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Effect of Interactive Digital Homework with an iBook on Sixth Grade Students' Mathematics Achievement and Attitudes when Learning Fractions, Decimals, and Percents

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Effect of Interactive Digital Homework with an iBook on Sixth Grade Students’ Mathematics

Achievement and Attitudes when Learning Fractions, Decimals, and Percents

by

Jennifer Zakrzewski

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
College of Education
University of South Florida

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Rational Numbers, Technology

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DEDICATION

To my husband, Rick, I could not have done this without you. You dried tears of frustration and supported nonsensical babble for four years never questioning me though I constantly questioned myself. Without your love, support and guidance I could never have made it through. Thank you, I love you!

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ABSTRACT

Over the past decade, technology has become a prominent feature in our lives. Technology has not only been integrated into our lives, but into the classroom as well. Teachers have been provided with a tremendous amount of technology related tools to educate their students. However, many of these technologically enhanced tools have little to no research supporting their claims to enhance learning.

This study focuses on one aspect of technology, the iBook, to complete homework relating to fractions, decimals, and percents in a sixth grade classroom. An iBook is a digital textbook that allows the user to interact with the book through various features. Some of these features include galleries, videos, review quizzes, and links to websites. These interactive features have the potential to enhance comprehension through interactivity and increased motivation.

Prior to this study, two pilot iterations were conducted. During each pilot study, students in two sixth grade classrooms used the iBook to supplement learning of fractions, decimals, and percents. A comparison group was not included during either iteration, as the goal was to fine-tune the study prior to implementation. The current study was the third iteration, which included a comparison and treatment group. During this study, three research questions were considered:

1) When learning fractions, decimals, and percents, in what ways, if any, do students achieve differently on a unit test when using an interactive iBook for homework as compared to students who have access to the same homework questions in an online static PDF format?
2) What are students’ perceptions of completing homework regarding fractions, decimals, and percents with an interactive iBook compared to students who complete homework in an online static PDF format?

3) In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook and a static PDF online assignment?

Thirty students from a small charter school in southeast Florida participated in the third iteration of this study. Fifteen students were in the comparison group and fifteen were in the treatment group. Students in both groups received comparable classroom instruction, which was determined through audio recordings and similar lesson plans. Treatment group students were provided with a copy of the iBook for homework. Comparison group students were provided with a set of questions identical to the iBook questions in a static digital PDF format. The comparison group students also had access to the textbook, but not the iBook nor the additional resources available within the iBook.

The study took place over three weeks. At the commencement of the study, all students were given a pretest to determine their prior knowledge of fractions, decimals, and percents. Students were also asked to respond to questions regarding typical homework duration, level of difficulty, overall experience, and additional resources used for support. During the study, both classes received comparable instruction, which included mini lessons, manipulative based activities, mini quizzes, and group activities. Nightly homework was assigned to each group. At the conclusion of the study, both groups were given a posttest, which was identical to the pretest. Students were asked identical questions about their homework perceptions as prior to the study, but were asked to respond in regards to the study alone. All participating students completed a
questionnaire to describe their perceptions of completing homework regarding fractions, decimals, and percents with an iBook as opposed to static digital PDF homework. Lastly, six students from the comparison group participated in a focus group and six students from the treatment group participated in a separate focus group.

Data were collected from the pretest and posttest, pre and post homework responses, collected homework, mini quizzes, audio recordings, teacher journal, questionnaires, and the focus group. No difference in achievement was found between the two groups. However, both groups improved significantly from the pretest to posttest. Based on the questionnaires and focus groups, both groups of students felt they learned fractions, decimals, and percents effectively. However, the questionnaire data showed the treatment group found the iBook more convenient than the comparison group did the textbook.

Data from this study provide a baseline for future studies regarding iBooks in middle school mathematics. Although the data show no difference in achievement between the two groups, further studies should be conducted in regards to the iBook. Questionnaire and focus group data suggest, with modifications, students may be more inclined to use the resources within the iBook, which may enhance achievement with fractions, decimals, and percents.
CHAPTER 1: INTRODUCTION

Statement of the Problem

Research has shown that, conceptually, rational numbers are the most difficult topic for middle school students to learn (Lamon, 2007; Ni & Zhou, 2010). Although much of the basis for rational number concepts is developed in elementary school, students still struggle to gain understanding of rational numbers throughout the middle grades (Wilson, Edginton, Nguyen, Pescosolido, & Confrey, 2011). Some researchers speculate that children need to be competent in the four arithmetic operations and measurement with whole numbers prior to being introduced to rational numbers (Pearn, 2007). Others state that teaching fractions as parts of a whole creates obstacles for students as they try to reason abstractly about rational numbers (Risconscente, 2013). “The National Mathematics Advisory Panel (NMAP, 2008) concluded, “U.S. students’ poor knowledge of core arithmetical concepts impedes their learning of algebra and is an unacceptable indication of a substantive gap in the mathematics curriculum that must be addressed” (p. 26).

Wilson, Mojica, and Confrey (2013) note that much of the middle school and elementary mathematics curriculum is rational number reasoning based, so that students should be proficient with rational numbers by Grade 8. According to the 2013 National Report Card from the National Assessment of Educational Progress (NAEP), Grade 8 students scored 22 points higher overall than they had in 2009. However, NAEP also reported the average national scores for numbers and operations and algebra (which includes questions regarding fractions) were 281 and 290 respectively, which are both below proficient according to NAEP scoring guides. Data from
the *Trends in International Mathematics and Science Study* (TIMSS) also suggest that fractions are a problem for American children, perhaps more so than for children in other countries (Cooper et al., 2012). These national and international results indicate that the comprehension of rational numbers needs to be addressed, because as noted by Lamon, they are “…the most essential to success in higher mathematics and science…” (2007, p. 629).

According to the National Council of Teachers of Mathematics’ (NCTM) *Principles and Standards for School Mathematics* (2000), mathematics should be relevant and useful to middle grades students. However, middle grades students often show a noticeable decrease in engagement, particularly with mathematics (Bobis, Anderson, Martin, & Way, 2011). Therefore, it is critical to aid students in becoming reengaged with mathematics. One method of reengaging students is through homework.

Around the world students receive homework regularly (Dettmers, Trautwein, & Ludtke, 2009). Homework is a part of academia that is considered exceptionally important to students, parents, and teachers (Bembenutty, 2011; Kackar, Shumow, Schmidt, & Grzetich, 2011). In addition, many studies have shown a positive link between homework and achievement (Bembenutty, 2011; Dettmers et al., 2009). However, some research has shown that longer homework assignments can negatively affect achievement (Dettmers et al., 2009). Consequently, according to the work of Marzano and Pickering (2007), some students have become so overburdened by homework that their stress levels have increased and they no longer have time to do the things they enjoy due to tremendous amounts of homework. Therefore, students are often disengaged when they complete homework (Bembenutty, 2011).

According to Kackar, Shumow, