

WORCESTER POLYTECHNIC INSTITUTE

Creating an Electronic Textbook: A New Resource for WPI's Introduction to Robotics Course

A Major Qualifying Project Submitted to the Faculty of Worcester
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Requirements for the Professional Writing Degree Bachelor of
Science

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Abstract

This project created an electronic textbook for WPI's Introduction to Robotics Course. The course did not previously have any textbook or other supplementary materials. Five chapters were created based on an analysis of the most basic or important topics covered in the class. A template was produced for each chapter based on design choices that were derived from a literature review and was then tested in the early production phase of the e-textbook. Once the book was published for use in the course, usability testing was conducted to find any design problems or suggestions for future development.

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1 Introduction

The most traditional form of supplementary material in college classes is a hard copy textbook. Generally professors choose specific textbooks because they are readily available and certain sections are pertinent to the material covered in the class. However, many students have a different opinion of textbooks: they are heavy, expensive, and generally boring or irrelevant; these and other opinions contribute to students' general feelings of discouragement towards hard copy textbooks (Bode, 2013). Alternatively, over the last decade or so, electronic textbooks have been working their way into the market. Compared to hard copy texts, "e-books cost less, are more portable, are more convenient, weigh less and students consider them more up to date" (Bode, 2013). Furthermore, with emerging technology, such as HTML5, dynamic PDF, and others, there are options readily available to make e-books interactive, more visually appealing, and hypothetically more interesting overall to college students in an introductory college course.

The Introduction to Robotics class at Worcester Polytechnic Institute is currently the first of five core Robotics Engineering classes, aiming at gaining student interest in the program. However there is effectively no textbook or other form of supplementary material to help enhance the students' learning. For this reason, the course instructors believe that students are not benefitting from the course as much as they should be; further, the instructors believe that the lack of textbook is a reason for students to fall behind in the program or be put off from the major entirely. Typically, about 50% of students who take the introductory course do not continue in the Robotics Engineering Major Program. The instructors have observed that students who are not able to follow course concepts tend to drop out of the major. Hypothetically, students would benefit from having a form of supplementary material, especially one that is interactive. Further, if there was a form of supplementary material, the professors that teach the class could aim to convert the class into an inverted learning environment. Inverted learning environments encourage students to learn on their own rather than during class meeting times; course meeting times are then used to answer student questions or for students to work in groups on assignments. From these reasons it is apparent that there is substantial cause and opportunity to create a form of supplementary material for the Introduction to Robotics class at Worcester Polytechnic Institute.

There is an extensive amount of research previously done on e-Books, specifically as case studies of e-Books in a number of different classes. This research shows that many students are not using interactive modules as much as they could be. Little is known about what specifically makes certain modules more or less attractive; one exception is that research shows students seem to prefer anything that poses a question and gives instant feedback (Bode, 2013). Some other research has been done that looks into typography and how to present text to make it more comfortable to read. The research looks into the ideal font size, amount of white space, and text width for text on an electronic page. Finally, the research looks into usability and the testing process to determine the design flaws in a product.

This Major Qualifying Project (MQP) aimed to develop a set of design choices that would contribute to the creation of an electronic textbook for the Introduction to Robotics course. A model chapter

template was created to help ensure modularity and to encourage future work. Five chapters, with topics based on the Introduction to Robotics course lectures, were created. Further, this project evaluated the usability the chapters and features. Multiple tests were conducted in order to gauge student opinions of the different aspects of the e-textbook. These tests addressed the design, readability, and ease of access of the chapters created. Finally, all results and conclusions were compiled and presented as suggestions for future work that may be conducted on this project.

2 Background Research and Literature Review

Historians, rhetoricians, and education scholars all offer perspectives on the role and effectiveness of textbooks. The history of textbooks and of the development of teacher uses of textbooks will form a basis for the rest of the research presented. Study results will show student usage of textbooks in college courses and will present suggestions for obtaining higher usage rates; some of these suggestions will build into design choices for the final project and some fall onto the instructor to implement. Delving deeper, this literature review will look at the current stance of the debate on electronic textbooks in classrooms and how different features of electronic textbooks can help students. Usability concepts for electronic textbooks will also be reviewed. Finally, this section concludes with a summary of previous work done on a previous version of the textbook for the RBE 1001 class as well as work that is concurrently being done by a separate project group that is closely tied in with this e-textbook development.

2.1 History of Textbook Development in America

The current transition from print to digital textbooks is interesting to examine in the historical context of textbook development. Carpenter (1963) published a history of textbooks and their use in the American classrooms. American schoolbooks can originally be traced back to schoolbooks published in Europe, and specifically England. For about two hundred years after the colonization of America, most schoolbooks were imported rather than printed. Due to insufficient printing capabilities and high costs of importing, schoolbooks were not readily available in most educational communities. For this reason, either multiple students would either share a book or students would make due with a handwritten copy. When schoolbooks were almost completely unavailable, teachers would even resort to using the Bible or other commonly available texts to teach reading and other basic skills. When schoolbooks were available, it was not uncommon for students in the same learning environment to learn from schoolbooks with different presentations of material under the same topic. This most commonly occurred when newer editions of books were produced; teachers were encouraged to stretch out the use of older texts as long as possible to avoid problems such as this (Carpenter, 1963).

One of the first schoolbooks published in America was the *New England Primer*, printed in Boston in 1727. While the text was originally printed in England, it was considered one of the first major schoolbooks used in early American Education. The *New England Primer* illustrated the alphabet and introduced each letter with rhymes; these rhymes were religious in nature during early editions, but gradually became more secular. Later editions of the Primer consisted in part of lessons that were made up of admonitions of religious characters. The *New England Primer* also included lessons on words and syllables, which was a difficult concept for students at the time. Finally, editions of the Primer dated after 1767 contained story lessons that were considered to be innovative for their time. Story lessons engaged students in short stories and then asked questions for the purpose of teaching lessons about relevant concepts(Carpenter, 1963).

Additional schoolbooks used in colonial and later classrooms included Readers and Science books. Readers were schoolbooks published to teach students basic reading lessons. The earliest Reader was *The Grammatical Institute of the English Language*, published by Noah Webster, and was published

in three parts. Webster's Readers taught students about reading out loud and getting involved in the text in order to better understanding. Another Reader was *The Columbian Orator*, by Caleb Bingham, that contained lessons on a variety of subjects. Later, other schoolbooks that would become more common were Science books. Early science books started off as higher level Chemistry texts, but they gradually transitioned to being appropriate for younger, primary school audiences. The first Science books published for primary schools were created by Joel Dorman Steele from 1867-1870. Steele published four major schoolbooks in the fields of Chemistry, Astronomy, Natural Philosophy, and Geology. The final series by Steele became the most widely used set of schoolbooks in 19th century America(Carpenter, 1963).

In the 18th and 19th century American classrooms, schoolbooks were utilized where they could be to teach basic lessons and concepts such as reading. Toward the second quarter of the 19th century, organizations began approaching textbooks as business ventures which allowed for more diverse schoolbooks to be more available in classrooms. Students were then able to learn concepts from more disciplines from their schoolbooks(Carpenter, 1963).

Moving into the 20th century, critics began to question the roles of textbooks in American classrooms. Early in the 20th century, it was suggested that classes and instructors should stop relying heavily on textbooks and try to encourage self-instruction instead (Bagley et al., 1931). In the 1960's, the idea of incorporating early media, such as video or audio clips, into courses was introduced; media was intended to act as additional supplementary material, sometimes in place of textbooks (Carpenter, 1963). Alternatively, in the 1990's it was predicted that despite budget restrictions and changing curriculums, teachers would continue to use textbooks as a basis for courses (Whitley, 1998). And finally, in the current decade, textbooks as a concept are still in use. However, the traditional format and idea of a textbook is being challenged; current scholars are beginning to argue for open or electronic textbooks in modern classrooms(Matkin, 2009).

2.2 Textbooks in College Courses

A wide range of research shows that many college students do not use textbooks for assigned reading as they are instructed to (Bossaller & Kammer, 2014; Gurung & Martin, 2011; Landrum, Gurung, & Spann, 2011; Miller, Nutting, & Baker-Eveleth, 2012; Rockinson-Szapkiw, Courdoff, Carter, & Bennett, 2013; Skinner & Howes, 2013). There appear to be multiple reasons for this. One reason is that students perceive that the reading assigned by the instructor is not essential to academic success (Brost & Bradley, 2006). Further, Brost and Bradly (2006) go on to claim that students will generally not use their textbooks unless the instructor gives them some sort of incentive to do so. Williamson (2008) found that another main reason for college students to not use their textbooks is because the text is too difficult. Essentially, students have trouble understanding what they are reading and therefore do not feel the reading is worth their time. Instead students tend to use their textbooks as review tools, sources of diagrams or resources for discussions and homework (Burton, 2014).

Students tend to believe that readings from course textbooks are not beneficial to them, and this is only further cemented when instructors do not incorporate the textbook into their lectures or assignments (Gurung & Martin, 2011). In a recent study, students indicated that when a textbook is used

by an instructor it encourages the students to use it as well (Landrum et al., 2011). Some examples of incorporating textbook readings into the course include giving students study guides, homework assignments, or quizzes (Brost & Bradley, 2006). However, Brost and Bradley (2006) warn instructors to be wary of solely using quizzes as a way to force students to read; they argue that it sets the wrong precedent for classroom learning. Essentially, the way in which instructors use course textbooks should allow the students to interact with the reading material and tie it back to the course material presented in class periods. If implemented correctly, study guides, assignments or assessments can help increase student views of assigned reading and textbooks in regards to college courses.

A second reason for noncompliance, as repeatedly cited by researchers, is the unpreparedness of students to read typical college assignments (Brost & Bradley, 2006). Smith, Holliday, and Austin (2010) state that “students enrolled in first year college courses are not proficient in comprehending informational texts.” This claim is further backed up by a 2012 survey by Landrum and Gurung that found that when students rated a number of college textbooks, the best rated book classified in the lower middle level of difficulty. Basically, students are not reading because they believe that the text they are assigned is too difficult. For introductory students, a lack of completion of assigned reading may be due to poor study habits developed in high school. A study by Williamson (2008) found that students reading at an average high school level may only be prepared to read as little as 5% of college texts.

Instructors may want to consider assigning texts that are catered to both the reading level of introductory students with lower level reading skills and more advanced audiences. Burton’s study (2014) considers what makes a textbook “readable.” One strong factor that makes textbooks difficult to read is the vocabulary: there needs to be a balance between technical terms and lower-level explanations (Burton, 2014). The study suggests that removing unnecessarily difficult vocabulary words and simplifying some sentences allowed students to focus on the key concepts more in-depth. In addition, textbooks that provide study aids and practical applications of concepts to real life can help accommodate both students who like textbooks and students who simply use them (Landrum et al., 2011). According to Aagaard, Connor, and Skidmore (2014), “learning should be a dynamic process that involves engagement” and these techniques, as well as many others, are student-approved ways to engage students with a wide range of reading ability and experience.

