strangely with the two other elements of data – Participant’s quantity of non-class reading and the number of books participants had read outside of class. Despite the fact that students indicated they had an above-average enjoyment of reading, the participants read an average of less 45 minutes per day outside of class assignments and only two participants responded that they had completed more than 4 books in the previous year.

These results lead to the reinforcement of past trends that indicate students may have built an enjoyment from reading while younger, but no longer are able to read as much as they would like to after entering college. While lacking depth, this is an area that would be well understood to assess the development of electronic technologies for reading.

Using Electronic Textbooks

The results for electronic textbook use indicated that the overwhelming majority of participants have utilized this medium before, but despite the fact that students had experience and used this medium during their week, 75% of the participants indicated that they would prefer a physical medium prior to completing the assignment. The significance of this value is that in principle, many participants believe that they prefer physical content, but after completing the reading, only 37.5% of participants indicated that they would prefer a physical medium to complete the assignment.

This is likely related to the desired features students indicated when considering how to best complete assignments. The overwhelming majority of participants (75%) indicated that they would use a search function, which is one of the key elements of using an electronic textbook, or even just reading online. However, when the participants were asked to consider the criteria for preferring an electronic textbook, the only commonalities were ease of carrying, price, and convenience to obtain – additional functionality like searching was absent. This is in line with the research conducted by Rockinson-Szapkiw, Courduff, Carter, & Bennett in 2013 as well as Nicholas & Lewis' 2011 and 2007 papers which indicated that price was one of the primary factors students considered when deciding which medium of textbook to purchase.

Thus, we can see that prior to completing work, students are focused on external characteristics of textbooks, namely price and the convenience of a non-physical copy of the book. However, after

examining the content and completing assignments, students' preferences begin to vary more and their focus shifts to the features and functions that enable them to complete their work more efficiently.

Implications of the study

The implications of the Freda (2014) study show that many of the points raised in the previous iteration of research question review are valid and still worth investigating. In particular, the areas of validity, research method selection, identifying human levels, and additional qualitative research methods. These areas first examined in the initial research question summary have been elaborated and expanded upon below:

Validity Issues

Previously, the validity issues raised concerned External Validity. As the question seeks to understand students utilizing a specific electronic medium, the focus has narrowed and no longer places emphasis on the Construct Validity as previously discussed. By focusing on only one area of validity, the research question needs to continue to take into account other technological uses outside the specific scope of the research question. Conclusions can still be incorrectly drawn or improperly formed, but by taking into account additional use cases and scenarios, the risk can be mitigated (McGrath, 1981).

In addition to the risks posed by costs and the barrier to entry for participants, one major area of consideration that has become necessary is the demographic background of students. In the pilot study, two students were non-native English speakers, and the result was that their experience was drastically different from native English speakers when it came to completing the readings. This demographic difference has been noted in research papers, such as those by Hyman, Moser, & Segala (2014) which saw that learners in "Asian Pacific countries have come to adopt mobile technologies for learning" more

rapidly than Western counterparts. A study by Tsai, Ro, Chang, & Lee (2011), indicated that for a study of Asian-language reading participants, a primary complaint was text size, whereas the pilot study indicated that the mean text size rating was 2.75 with mode of 3, indicating that the overwhelming number of participants found the text size to be suitable in this instance, signifying a potential disconnect between different written language when it comes to reading. In specific, the intricacies and details of characters in pictographic languages would lend to this theory, while more broadly defined characters in alphabetical languages are more easily recognized at various scales.

Research Method Selection

After completing a pilot study that combined both qualitative and quantitative areas, the research methods required will continue to draw from both areas. The primary methods to gather information should be done through examining students in more controlled settings. After attempting to examine students in a natural setting, the amount of extraneous data and complications that arose from data collection indicated that it would be highly difficult to continue with a field study. To that end, conducting an experimental study with participants who are selected from varying backgrounds to create a diverse pool of participants will help to achieve the goals previously sought by the use of a field study.

Although bias will exist due to the nature of the experimental study, the aforementioned efforts to reduce bias and external factors (for example, the Hawthorne Effect) will continue to be utilized in order to help aid in maintaining quality and minimizing bias. Furthermore, the use of a blind (informing the students that the research is on comprehension rather than user perception and mental sentiment) will allow the continued use of students who may have used technologies prior and will help to mitigate some of the problems created by problematic participants.

Identifying Human Levels and Methods

The question still seeks to address the heterogeneity of students – that is, that the students will have beliefs and rationale that will allow them to be codified into various groups (Klein, Dansereau, & Hall, 1994). In order to continue to understand these students and their groups, a degree of focus must be applied to participants on the individual basis in order to allow for groupings that become apparent through the results of the research. The continued study of participants in experimental studies will be the foundation for describing and coding the groups, which will be analyzed to understand the groups.

Applicable qualitative research methods

As the research question has shifted, the project has moved to be more quantitative than before, but still predominantly qualitative in nature. In order to understand students' sentiment, qualitative analysis is less required, but the quality of qualitative answers must be increased. Understanding the student's rationale behind their decisions during the study offers a great deal of value, and identifying key demographic information that could otherwise be used to help create groups are points of data where qualitative analysis could expand and improve upon quantitative questions.

In addition, the end goal is still to gain a deeper understanding of the behavior of students. A combination of quantitative questions to seek data-powered trends that is supported by a qualitative further analysis sets the stage for a more effective research study and more powerful evidence. Moving forward, simply having data on these participants will be insufficient, and further understanding of students and their decisions and perceptions will be required to further the study and draw even more powerful conclusions.

Further Steps

In order to continue to define and explore this research area, further research is needed. Additional expansion of the study will require both a larger participant group as well as refined and more detailed questions in the research study. The larger participant group will add statistical power to the research and will also help to minimize any influence from a specific individual or group of individuals who have participated in the study by smoothing bias with a larger sample size. Adding detail to questions and refining qualitative questions will allow for a more in-depth analysis and understanding of the issue and will help provide a deeper level of response from the participants.

Chapter 4 IRB Study 00001227

Rationale

After conducting a preliminary study in the spring of 2014, it became apparent that a more comprehensive study was required. Additional research was needed, with a larger focus on understanding how students utilized their devices for note taking. Focus shifted from students' perception of the technology to a general analysis of why students approach electronic textbooks as they do. The Pennsylvania State University Institutional Review Board approved this research in November of 2014 as "STUDY00001227". Data collection began in January 2015 at the start of the spring semester to allow for a diverse range of respondents, all of whom have completed a minimum of one semester of university coursework. Students were selected from a class where both physical and electronic materials were required for assignments to provide perspective when students have exposure to both material types.

Research Question:

This research was conducted to answer the question, "What are the decisions and rationale students have when selecting the electronic medium for their textbooks as well as the effect that this selection has on their understanding?" This research carries value by virtue of being in a field with limited documented research but also by holding the potential to provide students and faculty with information that would enrich and empower their learning methodologies. The research hypothesis for this study is, "Students claim they prefer electronic readings, but what factors influence this preference?"

Methodology

Participants

The participants in this study are college students from the Pennsylvania State University. Students were solicited through partnerships with University Faculty members. In exchange for participation in this research, students were provided with the ability to earn in-class extra credit.

Experimental Design

The design of the study focuses on two separate groups of students – each limited to a single medium – either a physical textbook segment or an electronic segment with which to read. These students have their usage of various tools on the materials as well as their performance on comprehension and reading exercises linked to their medium, and the study will seek a link between preference for a specific medium and factors leading to that preference.

Responses will be collected following the conclusion of the trial and will be analyzed to understand if and how note taking tools are being used as well as what effect, if any, this had on the comprehension questions. Correct answers to questions offers one way to discover a potential trends across participants – namely if utilization of a specific medium contributes in any way to answering questions.

Rather than minimizing the risk of bias through the Hawthorne Effect, participants were informed the true nature of the experiment but were left in a quiet location without direct vision of the researcher. This decision was made to ensure that students were focused on an end goal of answering questions and were able to be candid regarding the technology and features that they preferred and utilized.

In order to better gather information from participants and to ensure that statistical power was attained, the target subject count was set as $N = 30$, with a projected attrition rate of roughly 20% due to

lack of commitment, schedule inflexibility, or ineligibility due to external factors. A higher number of subjects completing the study will only serve to increase the accuracy of the research, but 30 participants is the bar for accurately drawing conclusions based on observations

Equipment

- Microsoft Surface Pro 256 GB Touchscreen Computer
- Google Drive Form for participant data entry
- #2 Mechanical Pencil
- Blue Pen
- Black Pen
- Highlighter
- Printed Survey
- Printed copy of article #1, "Coach K: A Matter of the Heart"
- Printed copy of article #2, "Cultural Intelligence"
- Digital copy of article #1, "Coach K: A Matter of the Heart"
- Digital copy of article #2, "Cultural Intelligence"

Procedure

Participants will participate in single sessions to allow for increased flexibility and to avoid any bias that could arise as a result of participants repeatedly being tested using the same medium. Initial information (name) will be gathered during the pre-survey questionnaire, and demographic information (age, gender, GPA, etc.) will be gathered during the post-survey questionnaire.

Participants utilizing a physical medium for their session

The protocol for participants using a physical medium were as follows:

1. Interviewer reviews procedure and obtains verbal consent
2. Participant is given printed copies of the survey, question packet, and both reading passages
3. Participant answers printed pre-survey questions
4. Participant reads passage one and answers comprehension questions
5. Participant reads passage two and answers comprehension questions
6. Participant answers printed post-survey demographics questions

Participants utilizing a digital medium for their session

The protocol for participants using a digital medium were as follows:

1. Interviewer reviews procedure and obtains verbal consent
2. Participant is given Surface Tablet Computer and instructions on use
3. Participant answers pre-survey questions on the tablet
4. Participant reads passage one and answers comprehension questions on the tablet
5. Participant reads passage two and answers comprehension questions on the tablet
6. Participant answers post-survey demographics questions on the tablet

Duration of Participation

Individual sessions ranged in time from 30 to 60 minutes, depending on subject's reading speed and ability to answer questions. Participants will participate in single sessions, and will not be responsible beyond the scope of that session for participation.

Results

A total of 19 participants were involved in the project research, with ten participants utilizing physical materials and nine participants utilizing digital materials.

Preferred Materials – Before and After

Before reading the passages, roughly 58% of participants indicated that they would prefer to complete the assignment using an electronic medium. This increased to over 68% after the completion of the assignment, with zero participants shifting their preference from the electronic medium to the physical medium.

Classification	Count
Electronic -> Electronic	11
Physical -> Physical	6
Physical -> Electronic	2
Electronic -> Physical	0

Table 1 - Change in Medium Preference

Preferred Materials - Rationale

The most frequently cited reasons for selecting each medium are shown in the following tables – broken down by medium and then compared in a chart.

Physical Preference	
Reason	Count
Ability to physically turn pages	7
Ease of highlighting & Personal desire for a physical copy	5
Eyestrain	4
Ability to sell to another student after the semester ends & Price to obtain	2
Ease of Carrying/transporting & Ease of annotating & Convenience to obtain	1

Table 2 - Physical Medium Preferred Users' Rationale

Digital Preference	
Reason	Count
Convenience to obtain & Ability to have on multiple devices	10
Ease of carrying/transporting	9
Price to obtain	8
Ease of highlighting	2
Ease of annotating & Eyestrain & Search functionality	1