2.3 Conventional Textbooks and Electronic Textbooks

With electronic textbook use estimated to be rising (Miller et al., 2012) the question of whether or not college courses should adopt electronic course material is coming into light more and more (Rockinson-Szapkiw, Courduff, Carter, Bennett 2013; Daniel, Woody 2013; Bode 2014; Miller 2012; Bossaller, Kammer 2014). Currently, there is a mixed stance on e-textbooks in college courses. This mainly stems from the two different markets of electronic textbooks (e-textbooks) and the stigmas associated with both. The first is open-source textbooks: essentially textbooks written in a collaborative manner. These textbooks are low cost but have little to none of the standardization that commercial e-books have and may therefore be considered to be unreliable. The second system consists of closed-source books produced by private companies. These are generally electronic versions of pre-existing textbooks; they are more credible and standardized than open source textbooks. However, these books are generally no more interesting than hardcopy textbooks; in fact, generally these e-books are no more

than digitally recreated identical copies of the hardcopy books (Lokar, Horvat, Luksic, & Omerza, 2011). With improving technology, there is immense room for e-book design to grow and adapt to more innovative teaching styles.

Many studies have been conducted that discuss the transition in classrooms from traditional textbooks to e-textbooks (Bode, 2013; Bossaller & Kammer, 2014; Lokar et al., 2011; Miller et al., 2012). There seems to be a relatively standard list of advantages and disadvantages for each medium that is agreed upon in most of the surveys. Traditional textbooks are generally considered more usable as an advantage (Landrum et al., 2011; Miller et al., 2012). They are easier to access since you don't need an internet connection to use them. They are also easier to read; that is, they are not hard on the reader's eyes and the reader can flip to a specific section or page easily without knowing the exact page number (Wilson, Landoni, & Forbes, 2003). Finally, traditional textbooks are easy to annotate in margins, which many students regard as a worthwhile studying technique. Alternatively, electronic textbooks are cheaper than traditional textbooks making them more accessible on a large scale. E-books are also more portable as students can generally access them on any device with an internet connection: laptops, desktops, tablets, e-readers, mobile phones, etc. However, probably the strongest advantage of e-books is that students consider them to be more up-to-date than traditional textbooks because they are generally modular and easy to edit without reprinting (Bode, 2013).

Both types of books are not without their disadvantages (Bossaller & Kammer, 2014; Landoni, Wilson, & Gibb, 2001; Lokar et al., 2011; Miller et al., 2012; Rockinson-Szapkiw et al., 2013). Traditional textbooks are both heavy and expensive, so students don't want to buy them (Miller et al., 2012). Students also find traditional textbooks to be not interesting enough (Girard & Pinar, 2011). Essentially this means that students are not utilizing the resources they have at hand unless they are specifically assigned to and they feel it will affect their grade. Overall, students feel that traditional textbooks are not worth the investment (Miller et al., 2012). However, electronic books are also not dominating the markets for a whole separate set of reasons. They can be considered strenuous to read, especially if there is only a "black text – white background" option for the display (Rockinson-Szapkiw et al., 2013). Further, these books can be difficult to navigate without a smart index function (Landoni et al., 2001). Finally, electronic textbooks can be hard to annotate so students are forced to take notes in a separate document (Bode, 2013). Overall, there seems to be a large gap between the technology that exists and the current uses of said technology in the electronic textbook industry.

Future models of electronic textbooks could benefit from integrating new technology into their design (Lokar et al., 2011; Wilson et al., 2003). In 2011, Girard and Pinar composed a study to determine the usage of interactive modules in a college course, proposing that students would have a higher overall grade if they used the modules. Students were given access to interactive modules to use throughout a course and were surveyed at the end. The study found that students had positive overall opinions of the interactive modules and believed seven modules in a semester to be an ideal amount (Girard & Pinar, 2011); further students had increased course grades when they used the modules. Interactive elements would allow students to see causes and effects in different systems or other graphic situations. Further, Bode (2013) discussed electronic textbooks with interactive assessment tools to gauge understanding of key questions. A strong e-book design would ask questions at the end of

every section and then give instant feedback about the answer as well as an explanation. This tool would greatly help students who are struggling with homework concepts (Bode, 2013). Wilson and Landoni conducted a study in 2003 that resulted in a set of suggestions for electronic textbook features. Among the suggestions that were featured were note-taking and navigations tools. Note taking tools would, in theory, help students stay organized as well as reinforce concepts when used appropriately. Navigation tools were also found to be an important feature in electronic textbooks. Navigation features could include search features such as a smart index as well as a table of contents with hyperlinks and the ability to change pages, sections, or chapters easily. Both studies point to electronic textbooks relying more heavily on technological features and advancements to be more successful.

Given that technology is constantly improving and traditional textbooks are already considered to be out of date, it would not be unreasonable to argue that electronic textbooks will continue to grow in classrooms - especially in STEM fields. Aspects of electronic textbooks, like interactive modules, may be especially useful in these kinds of courses for helping teach concepts to all kinds of learners. While not all learners are visual learners, many concepts in STEM courses require the student to be able to accurately visualize a three-dimensional situation with at least one moving part. Interactive modules can help students by providing a picture than can be moved, affected, and even potentially changed by user input depending on the course. Additionally assessment tools would provide quick and easy feedback to students who are doing problems to check basic concept knowledge or as a part of a homework assignment. For these reasons, an electronic textbook with innovative design would be a strong fit for students whose field of study falls under Science, Technology, Engineering or Mathematics (Miller et al., 2012).

2.4 Principles for Effective E-Book Design

A strong design of an e-book will focus on the pedagogic value of the material as well as the usability of the book. This section discusses the interactivity and animation and the assessment tools that can go into an e-textbook. For the purposes of this section, the “written content” will refer to the text used to inform and educate students on specific course topics and details. This is essentially the information that is included in the course lectures as well as basic supplementary text to help improve understanding or expand students’ vocabulary. In a traditional textbook, the written content is generally at the discretion of the professor or other field experts, leaving little room for change as far as the information is concerned. For this reason, it is important for emerging e-books to look at ways to present all material, new or old, in an innovative and well-incorporated fashion. Some ways to achieve a well-incorporated design include a strong design that focuses on the technological features, such as interactive elements or animations, as well as assessment tools for students to use to check concept knowledge. Finally, it is important that e-textbooks are modular; that is, the template should be able to be easily changed or updated at any time in the future.

2.4.1 Interactivity and Animation

Interactive and multimedia features can help improve student learning but they are currently reported to be not widely used in e-books. Interactive elements or animated modules as a means of enforcing concepts are a newer trend in the domain of e-books. A 2013 study of college level calculus students using an e-book found that “students were initially enthusiastic about using an e-book and its

interactive figures, but in practice very few students took advantage of the interactive figures as a means of enhancing and extending their personal study” (Bode, 2013). For the means of this section, “interactivity” will not be used to mean any kind of assessment tool; it will instead reference any type of embedded activity or pop-up module that can be integrated relatively seamlessly with the written content. This includes any multimedia or animated content that can be changed by the users to see effects on a system or equation.

There are several positive uses for interactivity in an e-book for concept learning. The surface level is that such modules will provide a strong visual representation of abstract systems for students who may be more visual learners. These systems may be able to be 3-D modeled so that students can get a real-world idea of the example as opposed to a drawing on a white or blackboard. Anything that is 3-D modeled can also be animated to show changes over time, or to simply show a different perspective. Delving deeper, these modules can be used to show applications of concepts in physical situations. This can vary to include anything from statics or dynamic physics to electrical engineering to the effects of a programming system. Finally, as mentioned above, “interactivity” includes the potential for multimedia to be incorporated. It may therefore be even more beneficial to include video or sound for students who are auditory learners to be able to get the most out of these modules.

Most e-textbooks do not yet incorporate features that studies claim would be attractive to students, or are not being used to their full potential. The following suggestions for improvement emerge from those studies. First, using interactive modules and making them more relevant to concepts covered in a course would help improve student interest and use of the E-book as well as enhance learning (Girard & Pinar, 2011). Students who are more interested may be more likely to use the elements more. A second suggestion would be to have instructors support and endorse the modules; this makes them seem more credible or even worthwhile to students (Miller et al., 2012). If the instructor makes an effort to discuss specific modules or field questions about specific effects, students would be more compelled to use them. Third, include modules in different parts of the e-book. This could mean embed certain modules in sections for reinforcement, but also have modules that can pop up if a student answers a question wrong in an assessment portion. According to students participating in a 2013 study, adding more interactive or multimedia elements would help improve student interest (Kissinger, 2013). This can help the student assess their own thinking and figure out their mistakes on their own. Finally, the last, and probably most important, way to improve e-books with interactivity is to include many different formats including but not limited to animations, sounds, videos, and computer-generated models.

2.4.2 Assessment Tools

Assessment tools were found by Bode (2013) to be the most widely used of the electronic textbook features studied (Burton, 2014). Assessment tools are defined as any embedded or pop-up module that prompts users with homework or concept questions that are related to the section readings. According to Landrum (2011), one key reason students use any textbook is for study aids and chapter reviews. Assessment tools are created with regards to a question-based strategy to help improve student comprehension; the idea is that students may be able to learn more if they are given questions pertaining to material and instant feedback on their responses. These questions can rely on

higher order processes because students have more time to reflect deeply on them rather than quickly during a quiz at the beginning of class. These questions would be able to provide instant feedback from the instructor (Burton, 2014) and be able to give hints if an incorrect answer is entered. Currently there are many existing versions of this on the market such as Mastering Physics[®] by Pearson. High student use of assessment tools is believed to be linked to students prioritizing course grades above overall concept learning (Bode, 2013).

2.5 Usability

Students and users of electronic textbooks strongly prefer when publishers pay attention to usability in their designs (Kissinger, 2013; Landoni, Wilson, & Gibb, 2000; Landrum et al., 2011; Liaw, 2000; Luik & Mikk, 2008). Usability is essentially how intuitive or easy a product is to use to new users. For e-books, usability general includes navigation, readability, and ease of access to the book itself and any relevant links. Essentially, the end goal is that users can focus on learning the material presented in the e-book without having to worry about learning how to use the interface as well (Liaw, 2000). When users need to split their focus in such a way, they are almost guaranteed to not be able to retain some of the information they are looking for. A simple example of this is annotation of text in an e-book. When reading a hardcopy textbook, it's easy to take notes in the margins or highlight text on the page as a student reads. Therefore, it stands that a comparable version of note-taking in an e-book interface should be able to include highlighting and notes that can be flagged to a certain word or phrase. The latter should then be able to be saved in such a fashion that a student can go back to the flagged text for further reference and neither the notes nor the flag are lost when the computer or e-reader is shut down. Further, in order for a feature like annotation to pass a usability test, it should be easy for students to use or should have a straightforward set of directions easily accessed. Finally, this section will explore research regarding navigation, readability, and accessibility.

2.5.1 Navigation

One aspect of usability is navigation; navigation is the umbrella term for any feature or module that allows users to find specific material easily. The overarching way to achieve this is through a strong structure to the e-textbook content. Friesen (2013) discusses how textbook organization, specifically that of a "hierarchical structure, subsuming definitions and propositions under a unifying theme" is a historic but still relevant way to organize textbook content. Part of the structure discussed includes having a strong table of contents. This claim is supported further by research conducted by Landoni (2000) that found tables of contents to be an essential feature in electronic media. Landoni goes on to claim that tables of contents and overall navigability could be enhanced by also including a search function to find specific words or phrases. However, the study warns that search or index functions should work in tandem with the table of contents and should never replace one.

Aside from general structure, there are several other features of electronic textbooks that also can contribute to navigation. One such feature is the ability to easily jump or scroll to certain chapters or between pages. According to Kissinger (2013), student understanding of concepts increased with the ability to use an electronic textbook in a non-linear way. That is, they were able to skip around inside a chapter without having to read it from beginning to end. Two particularly helpful sub-features of non-linear use for e-textbooks are search and bookmarking functions (Kissinger, 2013). Further, Landoni

(2003) found that having sections or chapters split into different pages made the entire unit more navigable. A final feature that students seem to respond positively to is the utilization of familiar icons in the e-textbook interface (Luik & Mikk, 2008). Some examples of familiar icons may involve a floppy disk for a save function or a speaker icon for sound control.

2.5.2 Readability

One of the key ideas behind the design of an electronic textbook is the “sense of text” that a reader feels when using it (Landoni et al., 2001). This is called readability and it is more commonly defined as some general criteria that make any sort of publication easier to read or scan with the intent of finding specific information. In later research, Landoni (2003) goes on to claim that some key aspects of readability are page numbers, chapter or section headings, and keywords or abstracts associated with the chapter. Additionally, the type, design, and presentation of the font is not to be overlooked: “fonts should be large enough to read comfortably for long periods of time” (Wilson et al., 2003). All of these may help users find what they are looking for or help them determine which sections are more relevant to their needs. Using a variety of methods to produce a more readable e-textbook may appeal to current college students who want quick reads and highly illustrated texts (Skinner & Howes, 2013). Some such methods of achieving this may include bold or italicized text, colored sections or words, and summing up key points at the end of a section or chapter.

Another way readability helps improve user views of an e-textbook is that it helps remove superfluous text from already difficult concepts (Burton, 2014). As mentioned before, it is believed that college students are not adequately equipped with the reading skills associated with the assigned texts (Williamson, 2008). Therefore there needs to be a balance between student reading levels and difficulty of the text (Gurung & Martin, 2011), which is where readability concepts, such as making a text more easily scanned (Landoni et al., 2000), may come into play. Skinner (2013) states that another way to make a text more readable, for students of all ability levels, is to increase the number of visual elements in an e-textbook. Bode (2013), Landrum (2011), and Daniel (2013) all support this idea and add in that students prefer being able to skim over real-life examples in their textbooks to reading high-level blocks of text. These examples are commonly used by students to help complete homework assignments, or to study for exams because students find them easy to use, easy to find in the text, and helpful to their overall grade-driven goals (Bode, 2013). All of these studies point to a text being more readable, and therefore more usable, if the user can find what they are looking for within the text easily and without excessive amounts of reading or sifting through complex text.

2.5.3 Accessibility

A key concern of usability in the field of electronic textbooks is the ability to access it both during the course and after it ends (Bossaller & Kammer, 2014). During the course, the e-textbook should be accessible on as many different devices as possible and should be hosted on such a platform that there is minimal loss in presentation or content between devices (Lokar et al., 2011). Kissinger (2013) explains that having a mobile, accessible e-textbook is “perceived to benefit student learning due to the value placed on the affordance of situated study in everyday life.” Essentially, the students felt they were able to learn more and put more time into reading and assignments if they could access their e-textbook at any time on any device. But textbooks are not just bought to be used once; about 50% of

students participating in a 2014 survey stated that they thought it important to keep their textbooks for future reference after the end of a class (Bossaller & Kammer, 2014). Therefore, a fully accessible textbook should include an option for retaining the electronic textbook in a fully-working form at the end of a course.

2.6 Previous Work on an E-textbook for RBE 1001

Work on an e-textbook for WPI's Introduction to Robotics course began in 2012 with a WPI Interactive Qualifying Project (IQP) team. The goal of the project was to evaluate the effect that an electronic textbook would have on the WPI Introduction to Robotics course. In order to conduct this research, the team had to develop some sample chapters for students to use. These chapters were designed with regards to basic textbook design concepts, but the concepts were not extensively tested. Students were surveyed to find out how often they used the book. Additionally, students were given a quiz with questions whose answers could be found in the book; after answering each question, students were asked to record where they got the answer from. Overall, the test results were inconclusive, but they did show that students were not using the book enough for it to affect their learning.

Currently, there are two projects working on further developing an e-textbook for the Introduction to Robotics course. This Professional Writing Major Qualifying Project (MQP) worked to create the chapter content. The MQP focused on taking lecture material from the course and presenting it in a written medium that introductory college students would be easily able to understand. In addition, this included creating or integrating graphics, animations or interactivity into the chapters. Concurrently, an IQP team focused on repeating the first IQP group's research but with stronger sample chapters. The current IQP group will be conducting focus groups to determine how students would use an electronic textbook and which topics would be most beneficial for a textbook to cover; this information then went to the MQP for development. Finally, the IQP team is focusing strongly on how the finished chapters of the e-textbook influenced student learning and performance in the course.

3 Methodology

This project combined a series of design choices suggested from studies of currently existing electronic textbooks and used them to create a template and five chapters for Worcester Polytechnic Institute's (WPI) Introduction to Robotics course. In order to produce the chapters, all relevant course content first had to be gathered, organized, and analyzed to determine the importance of each piece. Then final design choices were determined through preliminary tests of early chapters. Due to the fact that some design choices came from decade-old research, certain choices were reworked to fit better in modern classrooms. Finally, the chapters were produced and tested for usability among students at WPI. This section details the process that went into creating the e-textbook, choosing the design decisions, and testing the created product.

3.1 Chapter Content

The first step in the creation of these book chapters was to decide which chapters to create and then collect and organize any relevant course materials for them. Some of the course content came from lecture notes and PowerPoint presentations from WPI Professors Stafford, Gennert, and Miller. Additional material came from reviewing other related or referenced external sources such as FIRST Robotics tutorial videos created by Brad Miller. In addition, course homework assignments and relevant quizzes were obtained and evaluated. The topics of these assessments were given special attention in the creating of relevant chapters. The chapters created for this project were: Power Transmissions, Circuits, Sensors, Introduction to Programming in C and Arduino, and State Programming.

Once the course material was completely assembled and organized into a logical structure, attention was turned to the interactivity, multimedia, and assessment tools to be embedded in the sections. A list of key vocabulary words and concepts by section was created and used to determine what sorts of graphics were needed. The chapters were then evaluated to determine the most ideal places for interactive modules. Finally, the assessment tool questions were drafted based on all other content outlined in a given section. In addition, hints to help solve the problems in the event of common mistakes were created to be embedded in the assessment tool.

3.2 Creating and Testing an Interface Design

All preliminary design choices were listed as options for creating an effective electronic textbook based on the Literature Review. Each choice was then either analyzed or tested to determine its effectiveness. Design choices covered everything from the general layout of the section to how sentence level changes affected student's ability to use and learn from it. The ethics of working with human subjects was considered when designing these tests. An application was submitted to the WPI Institutional Review Board for approval before any testing began.

The design choice tests were conducted throughout the production phase of the project. The design choice study was done in two parts using the Circuits and Programming chapters respectively. Each chapter was broken up into two different formats using various design concepts to be tested. Students were observed in an unobtrusive manner while they used the e-textbook and any questions or comments were recorded. At the end of the allotted time, students were prompted with specific questions about their experience with different design choices. Students were allowed access to the

sample chapter for reference during the interview process to help ensure quality of answers. Most questions were open ended. Answers were then compiled and were taken into account when creating templates for future chapters.

The rest of this section explains specific design options that were presented to test participants. Participants were originally chosen from a pool of students taking psychology courses at WPI and could be any major. Allowing any major to participate was originally chosen because the e-textbook was designed to be used by students with little to no background in the subjects covered. After the first round of testing, it was decided to narrow the testing to specifically Robotics Engineering majors, or related majors, because the participants from other majors were focusing more on the material than they were on the design and interface. There were a total of ten test participants between both rounds of the design choice study.

3.2.1 Structure and Layout

The general structure of the book was laid out in a hierarchical format, with a chapter for each topic, followed by sections and subsections for key points. All the links to the chapters were laid out in the main page as a table of contents. The chapters were set up in a two-column layout with text on the left and corresponding graphics on the right. Headings were used to break up specific sub-sections. For navigation, each heading had a corresponding link on the far right side of the page. Some chapters had in-text example problems with explanations in pop-up windows. Finally, each chapter ended with an assessment tool that asked key questions about chapter content.

Several different options for the layout of the text and graphics were explored and tested. The first iteration of this design test gave participants two layouts to choose from, as illustrated in Figure 3.1. The first was “chunked” so that content text was broken up by corresponding graphics. This design was intended to create stopping points for readers where they could reflect on the content. The second was a non-uniform columned layout where the text was on the left and the graphics were on the right. These columns were non-uniform because the width of each block of text was dependent on the width of the graphic next to it. After further research into how to construct more robust columns in webpages, a secondary design choice test was run comparing the non-uniform columned layout to a new, uniform one. In the uniform layout, the text columns were the same width and the graphics were scaled to fit next to those columns.