Table 3 - Digital Medium Preferred Users' Rationale

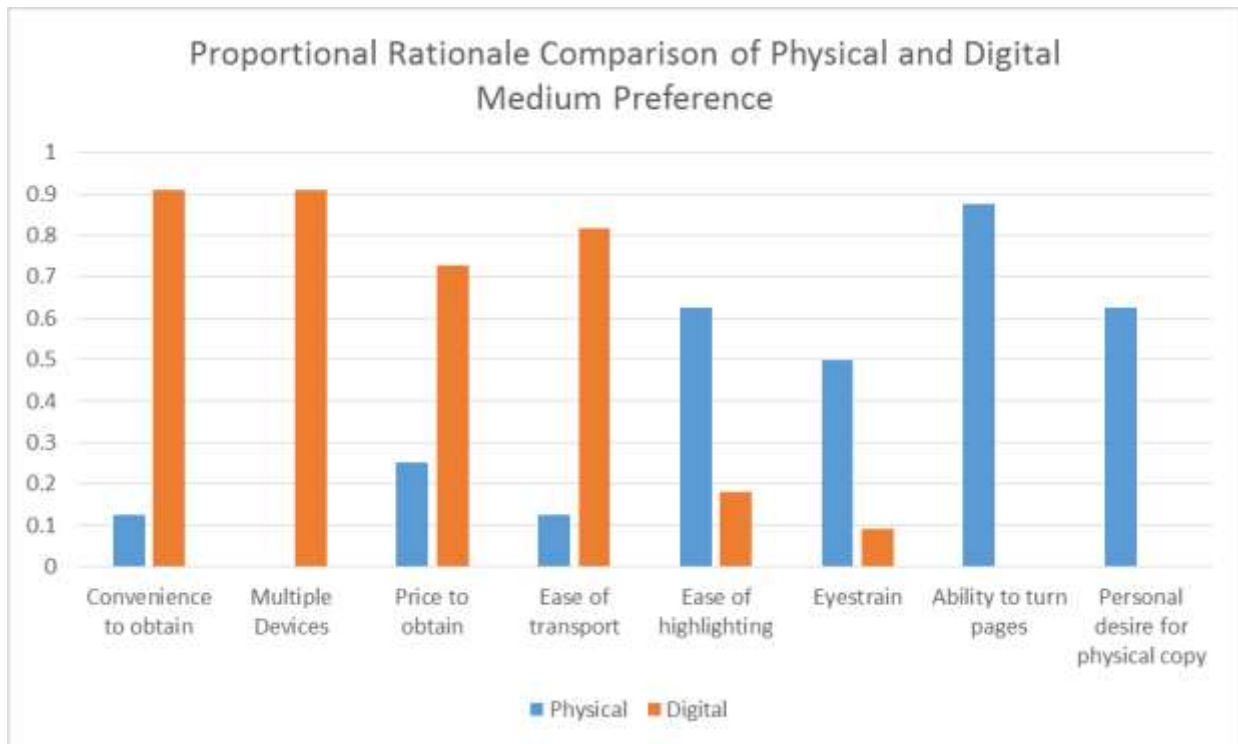


Figure 1 - Proportional Rationale Comparison for Preference

In the group overall, less than 32% of participants kept their rationale for medium selection consistent before and after the reading passages. Of the seventeen students who remained consistent in preferred medium, the changes in response can be seen below:

Change	Physical Count	Digital Count
Drop “Ease of carrying/transporting”	3	1
Add “Ease of highlighting” or “Ease of annotating”	1	4

Table 4 - Change in Rationale after Exercise Completion

Tool Usage and Requests

When asked, only two out of nine students who used the digital medium responded that they had used a search feature. Three out of nine students indicated that the use of a highlighter would have helped them complete the assignment, and one mentioned the use of magnification.

When asked, five out of the ten students who used the physical medium responded that they would have liked to use a search feature; four indicated that a highlighter would have helped, and two discussed the use of magnification. This is visually represented with the figure below:

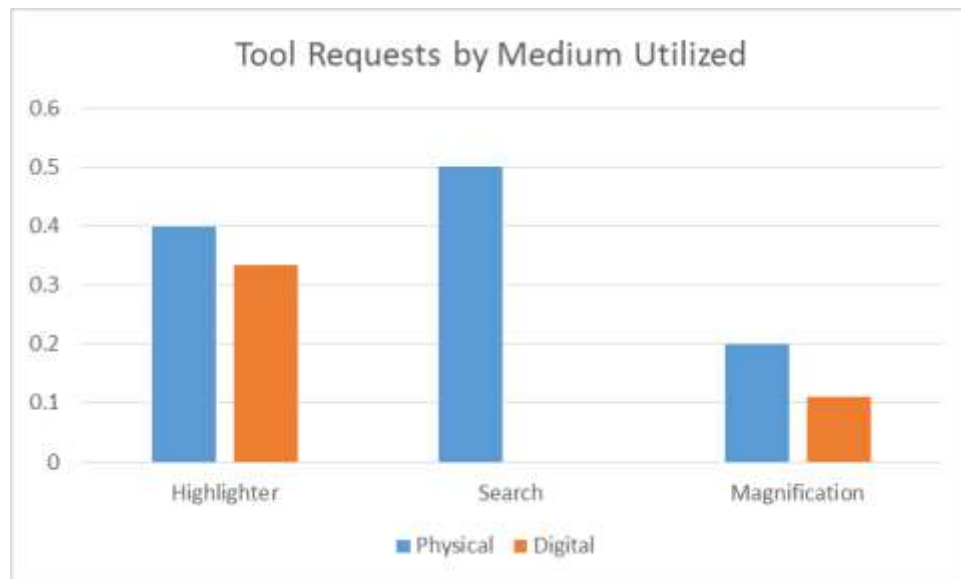


Figure 2 - Tool Request by Medium Utilized

Five out of nine digital-medium utilizing students had no requests for tools to make the assignment easier, while nine of ten physical-medium utilizing students had requests for tools that would have made the assignment easier. Overall, two students had multiple requests and six had no requests.