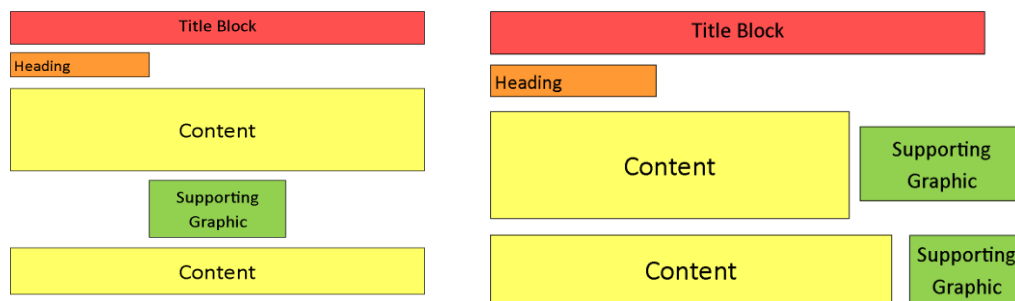


Figure 3.1: Chunked Layout (left) and Preliminary Columned Layout (right)

Different aspects of typography were taken into account when designing this e-textbook. The ideal font size was set to 10 pixels, which is about equivalent to 12-point font. This ratio was determined because it was the standard font size created by the HTML editor that the IQP team used to host the e-textbook. Further, there was a small gap of white space between each subsection. The gaps were intended to create a logical point for users to stop reading, whether for a second or for that session, and to help to break up the text in a more logical manner.

3.2.2 Chapters and Subsections

Test participants were presented with two choices for the organization of chapters and subsections, as seen in Figure 3.2. In the first option, each chapter was split into multiple subsections and each subsection was hosted on its own webpage. The alternative option was to have each chapter hosted in a single webpage. In the latter option, all the sections would be available under the same URL in order to keep the material organized. Splitting the sections up would allow students to information about very specific topics and was intended to aid student research. Keeping the sections together was intended to allow students to more easily see the overall concepts and big picture. The option of having each section on separate pages presented additional logistic and organizational issues; specifically, each section would have to have its own web address and additional navigation tools in order to make the chapters seem more connected.

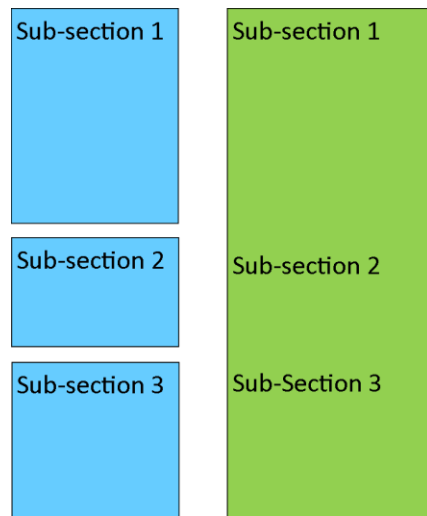


Figure 3.2: Sections on Separate Webpages (left) and Sections on Singular Webpage (right)

3.2.3 Examples and Assessment Tools

To determine the most ideal format for example problems participants were given two different options as shown in Figure 3.3. The first option was to have the example in the middle of the chapter, directly after the section it related to. This option supported the chunked layout by breaking up the text and also was intended to allow users to see a real application of the concepts they had just read. The alternative option was to put the example problem at the end of the chapter. This option would allow students to see if they could put all the concepts they had just learned together and to assess which ones they would need. It allowed students to read through the entire section without interruption.

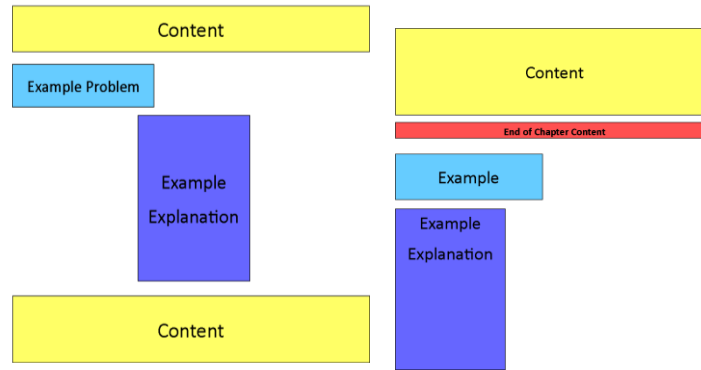


Figure 3.3: Example Problem Embedded (left) and Example Problem at End (right)

In a section phase of design testing, participants were presented with an additional option as shown in Figure 3.4. This design had the example problem embedded into the chapter content but the explanation was taken out to keep the page shorter. To accomplish this, the example problem was broken into two parts: the problem itself and the explanation. It was noted during the study that removing the explanation from being directly embedded with the problem would allow students to work through the problem before seeing the answer if they wanted to. For this reason, the example problem was left in the section, but the explanation was moved to a pop-up window. Students actually using the e-textbook were asked about how well this design option was integrated.

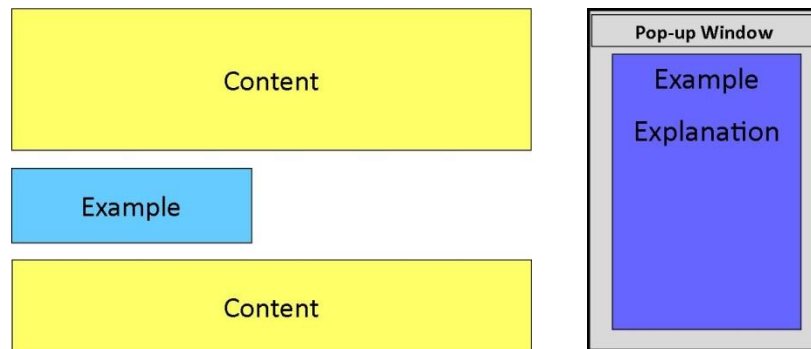


Figure 3.4: Embedded Example with Explanation in Pop-up Window

Assessment tools in the form of multiple choice questions were included at the end of the chapter. Assessment tools were created in the form of multiple choice questions. This design decision was not tested because the technology used would not support any type of questions where users typed an answer in. There were originally plans of testing multiple choice questions versus open-answer questions but it was quickly found that the latter would cause many more problems than the former. Further, another design decision that did not end up requiring a test was where to put the assessment tools. Because the examples were embedded in the text, it was decided that assessment tools should be placed at the end of the entire chapter. This allowed students to try to apply all of the chapter concepts after reading through all of them. Because of this, the assessment questions provided some feedback to users if they chose an incorrect answer.

3.2.4 Interactive Modules

Interactive modules were created to help students learn material on a conceptual level. Two chapters were given interactive elements: Circuits and Power Transmissions. The elements allowed students to change different values of variables and see how other outputs would change. The interactive elements were embedded in the text with instructions for how to use them. This choice allowed for users to easily access the module and to not have to worry as much about pop-up blockers or other software issues. The alternative option was to give users a link that would bring them to an external page when clicked. This option would keep the webpage from loading slowly and would not break up the rest of the content as much.

3.2.5 Vocabulary

The format of vocabulary words was tested to see how easily students could find them. Each word was defined in-text to aid readers who were unfamiliar with the chapter topic. This design concept was tested by giving participants two versions of the same page. The first had bold, red vocabulary words; this design was intended to allow users to quickly find the words they were looking for. The second had words in standard font but colored in a light blue; this design was intended to make the words stand out slightly but to not be distracting by requiring immediate attention. Participants were asked which font format made it easier to identify the words as well as which was more comfortable to read.

For further reference, each chapter contained a list of all vocabulary words in the chapter. The main test that was done for this design choice gave participants the list in two places, as seen in Figure 3.5. The options were to have the vocabulary list at the end of the chapter or in a pop-up window. With the list at the end of the chapter, users were given a navigation panel on the side of the page that could allow them to automatically jump to the vocabulary list. The pop-up window was able to be triggered by clicking on any vocabulary word in the section.

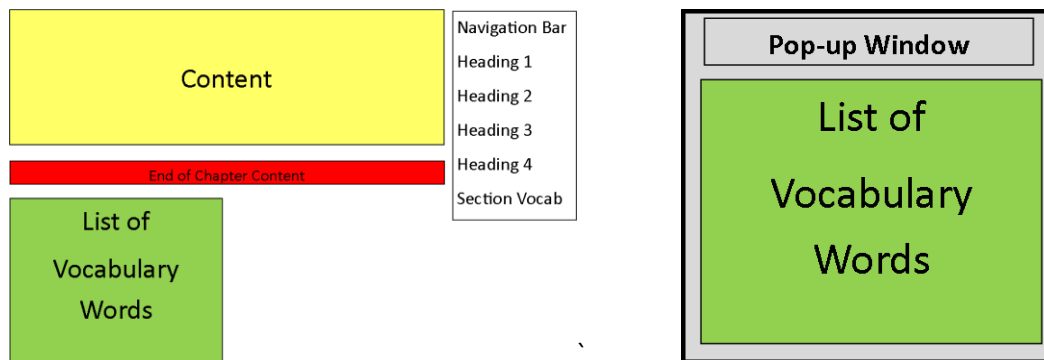


Figure 3.5: Vocabulary Words at End of Chapter (left) and Vocabulary Words in Popup Window (right)

3.2.6 Navigation

Completed pages included different options for users to navigate. These decisions were not tested with other design choices because the IQP team was only able to create certain options. The first decision was to include a top navigation bar as seen in Figure 3.6. The top bar contained a link for the “Home” page, the “About” page and a dropdown menu for each of the chapters. The other navigation

feature that was included was a list of headings for the different subsections in each chapter, as seen in Figure 3.6. The headings were each hyperlinked to the corresponding place in the text. Included in this list was a link for the top of the page as well as a link for the section vocabulary list at the bottom of each chapter.

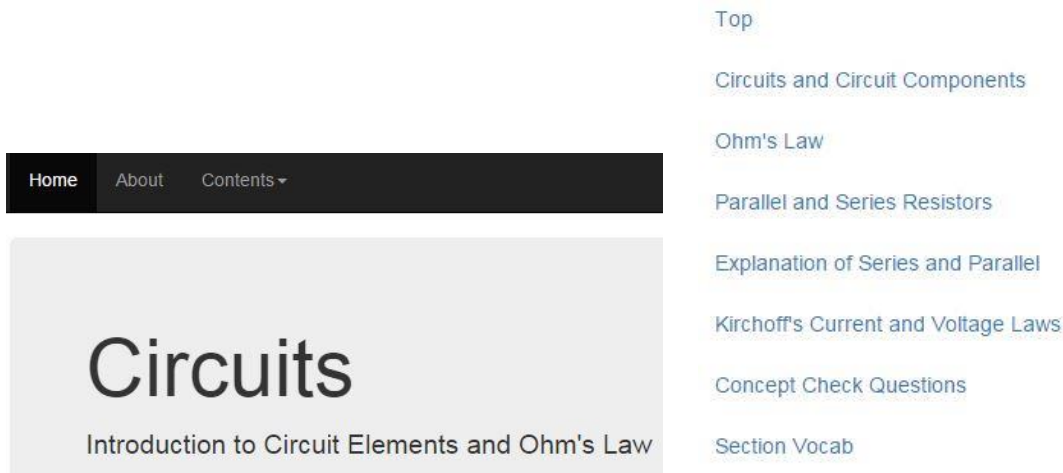


Figure 3.6: Top Navigation Bar (left) and Side Navigation Bar (right)

3.3 Production

The production process involved choosing specific design choices based on the results of the design choice testing. With the design choices established, student-preferred design elements were compiled into a template chapter. All subsequent chapters were then compiled and written with regards to the template chapter. Along with producing each chapter, all graphics, tables and equations were assembled. Two animations were specifically created by the IQP group to serve specific functions in the book; those were embedded in their respective chapters.

The final chapters were published as HTML pages and were hosted as a series of webpages through WPI. The decision to use HTML, as well as to host on webpages, came from the IQP team. HTML webpages were determined to be the easiest, most robust option. The IQP team had wanted the e-textbook to be accessible on as many devices and operating systems as possible. HTML would be accessible on all intended devices. Assessment tools were created using java script and were designed to give feedback if a student answered a question incorrectly. Navigation bars were implemented in every page to allow students to access all the chapters from any point. A side bar was added to each page with links to each heading in the chapter to further help navigation.

3.4 Usability Testing

In order for usability tests to be valid, they must have participants perform tasks with the product (Dumas & Salzman, 2006). Therefore, each usability test performed gave participants a simple task or series of tasks to complete. In addition, a usability survey was distributed with the intention of getting quantitative, statistically significant results. The IRB application and approval covered these tests as well. All responses were recorded in an anonymous manner in accordance with the IRB approval

conditions. This section discusses the different tests that were performed and how they were intended to be used in the scope of this project.

Observations were conducted as one of the tests in order to determine how intuitive the final interface was to use. Observation participants were volunteers from a pool of WPI students with experience in Computer Science, Electrical and Computer Engineering, Mechanical Engineering, or Physics; these subjects were deemed to be the most relevant to the chapters tested. The reasoning for this criterion was that it was believed that participants who already had some experience with the topics presented would spend less time trying to understand the material and focus on the tasks instead. This section discusses the

Participants were allowed time to explore the interface and then were given specific tasks such as navigating between chapters and using the concept questions or interactive elements (the specific tasks and raw results are shown in Appendix B). One example of a task was to have users navigate from a random point on a page to a separate page entirely. All participant questions, comments, and other forms of feedback were transcribed on a separate computer during the study. Participants were explicitly informed that the purpose of the study was to test the final product and not their individual skill levels. Throughout the study, participants were asked to continuously voice their thoughts; this included, but was not limited to, any questions they may have had about the instructions, prompt, or interface. For this specific usability test, a retrospective think-aloud test was considered but was ruled out due to lack of time and accessible technologies; this test would have participants complete the same tasks but they would answer all questions and give a summary of their thoughts after they finished. Five students participated in the think-aloud survey; according to Nielsen (2000), only five participants are needed to find 80% of the errors in the interface.

A survey, created using Qualtrics, was distributed to the students enrolled in the RBE 1001 course in C-term (a full survey can be found in Appendix A). The survey was intended to be the quantifiable contribution to the qualitative responses of the observations. The survey was distributed via email and was promoted during lab periods. The survey aimed to determine the overall usability of the interface. Questions were asked about how easily participants were able to find information, headings, and vocabulary words. Participants were also asked to rate how complex and well-designed they found the overall interface to be. Finally, students were asked if they would use the e-textbook or a similar interface again. In order to further quantify the data, students were additionally asked if they had ever accessed the e-textbook previously and how many chapters they had accessed. Further, the survey asked if the students had used the book for research of any kind; this question specifically aimed to determine if participants had specifically used the book or had simply looked at it.

4 Results and Discussion

This section details the results and associated conclusions or recommendations associated with each test. The design decisions that were used to create the chapters are detailed below. Further, this section discusses the results of the different usability tests. The survey results are compiled and the responses from the observations are used to draw conclusions or create suggestions. Usability tests were used to find recommendations for future work on the project.

4.1 Design Choices

The major design decisions for this book were each determined based on the results of the design choice studies. Each study presented two versions of the same chapter and then asked specific questions about the format or design. Topics discussed in the studies included readability, such as text width and vocabulary text, as well as e-textbook features, such as example problems and assessment tools. Representative screen shots of content from multiple chapters of the e-book are shown in this section. The full e-book can be found at <http://users.wpi.edu/~rbe1001book>.

4.1.1 Page and Text Design

The chapters were written in a broken up or “chunked” manner in order to help engage student interest. Eighty percent of participants preferred having the book laid out in sections with pictures, examples or headings to break up larger chunks of text. Most of the participants from the design choice study indicated that they would prefer to read something broken up with pictures or headings. The overall reason given was that students prefer not to have to read large bodies of text. Further, all participants indicated that they preferred having visual aids to help enhance their learning; this was especially true if the concepts were new to them.

The alternative design choice would have consisted of breaking up chunks of text with white space and making the pictures in-line with the text. One positive response given for this layout was that it reminded the participant of online articles like Wikipedia. This supports a finding of the study done by Landoni in 2000: people prefer to use online books that look or feel familiar.

However, it was noted that the columns were not uniformly formatted. For this reason, the test was run again and participants were presented with a columned layout that was more robustly formatted as well as the same, broken-up layout from before. Eighty percent of participants preferred the columned layout to be more. Further, all participants – regardless of which layout they preferred – commented that reading from the skinnier columns was more comfortable. This supports research done by Landoni (1999) that defined how wide columns could be before they were uncomfortable to read. Therefore, the optimal layout was determined to be the columned layout, broken up by white space, as shown in Figure 4.1.

Circuits and Circuit Elements

A **circuit** is the interconnection of electrical devices in a circular path. To power the circuit, voltage is generated from a power source and moves through the wires and components. **Voltage** is the total work per unit charge associated with the motion of charge between two points. The rate at which the electrical charge is flowing through a wire or conductor is called **current**. Both current and voltage are required to achieve electrical power.

Some people have trouble conceptualizing electricity because they cannot see it. Try considering the circuit to instead be a system of pipes. Each pipe is essentially a very large wire. The power source, which is essentially a pump, takes in charge with low voltage and outputs charge with high voltage. Similarly, a pump which takes in water of low pressure and pushes out higher pressure water. The flow rate of the water moving through the pipe would be the voltage. Water flows from areas of high pressure to low pressure; likewise, electricity flows from areas of high voltage to low voltage. The speed at which water moves through a pipe is the current. The size of the pipe acts as resistance. If the pipe is very large, the resistance is very low and the water can flow freely; if the pipe is small, the water flow is much more restricted. Small resistors are basically large pipes, and large resistors are small pipes.

Resistance, measured in Ohms, of an electrical component is when current opposes, or resists, flowing through that component. The most common

$$P = I \times V$$

P: Power (Watts)
I: Current (Amps)
V: Voltage (Volts)

Power Relation to Voltage and Current

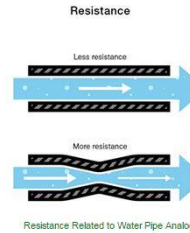


Figure 4.1: Uniform Column Layout

The final design decision was to use a uniformly formatted column layout. The columns were divided up such that the text was seven “parts” wide, and the graphics were four “parts” wide. The “parts” are non-specific units because they will adjust and keep the same ratio for any size screen. The example used in the previous test had inconsistent column sizes between subsections of the same chapter and was coded in a less robust manner. Therefore, the columned layout appeared sloppy. Forty percent of participants tested with this second revision agreed that the ratio was perfect as it was, and 20% advocated that the text column could even be made smaller because some of the graphics were larger than the accompanying text. The ratio was left at 7:4 in order to help achieve consistency between the chapters. That is, all the other chapters have smaller graphics, so making the text column smaller would result in there seeming like there is significantly more text than visuals.

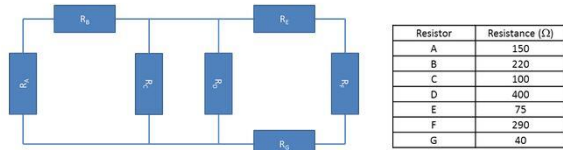
4.1.2 Embedding Example Problems and Assessment Tools

Examples were determined to be best utilized by embedding them within the section that they related to. Sixty percent of students preferred having the example question at the end of the section so that they could read through all the material before they answered it. The remaining 40% expressed that having the example problem in the section that it was related to made the problem seem more relevant and less confusing. All the study participants liked having a fully solved example problem that they could reference. Some participants were concerned that the example problem at the end was misleading as it was placed after topics that it was not related to. Other students preferred having the option to read through the entire section before trying to apply what they had learned.

Because neither option was able to secure support of an overwhelming majority of participants, a different approach was considered. In the redesign, the example problem was still left embedded in the section. However, all the work was moved into a pop-up window that would only open if the reader clicked on the problem (see Figure 4.2). Students found that this approach allowed them to read through the page with fewer distractions but they were still able to access the explanation for more

information. Further, to give readers a chance to apply what they had learned after reading everything concept questions were added to the end of each chapter.

Here's an example:



Try to reduce the circuit above. Click on the circuit for the solution.

Explanation of Series and Parallel

Why do series resistors simply add together while parallel ones are so much more different? The reasoning lies in how the current moves through the circuit. When resistors are in series current is able to flow through all of the resistors in a single loop. So the equivalent resistance of series resistors has to be larger than the largest resistor in the circuit. However when resistors are in parallel the current has to split between the loops created by the parallel resistors. This means that the equivalent resistance will always be smaller than the smallest resistor in the loop. It is important to note that when current flows through a loop of parallel resistors, it splits in a way that is proportional to the resistance of the resistors; higher resistors will have less current flowing through them and vice versa to ensure that there is the same amount of voltage going through the entire circuit.

First, recognize the series and parallel resistors in this circuit. Start by reducing resistors A and B into an equivalent resistance:

$$R_{AB} = 150 \Omega + 220 \Omega = 370 \Omega$$

Next, reduce the parallel resistors C and D:

$$R_{CD} = \frac{1}{\frac{1}{100 \Omega} + \frac{1}{400 \Omega}} = \frac{1}{\frac{5}{400 \Omega}} = 80 \Omega$$

Third, reduce series resistors E, F and G:

$$R_{EFG} = 75 \Omega + 220 \Omega + 40 \Omega = 335 \Omega$$

The final configuration:

Figure 4.2: Example Problem Embedded in Chapter (left) and Popup Window with Explanation (right)

One hundred percent of students agreed that having some sort of assessment tool that would give instant feedback to student answers would be useful. All participants had experience using similar assessment tools in past courses and expressed positive opinions of them. Based on responses to the earlier question about the placement of example problems, it was determined that assessment tools would be best placed at the end of a section. This allowed students to be able to test their understanding of the material after reading through the entire chapter. When students answered a question incorrectly, the assessment tool was able to give simple feedback, such as which section(s) to review. For more complicated questions, the correct answer was also explained so that students would know specifically why that was correct even if they had guessed.