Demographic Data

Seventeen of nineteen participants were between the ages of 18-21. Twelve participants identified as Caucasian, three as East Asian, two as South Asian or Indian, and one as Hispanic. Sixteen of nineteen

participants first learned to read in English, and eighteen of nineteen most frequently read and write in English. There were eight freshmen, seven sophomores, three juniors, and one senior who participated. Six participants identified as female and thirteen identified as male.

Seven of nineteen students are working part-time, and none are working full-time. Grade-point average information is displayed in the table below:

Group	Mean GPA	Median GPA	Mode GPA
Female	3.29	3.22	N/A
Male	3.17	3.12	3.00
Combined	3.21	3.17	3.00

Table 5 - Grade Point Average Information by Gender

Students provided other background information about their reading habits and views on reading. On a 5-point Likert scale, students responded to the question “Do you enjoy reading?” where a score of 5 corresponded to highly enjoying reading. The mean score for this evaluation was 3.84, indicating that the population in question favored reading.

Chapter 5

Interpretation and Conclusions

Interpretation

After reviewing the data, there are several key areas of interest. The primary goal of the research question is to understand the rationale behind students' decision to utilize a specific medium for their textbooks, and this breaks down into several areas of investigation:

- Preference by Feature
- Preference by Predisposition
- Preference by Demographic

Preference by Feature

The trend amongst users with regard to feature implies that students are picking physical textbooks overwhelmingly because they want to be able to physically interact with the materials. Turning pages, highlighting the text, and having a copy for personal use all topped the list shown in Table 2, with eyestrain issues showing up as the fourth highest reason for a student to use a physical copy. Financial incentives (Selling the textbook at the end of the semester and the purchase price) were only minor factors in the decision process.

Digital consumption is based primarily on features of convenience. The convenience to obtain a copy which can then exist on multiple devices, as well as the ease of transporting a digital copy and the price point made up the list of reasons why students would choose digital copies. Table 3 showed that

although investigating pirated and illegal copies were not part of this research, textbook pricing and availability play a large role which will likely increase as student textbook costs rise.

The diversity in selection rationale, shown in Figure 1, demonstrates the need for further research and development into a medium that serves the needs of both populations. Search and highlighter functionality are both important to this future medium as shown in Figure 2, but worth noting is the fact that digital students did not request search functionality at all – *likely because they already were aware of the capability and were utilizing it*. The students reading physical copies of the medium are certainly aware of this capability, and 50% of students mentioned a desire for a search tool after reading printed passages.

Finally, Table 1 addresses the increase in student response citing a preference for electronic medium – from 58% of students at the start of the study to 68% at the conclusion of the study. One possible explanation for this change stems from the fact that students who switched from physical preference were uncomfortable completing the assignment and their hindsight was that using an electronic device would have been easier.

Preference by Predisposition

Goodness of Fit

To evaluate and potential case where users are predisposed to prefer one medium due to an external source, a chi-square analysis was utilized to evaluate whether there is a statistical difference between the expected preference and the observed preference. Although typically reserved for sample sizes larger than 30, the chi-square test is a staple of introductory research and is being provided here to demonstrate basic use and to show differences between other methods. In some of the following tables, Yates' Correction for the Pearson chi-squared statistic and Fisher's exact test are also provided to give

information that will be lower in confidence but be considered a more advanced and in some cases, accurate statistical measure.

	Final Preference Electronic Medium	Final Preference Physical Medium
Observed	13	6
Expected	9.5	9.5
Deviation d	3.5	-3.5
d^2	12.25	12.25
χ^2	1.289	1.289
$\Sigma\chi^2$	2.579	
α	0.05	
df	1	

Table 6 - Chi Square Calculations for Medium Preference

With the null hypothesis “An equal number of students will prefer electronic compared to physical mediums for this assignment,” alpha value of 0.05, 1 degree of freedom, and χ^2 of 2.579, Table 7 shows the Chi Square evaluation. This chi-square value is for a goodness of fit, 2-tail approach, so the critical value of half of 2.579, or 1.289 is used. This value falls below the 0.05-alpha threshold of 3.841 and thus is unable to reject the null hypothesis and conclude that based on this sample, an equal number of students prefer electronic compared to physical mediums for the assignment. However, the calculated p -value is equal to 0.108, and would be very near consideration if the 0.10-alpha threshold were utilized instead.

Degrees of Freedom	Chi-Square (χ^2) Distribution							
	Area to the Right of Critical Value							
	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01
1	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086

Table 7 - Chi Square Distribution

Enjoyment of Reading

A second question was raised regarding whether or not a student who enjoyed reading would be more predisposed to want a physical textbook. Thus, a second null hypothesis of “Students who enjoy reading (rating themselves a 4 or 5 on the Likert scale in the survey) are no more likely to prefer the physical medium” was investigated. The threshold of 4 and not 5 was selected in an effort to gauge general sentiment and not the explicit level of sentiment towards reading. Table 8 shows the measured contingency table while Table 9 shows the expected values for the null hypothesis.

	Electronic Preference	Physical Preference	Total
Enjoy Reading	8	5	13
Do not Enjoy Reading	5	1	6
Total	13	6	19

Table 8 - Contingency Table of Enjoying Reading and Medium Preference

	Electronic Preference	Physical Preference	Total
Enjoy Reading	6.5	6.5	13
Do not Enjoy Reading	3	3	6
Total	9.5	9.5	19

Table 9 – Expected Value Contingency Table of Enjoying Reading and Medium

Using a statistical calculation plugin for Microsoft Excel, the test statistic chi-square value can be calculated as $\chi^2 = 0.903$ and the p -value is found to be 0.342 (Zaiontz, 2014). However, as the sample size is small, a 2x2 contingency table, and features small expected values (less than 5), Yates’ correction for the Pearson chi-squared statistic can be utilized (Yates, 1934). This calculation will yield $\chi^2_{\text{Yates}} = 0.176$ with a p -value of 0.675. Neither of these p -values is sufficient to overturn the null hypothesis, thus the association between enjoyment of reading and medium preference is not considered to be statistically significant.

Provided Medium

A third question was raised regarding potential bias of respondents – that is, that providing a participant with a printed passage predisposed them to prefer the physical medium. To test this, the null hypothesis of “A user given an electronic device is no more likely to choose an electronic device, nor is a user who receives a physical passage any more likely to choose the physical medium” was used.

	Electronic Preference	Physical Preference	Total
Tablet	5	4	9
Printed Passage	8	2	10
Total	13	6	19

Table 10 - Contingency Table for Provided Medium and Medium Preference

Table 10 shows the contingency table that was used to calculate the test statistic. Using Zaiontz’s Excel Statistics calculation package with an alpha value of 0.05, the calculated χ^2 is equal to 1.310 and the p -value is found to be 0.252. This is another instance where Yates’ correction can be applied, and doing so yields a χ^2_{Yates} equal to 0.423 and a p -value of 0.515. Neither of these results is sufficient to overturn the null hypothesis and conclude that the medium provided a statistically significant influence on the final preference. This result helps reaffirm that the sample’s results were random and in line with what would be expected for a cross-section of students.

Preference by Demographic

Gender

The first research question pertaining to demographics looks at reported gender information. One supposition based on past studies (Marks, 2008) has noted that there is a gap in reading comprehension

between male and female students. Much of this research is founded on standardized K-12 testing, and a hypothesis was born to see if this gap in reading comprehension had manifested into a medium preference for reading in college. Table 11 below shows the contingency table that was used to perform a hypothesis test on null hypothesis “a female student is no more likely to prefer a physical medium when compared to a male student.”