4.1.3 Vocabulary Format and Reference List

All participants agreed that it would be useful to have a compiled list of all of the vocabulary words from the chapter. One hundred percent of participants stated that having all of the vocabulary words from the chapter in one place would be useful, regardless of where it was placed in the chapter. Eighty percent of participants were content with having those vocabulary words in a pop-up window. The window would open to all of the vocabulary words in a section if the reader clicked on any vocabulary word in a section. The participant who advocated against having a pop-up window still agreed that the list was important to include, but that it should be embedded somewhere in the chapter. Further, it was pointed out that the only option presented to students for having the compiled list was in a pop-up. This design choice was followed up on during the second concept test due to potential for ambiguity in the testing process.

First, the concept of the pop-up vocabulary window was revisited. The final decision was to put all the words in a list at the end of the chapter. When presented with both options, 60% of participants found that having the vocabulary list at the end, as seen in Figure 4.3, would be easier for reference. The remaining 40% was split evenly between wanting a pop-up window and having no preference either

way. The decision to simply embed the vocabulary takes into account that full functionality of the pop-up module has yet to be tested on a range of mobile devices and may face technical difficulties when opening.

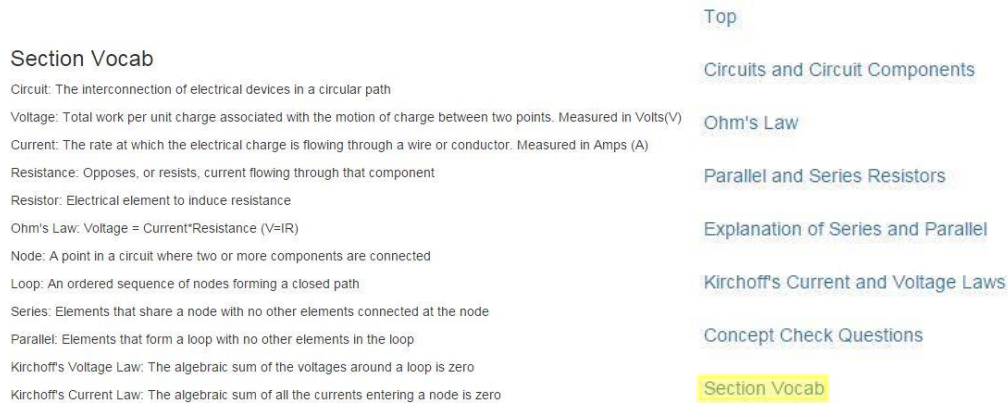


Figure 4.3: List of Section Vocabulary Words and Definitions (left) and “Section Vocab” Heading Hyperlink (right)

In addition, a concept was tested regarding the styling of vocabulary words to make them easier to pick out in a page. One hundred percent of participants responded that they found that colored or styled text for vocabulary words made them easy to pick out in the page. All participants found that this would be useful for taking notes, checking definitions, or just identifying key concepts. For this reason, vocabulary words will be colored, as well as bolded and italicized, as seen in Figure 4.4, to help students with color deficiencies to pick them out. The colored words were not hyperlinked the way the original words were. The hyperlinks were found to be less intuitive than was originally predicted. Instead, a link for the section vocabulary was added to the list of heading links on the right side of the page.

Two elements are in **series** if they share a node with no other elements connected at the node. Resistors in series add together to get an equivalent resistance. In the figure below, resistors A and B are in series. Two elements are in **parallel** if they form a loop with no other elements in the loop. Resistors in parallel combine by adding the reciprocal sum of each value. In the figure below, resistors C and D are in parallel.

Figure 4.4: Vocabulary Words Colored in Red and Bolded to Stand Out

4.1.4 Hosting and Navigation for Chapters and Sections

Preliminary results for the choice of splitting the pages or keeping all sections on one page were inconclusive; each option received support from 50% of participants. For the sake of simplicity with the pages and ease of navigation for students, chapters will be kept in single pages. Further, participants believed that such a format would make searching within a chapter easier. The alternative option is to break up each chapter into sections to be hosted on different webpages. The content would remain the same, but the breakup would be more pronounced; for example, the Sensors chapter would have three different webpages: Location Sensors, Orientation Sensors, and Interrupt Service Routines. Additional material, when applicable, could still be included at the end of the chapter as links to external pages.

4.2 Interface Usability

This section details the results of the usability testing done on the e-book interface. Many of the results recorded here were used to determine design flaws or suggestions to make the interface more usable. Overall, students found the interface to be generally user-friendly; most students reported the same usability issues throughout the testing process, further confirming the research that usability tests only require about five users to find most major issues.

4.2.1 Observations

The usability observations revealed some successes and some weaknesses with regard to navigation and the interactivity in the pages. Students were observed to have challenges with navigating between chapters and between sections. Further students noted that the different elements on the page that were interactive such as modules, concept questions, and example problems were not very intuitive to use.

4.2.1.1 Navigating Between Chapters and Sections

All of the participants were able to find the correct link to the Circuits page from the main page in less than five seconds. After completing some other tasks, participants were asked to navigate from the Circuits chapter to the Power Transmissions chapter. This proved to be more difficult. Most participants did not use the navigation bar at the top of the page, as seen in Figure 4.5. The navigation bar, when clicked, gave a drop-down menu of links to all the chapters from any point in the e-textbook. Instead, most participants navigated to the top of the page and clicked on the home button. From the main index page they then moved into the correct chapter. All participants who used this method expressed either confusion or slight annoyance at having to go through two steps.

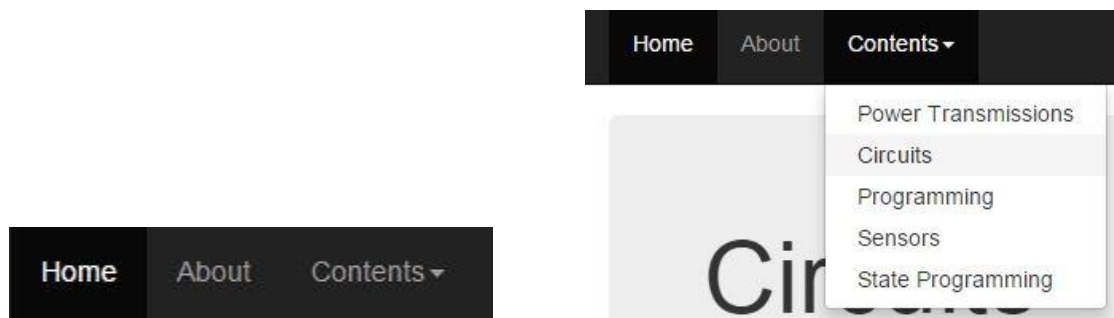


Figure 4.5: Dropdown Menu at Top of Each Page for Navigating Between Chapters

These findings suggest that users are not likely to notice the black navigation bar at the top of the page when using the e-textbook interface for quick references. Further, when users do notice the navigation bar, they are more likely to go back to the home page because they know it will allow them to navigate to other pages. Users acknowledged that there should be a better way to navigate between chapters however none of the users appeared to look for any navigation links. This suggests that having shortcuts to each chapter is intuitive but having them in a drop down menu is not obvious enough. One future suggestion is to put the different chapter links in the side navigation bar as seen in Figure 4.6 on right. A second one is to put each individual link at the top of the page, as shown in Figure 4.7, rather than having the drop-down menu. However, this would become a potential issue if there were more than about seven or eight chapters because there would not be enough room in the bar to fit all the links.

- [Top](#)
- [Circuits and Circuit Components](#)
- [Ohm's Law](#)
- [Parallel and Series Resistors](#)
- [Explanation of Series and Parallel](#)
- [Kirchoff's Current and Voltage Laws](#)
- [Concept Check Questions](#)
- [Section Vocab](#)
- [Other Chapters:](#)**
- [Power Transmissions](#)
- [Sensors](#)
- [Programming in C](#)
- [State Programming](#)

Figure 4.6: Proposed Chapter Links in Side Bar

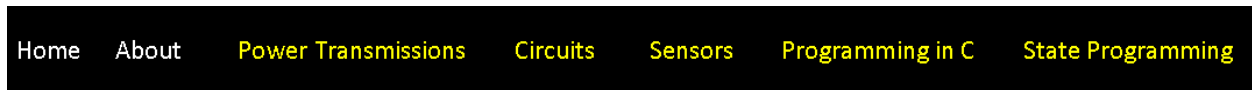


Figure 4.7: Proposed Top Bar with Chapter Links (yellow)

Participants were given several tasks that included navigating within the Circuits chapter. First, they were asked to find vocabulary words. All participants scrolled until they found the words in the body text of the chapter. When asked, retroactively, if they had considered using the navigation bar on the side most participants said they had not considered or noticed it. One participant noted that he did notice and appreciate having the side bar but the chapters were short enough that the person felt more comfortable scrolling than jumping with the links. All users were able to easily identify vocabulary words within the text. When asked to find a key concept within a section, most participants chose to scroll rather than use the links once again. However, all participants knew they were in the right section when they read the headings. About half of the participants stated afterwards that if they had noticed the side bar earlier, it would have been helpful in finding the key information more easily.

Only about half the participants recognized the side navigation bar and even fewer used it. This implies that the headings are not obvious enough. One hypothesis on this finding is that users read from left to right and tend to naturally stop at the end of the body text. This means that they are never directly looking at the side bar links. Further, this may be because the links do not stand out enough. Some suggestions for future development would be to incorporate the links with another font color or put them in a box with a separate background color. Another option would be to try to draw attention to the side bar by pointing it out at the top of the chapter, near the heading. The most important thing with this navigation bar is user awareness; without users being aware of the feature, it probably will not be utilized as much as it could be.

4.2.1.2 Example Problem, Interactive Module and Concept Questions

Participants were asked to interact with an example problem and interactive module as well as two concept questions. Overall, most participants were observed to have trouble figuring out how to begin interacting with each of the above listed elements. The example problem and interactive module each had instructions written below them but participants generally took at least 30 seconds to find, read and comprehend them. Most participants dove directly into the interactive module and only found the in-text instructions afterwards. All participants got the concept questions correct on their first try. One participant used the side navigation bar to jump to the relevant section title before answering. The rest of the participants worked through the problem or were able to answer without needing references.