	Electronic Preference	Physical Preference	Total
Female	3	3	6
Male	10	3	13
Total	13	6	19

Table 11 - Contingency Table for Gender and Medium Preference

When calculated using statistics software (Zaiontz, 2014), with an alpha value of 0.05, the calculated χ^2 is equal to 1.377 and the p -value is found to be 0.241. This means the null hypothesis is again not rejected, and so there is not statistically sufficient evidence to conclude that either gender group is predisposed to either medium. However, anecdotally, male students are much more likely to elect for the electronic medium, which poses a question that requires further investigation with a larger sample size.

First Language

The second research question pertaining to demographics examines whether the language a participant learned to read in impacts their preferred medium. Tsai, Ro, Chang, & Lee (2011) noted that a complaint regarding text size was present in Asian character passages on digital readers, but other researchers and this study saw no statistically significant case in Latin character passages. Table 12 shows the contingency table utilized for the hypothesis test on null hypothesis “medium preference is independent of which language a participant learned to first read in.”

	Electronic Preference	Physical Preference	Total
English	11	5	16
Non-English	2	1	3
Total	13	6	19

Table 12 - Contingency Table for First Language and Medium Preference

Statistics software calculation (Zaiontz, 2014), with an alpha value of 0.05, yields a χ^2 equal to 0.005 and the p -value is found to be 0.943. Thus, there is not a statistically significant difference that would reject the null hypothesis. Although Asian-language students were not intentionally sought, it remains a possibility that learning to read in a non-Latin-alphabet language has an impact when large samples are evaluated.

Grade-Point Average

The third research question seeks to establish whether or not grade-point average and medium preference are independent. For this test, students were grouped based on reported grade-point averages. One student opted out of providing this information, and so this data is based on a sample of size $N = 18$. Table 13 below shows the contingency table used to calculate the following statistics. The null hypothesis was “holding an average of B or higher grades does not have an impact on which medium is preferred”.

	Electronic Preference	Physical Preference	Total
Grade-Point average above 3.00	9	2	11
Grade-Point average of 3.00 or below	3	4	7
Total	12	6	18

Table 13 - Contingency Table for Grade-Point Average and Medium Preference

Using Zaiantz's statistics software calculation package yields a χ^2 equal to 2.922 and a p -value of 0.087. Although this is not statistically significant at the $\alpha = 0.05$ level, it is statistically significant at the $\alpha = 0.10$ level. Thus, it can be noted with 90% confidence that the null hypothesis can be rejected and it is possible to conclude with 90% confidence that having a grade-point average of higher than 3.00 has an impact on which medium a student will prefer. To assess this test with greater statistical power, Fisher's exact test can be used. This yields a 2-tail p -value of .1414, sufficient for a correlation with 85% confidence still. The combination of a Fisher's exact test result with an 85% confidence interval with a chi-square result with a 90% confidence interval is sufficient to show that this area holds great potential for expanded research and could offer valuable information, especially with a larger sample size.

Conclusion and Implications

Demographics and the sample

The results from the chi-square testing revealed that although the sample was small, there was not a statistically significant link between gender, the language a participant learned to read in, enjoyment of reading, or the provided medium. Grade-point average showed with 90% confidence that having a grade-point average of higher than 3.00 has an impact on which medium a student will prefer, but this confidence is lost if Yates' correction is applied. The bigger impact of this conclusion is that more research is required to determine if there is a connection between students' academic success and their preferred textbook medium.

Rationale for Device Selection

The rationale students provided for their selection of textbook medium was polarizing. Students who preferred digital textbooks had clear goals of convenience and flexibility, focusing on the features of the medium that supported the digital content being consumed in many locations or forms. Conversely, students who preferred physical textbooks had a strong focus on the tactile aspect of the textbook, as well as the overall interactive experience they had with the textbook. Despite the fact that many students discussed or mentioned the use of a search function, this tool ultimately is not convincing students to pursue a purely electronic medium.

Methodology and Results

With a sample size of only 19, chi-square statistics become weaker than if the sample size were sufficiently large. While there exist several options to improve accuracy without increasing the sample size, such as Yates' correction or Fisher's exact test, neither of these is a substitute for the simple statistical power gained by having more participants. This research has demonstrated that for a sample of students, there is little reason not to investigate further – both for the sake of understanding the technology and also to understand why students select each medium.

For a more exact calculation, Fisher's exact test could be utilized to analyze the small-sample results. For the sake of this work, chi-square values were primarily used to look at data and practice basic research methodologies and calculations. The use of Yates' correction and Fisher's exact test both offer next steps that could be used to gain more statistical insight.