The main complaint was not being able to find the directions quickly. Once users found the instructions, they had an easy time actually using the elements. One suggestion for this would simply be to change the color or format of the instructions. In addition, moving the instructions to be above each feature, rather than below them, might help. All concept questions were created in a multiple choice format. Therefore, the usability results for that aspect should only be applied to future multiple choice questions. Open-ended questions will require additional testing to determine how helpful feedback and instructions are as well as how well the program is able to identify correct or incorrect answers.

4.2.2 Survey Results

The students taking RBE 1001 were asked to participate in a survey addressing the usability of the e-textbook interface. The survey was distributed at two different points in the term via email to ensure that everyone had access to it. Because the class had 42 students enrolled, at least 24 responses would need to be collected to be statistically significant at a 90% confidence level; the survey was only able to gather seven responses. The few responses collected showed that most people were generally at least neutral and at best very satisfied with the e-textbook interface and design. All participants said that they would use the e-textbook again. A full report of the results can be found in Appendix A.

5 Conclusions

While this project was successful in creating a design template and several preliminary chapters for the e-textbook for WPI's Introduction to Robotics class, it also definitely brought about some suggestions for future work. The current e-textbook in use by the RBE 1001 students consists of five chapters and a title page. All of the chapters have concept check questions, three chapters have example problems with answers, and two chapters currently have interactive modules. There are plans in place by other WPI students to further develop interactive modules for other chapters. These chapters that were created were intended to be somewhat of a prototype. A completed e-textbook for this course should have around 25 chapters. This number comes from looking at the syllabus and picking out all of the major topics. Some topics may be able to be combined into one, larger, chapter but accomplishing this would require further exploration into the course topics and materials. Further, both the professors of the course and students interviewed during design choice studies expressed a desire to have more example problems in textbooks. The professors specifically suggested having an entire chapter made up of example problems similar to homework problems. Other students have asked for a chapter on good design practices for final projects. This chapter could include examples from previous years and discuss the good or bad design aspects. This class could also include basic trouble shooting for the programming involved in the final project for the class.

Some of the features of the e-textbook were successful overall. There is one main feature of the e-textbook that came out well: the concept check questions. The concept check questions are simple and provide feedback to users if they answer a question incorrectly. When the questions were more difficult, the questions also provided an explanation as to why that answer was correct. There were also some successful aspects of the design template. The first is the formatting of the vocabulary words. Students noted during the usability testing and design choice testing that having bright-colored, bolded words made them easier to find in chapter text. Another successful template aspect was the columned layout. During design choice testing, students were presented with the columned layout and commented that the text was a comfortable width to read. Those students also commented that having the pictures next to the text made them seem more relevant. Finally, having each chapter on a single page was considered successful. Both students and course professors noted that this option made the book simpler and more compact overall.

From a usability perspective there are several features that are not working well. The first set of features are those used for Navigation. The strongest suggestion that can be given in regards to navigation features is to make the links or tools more obvious to users. Further testing would most likely be needed to figure out how to best accomplish making the navigation feature more usable. The next feature that needed some work was the example problems. The problems were easily found in the text but users had trouble finding the text that told them to click on the problem for the answer. One suggestion to help this is to put hover text over the problem. The hover text would make it so that any time the users mouse crossed over the problem or picture, a text bubble would appear with the instructions to click on the problem. Hover text or any other method of displaying instructions would probably also have to be tested to ensure that the instructions are noticeable and easy to understand.

Further, there are some suggestions from the literature review for new features that were not able to be implemented into this prototype. One suggestion is to have a comprehensive table of contents or an index. The table of contents could include major section headings as well as chapter headings. The index could have all the vocabulary words as well as any other key words from all of the chapters and would be combined in one place. The index could then link users to the pages or sections that contain the word in question. A second would be the ability to bookmark. Landoni (2003) noted from her research that users had a desire to be able to bookmark or highlight key pages or points. Therefore, it may be worth investigating how to incorporate features for bookmarking or highlighting, as well as annotating, and how those features are received by users.

Finally, there are a few additional concepts that could be looked at in a future project or study. The first would be the ability to make the e-textbook available and fully functional offline. The professors expressed a strong interest in have a downloadable version of the e-textbook. The key would be to have all of the interactivity and animations to still be able to work even without any internet connection. This would allow students to access the e-textbook anywhere they had a computer or mobile device. Further, there are certain aspects, such as the interactivity, of the current e-textbook only works on certain operating systems or platforms. A potential path that a future project could take is to make the full e-textbook work on all operating systems. Finally, it would be interesting to have a future project group conduct a usability study relating particularly to e-textbooks. There is very little research that currently exists that discusses how to design a user-friendly e-textbook. Given that technology is becoming more powerful it is possible that e-textbooks will become more commonplace in classrooms in the future; a usability study relating specifically to creating e-textbooks may benefit that industry and the future e-textbook designers well.

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Appendix A – Usability Survey Questions and Results

Initial Report

Last Modified: 02/24/2015

1. Were you able to access the E-book? The E-book can be found at <http://users.wpi.edu/~rbe1001book>

#	Answer	Response	%
1	Yes	7	100%
2	No	0	0%
	Total	7	100%

Statistic	Value
Min Value	1
Max Value	1
Mean	1.00
Variance	0.00
Standard Deviation	0.00
Total Responses	7

2. How many chapters have you accessed so far?

#	Answer	Response	%
1	None	0	0%
2	One Chapter	1	14%
3	Two-Three Chapters	2	29%
4	Three-Four Chapters	4	57%
	Total	7	100%

Statistic	Value
Min Value	2
Max Value	4
Mean	3.43
Variance	0.62
Standard Deviation	0.79
Total Responses	7

3. Have you used the E-book as a reference material of any kind? Include use for class assignments, personal research, or any other reference

#	Answer	Response	%
1	Yes	7	100%
2	No	0	0%
	Total	7	100%

Statistic	Value
Min Value	1
Max Value	1
Mean	1.00
Variance	0.00
Standard Deviation	0.00
Total Responses	7

4. Were you able to find the information you were looking for on your own?

#	Answer	Response	%
1	Yes	7	100%
2	No, I had to ask course staff	0	0%
3	No, I had to ask the authors	0	0%
4	No, I had to ask someone else	0	0%
	Total	7	100%

Statistic	Value
Min Value	1
Max Value	1
Mean	1.00
Variance	0.00
Standard Deviation	0.00
Total Responses	7

5. Please rate the difficulty level you had with the following tasks:

#	Question	Very Difficult	Difficult	Neutral	Easy	Very Easy	Did Not Attempt	Total Responses	Mean
1	Navigating Between Chapters	0	0	1	3	2	1	7	4.43
2	Navigating Between Headings	0	0	1	1	4	1	7	4.71
3	Finding Vocabulary Words and Definitions	0	2	2	0	2	1	7	3.71

Statistic	Navigating Between Chapters	Navigating Between Headings	Finding Vocabulary Words and Definitions
Min Value	3	3	2
Max Value	6	6	6
Mean	4.43	4.71	3.71
Variance	0.95	0.90	2.57
Standard Deviation	0.98	0.95	1.60
Total Responses	7	7	7

6. How well did you feel the various elements in the E-book were integrated together? “Elements” include examples, concept questions, animations, navigation links, etc.

#	Answer	Response	%
1	Very Poorly	0	0%
2	Poorly	2	29%
3	Neutral	0	0%
4	Well	5	71%
5	Very Well	0	0%
	Total	7	100%

Statistic	Value
Min Value	2
Max Value	4
Mean	3.43
Variance	0.95
Standard Deviation	0.98
Total Responses	7

7. How consistent did you find the format and design to be between the chapters?

#	Answer	Response	%
1	Very Inconsistent	0	0%
2	Inconsistent	0	0%
3	Neutral	1	14%
4	Consistent	4	57%
5	Very Consistent	2	29%
	Total	7	100%

Statistic	Value
Min Value	3
Max Value	5
Mean	4.14
Variance	0.48
Standard Deviation	0.69
Total Responses	7

8. Please rate your level of agreement with each of the following statements:

#	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total Responses	Mean
1	I found this E-book to be more accessible than a paper book.	0	0	0	2	5	7	4.71
2	Reading this E-book was more comfortable than reading a paper textbook.	0	0	1	3	3	7	4.29
3	This E-book was easier to navigate than a paper textbook.	0	0	3	1	3	7	4.00
4	I was able to quickly learn or understand the interface.	0	0	1	2	4	7	4.43
5	The width of the text columns made them comfortable to read.	0	0	2	4	1	7	3.86
6	I was able to easily identify vocabulary words.	0	1	4	1	1	7	3.29

Statistic	I found this E-book to be more accessible than a paper book.	Reading this E-book was more comfortable than reading a paper textbook.	This E-book was easier to navigate than a paper textbook.	I was able to quickly learn or understand the interface.	The width of the text columns made them comfortable to read.	I was able to easily identify vocabulary words.
Min Value	4	3	3	3	3	2
Max Value	5	5	5	5	5	5
Mean	4.71	4.29	4.00	4.43	3.86	3.29
Variance	0.24	0.57	1.00	0.62	0.48	0.90
Standard Deviation	0.49	0.76	1.00	0.79	0.69	0.95
Total Responses	7	7	7	7	7	7

9. Please rate the level of complexity that you associate with the design of this E-book overall:

#	Answer	Response	%
1	Very Complex	0	0%
2	Complex	0	0%
3	Neutral	3	43%
4	Simple	4	57%
5	Very Simple	0	0%
	Total	7	100%

Statistic	Value
Min Value	3
Max Value	4
Mean	3.57
Variance	0.29
Standard Deviation	0.53
Total Responses	7

10. Overall, how do you feel about this E-book? Please choose your answer based on the design, aesthetics, and overall usability, rather than content

#	Answer	Response	%
1	Very Dissatisfied	0	0%
2	Dissatisfied	0	0%
3	Neutral	1	14%
4	Satisfied	6	86%
5	Very Satisfied	0	0%
	Total	7	100%

Statistic	Value
Min Value	3
Max Value	4
Mean	3.86
Variance	0.14
Standard Deviation	0.38
Total Responses	7

11. Would you use this E-book again?

#	Answer	Response	%
1	Most Likely	7	100%
2	I Would Consider It	0	0%
3	Probably Not	0	0%
	Total	7	100%

Statistic	Value
Min Value	1
Max Value	1
Mean	1.00
Variance	0.00
Standard Deviation	0.00
Total Responses	7

Appendix B – Observation Instructions and Results

Instructions

Thank you for participating in this study. To start, it is important for you to understand that the purpose of this study is to test the interface and design of the E-textbook rather than your knowledge of the concepts. Each question has an answer already defined somewhere in the text. You are not expected to write the answers of those questions here - simply find and record the locations where you found the answers. If you are unable to find the answer or if you experience any technical difficulties (something is incompatible with your browser, doesn't load, etc.) please make a note under that respective step. Otherwise, please record any general comments, questions, or difficulties you have under each step as they come up. When finished with the tasks, please answer the questions at the end; these answers will help us refine the design in later iterations of the E-textbook. Finally, please note that participation in this survey is voluntary and will be recorded anonymously in all publications.

Tasks

- Start at the “index” page – users.wpi.edu/~RBE1001book/index.html
- Navigate to Circuits Chapter
- Define Resistance and Resistor
- Why do you add the values of series resistors but take the inverse of the sum of the inverses of values of parallel resistors?
- What are the equivalent resistances for each step of the example problem in the Circuits Chapter?
- Navigate to Power Transmissions
- Use the interactive module
- Answer two of the concept questions at the end

Responses

- Start at the “index” page – users.wpi.edu/~RBE1001book/index.html
 - Done correctly by all users, no comments
- Navigate to Circuits Chapter
 - Done correctly by all users, no comments
- Define Resistance and Resistor
 - User 1: Didn't use section vocab – found definitions in the text
 - No comments
 - User 2: Third paragraph in circuits and circuit element.
 - Comments: “super easy to find” ; “Didn't even read and the red text made it stand out”
 - User 3: Found words in red font
 - Font made the words stand out
 - User 4: Used Section Vocab section via side navigation bar
 - User 5: Found words in text

- Comments: “Noticed section vocab heading later”
- Why do you add the values of series resistors but take the inverse of the sum of the inverses of values of parallel resistors?
 - User 1: Scrolled until he found the heading – did not use the side panel
 - No comments
 - User 2: Found under *explanation of series and parallel*.
 - Comments: “Also easy to find, just required scrolling down.”
 - User 3: Found under section heading
 - Comments: “I originally missed it as I read the prior section”
 - User 4: Found under section heading
 - No comments
 - User 5: Found under section hearing – Used side bar to find the heading
 - Comments: “Easy to find”
- What are the equivalent resistances for each step of the example problem in the Circuits Chapter?
 - User 1: Took a minute – didn’t understand the question as much or what it was asking for. Once he understood the question he found it quickly
 - Comments: Expressed confusion with the task and finding the window
 - User 2: Found by clicking on the example.
 - Comments: “Finding example was not as easy to find as other things, but wasn’t hard. The other two diagrams in **Kirchoff’s Voltage and Current Laws** made it harder to find (they could have been examples too).”
 - User 3: Found by clicking on the example – took some time to find it
 - Comments: “Took me a minute to realize I had to click on the image to make the solutions appear:
 - User 4: Clicked on the example
 - No comments
 - User 5: Clicked on the example
 - No comments
- Navigate to Power Transmissions
 - User 1: Went from circuits to home page then onto power transmissions from there; Did not use navigation bar at the top
 - No comments
 - User 1: Went to home page then to Power Transmissions
 - Comments: “It’s a little weird that Home is always highlighted in the top bar (as if that is the current location). Made it less clear that I should click home to get to power transmissions.”
 - User 3: Went to home page then to Power Transmissions
 - Comments: “Felt a bit clunky having to press on home to get back to the “index”, but I got there.”
 - User 4: Went to home page then to Power Transmissions

- No comments
 - User 5: Went to home page then to Power Transmissions
 - Comments: “I feel that there should be an easier way to do this”
- Use the interactive module
 - User 1: Correctly used module
 - No comments
 - User 2: Correctly used module
 - No comments
 - User 3: Correctly used module
 - Comments: “Pretty intuitive, some of the vocab was unknown, but I didn’t read. Also I only remembered later that the squirrel told me I can hit the space bar. Upon later inspection I found the information in the caption, but only after I had played with the thing for a few minutes.”
 - User 4: Used Module
 - Comments: “Liked it overall, worked well”
 - User 5: Correctly Used Module
 - No comments
- Answer two of the concept questions at the end of the section
 - User 1: Got them correct, didn’t use feedback
 - No comments
 - User 2: Did not use feedback
 - Comments: “I don’t think there is anyone that would find that hard to find.”
 - User 3: Got them correct
 - Comments: “I did not see that there was explanation for the first two questions above the diagram and only found it half way through counting the teeth on the gears. Consider having question numbers”
 - User 4: Got them correct
 - No comments
 - User 5: Got them correct
 - No comments

Appendix C – Design Choice Testing Questions and Results

Design Choice Test 1 Questions:

- Do you prefer the sectioned layout in the first example or the side-by-side example in the second layout? Why?
- How do you feel about the pop-up vocab module? Do you think you would use it for studying or personal research?
- Do you prefer the example problem in the middle of the section? Would you like it better at the end of the section?
- Would you like having an example that you could try yourself and check your answer?
- What is something you like about this sample chapter?
- What is something you wish you could change about this sample chapter?

Answers:

- User 1:
 - RBE Major? No
 - Taken RBE 1001? No
 - The sectioned layout because when its broken up its easier to take in each piece. The layout of the example in the second one is better
 - Prefer having all the vocab words for the chapter all in one place. Use would depend on what you're being tested on. Probably would not use for examples
 - Prefers example near section that it is related to rather than at the end. When at the end, thinks that the question is confusing – could be relevant to later material
 - Example questions are good. So you have your own experience. Helps with understanding. Would use if problems are similar to an examination. Would rather have questions within each section at the beginning, but thinks that mixing them up would be better as the course went on.
 - Like the visual aids and the colors for both sections. Not too “wordy” likes the broken up section?
 - Closely relate objectives to subject headings labeling should be used more efficiently is the example is not in the section it is related to. More examples for each section
 -
- User 2:
 - RBE Major? No
 - Taken RBE 1001? No
 - The first layout – likes how it breaks it up. Second one is too overwhelming
 - Likes all vocab words in one window. Would use it for studying
 - Prefers example problem at the end of the section. Gives you a chance to get all the material first then see if you can put it together
 - Would like example problems. Would prefer them at the end
 - Like the break-up of the first chapter. Like the question at the end on the second one. Likes the pictures
 - Nothing

- Participant 3:
 - RBE Major? No
 - Taken RBE 1001? No
 - Prefers sectioned layout. The pictures are not necessarily related to the text directly beside it in the second one.
 - Like the vocab words. Able to look at all the vocab words at the same time. Especially useful if there's a lot to read. Would use pop-up window
 - Example in the middle. Seems to have more information, easier to follow
 - Would like interactive questions. Makes you think about what you read and would help you understand what you have learned
 - Likes the water pipe analogy, Likes the example problem and the steps to solve it
 - The resistor color code picture is too small – couldn't read all the values, Could explain how to calculate the resistor values
- Participant 4:
 - RBE Major? No
 - Taken RBE 1001? No
 - First layout. Content order in the second one is better
 - Would use vocab pop-up module Liked that it had all the vocab words in it. Quick easy way to preview to chapter
 - Preferred the example question at the end because she found that the KVL and KCL stuff felt like it was left out. Had already seen the resistance and felt that it was less relevant
 - Would like example problem. Has some experience with it, liked having the answers available
 - Really easy to follow, concepts were easy to follow. Likes that simple concepts are explained.
 - Thought it was fine, no real comments
- Participant 5:
 - RBE Major? Yes
 - Taken RBE 1001? Yes
 - Side by Side layout because it looks more like a Wikipedia article
 - Thinks having all of the vocab in one place is useful. Pop-up is ugly – should be on a page
 - Likes example better at the end. Practice applying what you read
 - Yes – because it lets you practice
 - Example
 - The Pop-up, having pictures between blocks of text might interrupt thought process while reading

Design Choice Test 2 Questions:

- Do you prefer having all of the text in a single page or having separate sections on separate pages? Why?
- Do you prefer having the vocab in a pop-up window or at the end of the chapter?
- Do you find the wider text or the skinnier text more comfortable to read?
- How do you feel about the width ratio of the columns in the side-by-side layout?

- Does having the vocab words in a different color and style help you identify key words?

Answers:

- Participant 1:
 - Separate pages. Makes it easier to mentally keep topics separate.
 - Both.
 - Skinnier text. I was able to read faster.
 - Slightly awkward
 - Yes! Helps to draw the eye in
- Participant 2:
 - I prefer to have all of the text in a single page, that way I can reference all of it at once, rather than searching through multiple web pages
 - I prefer the vocab at the end of the chapter, that way I can just go to the bottom of the page and reference and compare it to the other vocab if needed
 - I find the skinnier text (the first link) easier to read as it fits nicely into my field of vision.
 - The column widths are nice and efficient and fit well together
 - Vocab in different color and style would help me to find it when I need to go back through the text and look up definitions
- Participant 3:
 - Liked having all of the sections on a single page, because it allows you to quickly and easily refer to previous sections without having to jump pages or keep track of tabs. You can easily find a section you're looking for using the Find command within the browser to search the page.
 - Preferred having the vocab in a pop-up window. For an online/interactive textbook, thinks the key is to minimize scrolling and jumping around to make reading as smooth as possible. Having the vocab in an easily-accessible pop-up window lets you see all of the vocab without having to go to end of the page to find it. This would be especially important if the single-page format was used.
 - The skinny text with the corresponding picture on the right side is more comfortable to read. The wide text makes the picture placement look awkward and inconsistent. It would also prevent having to scroll down to look at the corresponding picture if the paragraph is long.
 - Perfect, don't change it.
 - Yes. It's helpful to know which words will be important as you're reading, especially for taking notes. It would also pair well with the pop-up vocab so you know the exact definition as you're reading.
- Participant 4:
 - Prefers that the content be split into smaller portions. That way you feel like you're accomplishing more. Plus it gives logical stopping points if you only have a small amount

- of time free. “For your particular site, I think I liked having it all on one page, but that's probably because overall there isn't too much content and none of it was new to me.”
- No preference one way or the other. “If you absolutely need me to choose, I guess I'd say end of the chapter, because I might not bother to open the popup, and because you can search all instances of the vocab word in the page. But a popup is still a good reference. Another option might be to have the definition appear when you hover over a word, though that might not work if you access the page via a smartphone.”
 - Prefers the skinnier text column size but can't express why. Usually uses websites when they offer the option to narrow the text. “Maybe I feel like I'm accomplishing more by having to scroll more often? Or maybe it's less intimidating to get through?”
 - Thinks the text column could be made thinner. There are several pictures that are much longer than the text for each picture, so there ends up being a few sentences, then a bunch of blank space. Maybe consider playing around until they're closer to equal in length?
 - Yes, different fonts, font styles, and colors help me see what an author is trying to emphasize. “Partly because that's how most of my textbooks did it throughout school-- usually with bold type for vocab and italics for emphasis.”