Future Implications and Research

In the future, this research will hopefully serve as the basis for more investigation and an increased understanding of what factors contribute to how students consume information. The educational system and students alike both stand to benefit from this research, and this opportunity for growth and knowledge should not be passed up. While too soon to say that current high-achieving students are more likely to prefer electronic textbooks, for a sample size of half of an introductory class, the statement holds true. If so, this could be a research area towards understanding student academic success in college and how faculty can create a more productive learning environment.

Despite best efforts to minimize bias and outside influence, there are still factors that prevent these results from being considered definitive. The small sample size poses the biggest threat to statistical power, and future research needs to examine a body where sufficiently many individuals can be obtained. Choosing a class allowed for a very targeted sampling, but sacrificed sample size due to the limits of the class itself. Next steps in research could target many of the other demographic variables as well as using follow-up studies to ascertain whether any correlations between variables are causal or coincidental.

In addition, further research could benefit from a diversification of polling materials. This study focused on articles from the Harvard Business Review and further research would be needed to determine correlations with regards to other types of publications such as shorter news articles or longer textbook or manuscript chapters. With additional participants and publications to test again, the research methodology of this study has demonstrated the potential for connections and correlations and merits further investigation. While there is still no definitive answer to the exact criterion or rationale students use when selecting textbooks, the results have shown that there are trends and common threads students think about and utilize in making their decisions.

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Discrete Mathematics for Computer Science Effective Speech
Data Structures and Algorithms Critical Thinking for Leadership
Applied Statistics in Science Usability Engineering
Engineering of Complex Software Systems Social Network Analysis

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Work Experience

Program Manager Intern, Microsoft Corporation (May 2014 – August 2014)

- *Xbox One Platform Developer Tools Team*
- Lead a project to develop a graphic user interface for nontechnical developers
- Mentored an intern and helped provide career insight and developmental feedback
- Drove a team through feature work and ensured a high level of quality over multiple releases
- Collaborated with 1st and 3rd party Game Studios to ensure that customer feedback directly influenced and shaped the vision of the tools that were created for their use.
- Developed internal tools to provide a premier development environment for Xbox One.

League of Legends Coordinator, After Hours Gaming League, LLC (August 2013 – Present)

- Serving as coordinator for League of Legends Division and as a member of the leadership team for the After Hours Gaming League.
- Delegating responsibilities within volunteer team to deliver a premier experience to hundreds of corporate employees who want to participate in a charity gaming league.
- Communicating with team captains and broadcasters to schedule matches for nearly 500 players each week.
- Produced live finals event in May 2014 involving live matches and professional video production and commentary, broadcast to tens of thousands of viewers.
- Aided charities through tens of thousands of dollars in donations

Intern Ambassador, Microsoft Corporation

(July 2012 – August 2014)

- Served as a Student representative, coordinating on-campus events with Microsoft Recruiters.
- Mentored underclass and traditionally underrepresented student populations to find internships and jobs at companies such as Microsoft, Boeing, IBM, and Booz Allen Hamilton.

Program Manager Intern, Microsoft Corporation

(May 2013 – December 2013)

- *Xbox One TV Team*
- Led effort to document and instrument code for metrics analysis over three sub teams.
- Investigated naming conventions and viability of various voice commands.
- Coordinated team preparing Voice-enabled commands and direction for guide movement.
- Managed a partnership to develop Achievements and Challenges.
- Provided feedback through testing to log, triage, and assign bugs leading to product launch.

Program Manager Intern, Microsoft Corporation

(May 2012 – August 2012)

- *Visual Studio C++ Team*
- Became the “resident expert” on a quality-metric tool
- Developed and wrote documentation to provide employees with a handbook and directions to better utilize the metrics-gathering tools.
- Collaborated with a developer to prototype new functionality into the toolset.

Supervisor, Penn State University Information Technology Services

(April 2012 – May 2013)

- Supervised over 180 Student Consultants and work to run over 50 on-campus computer labs.
- Conducted Inventory Management, employee training, and managed keys for campus rooms.

Activities and Awards

Recipient, Presidential Leadership Academy Grant for Independent Development
National Champion, International Shotokan Karate Federation
Recipient, Teradata Corporation National Merit Scholarship
All-American, Swimming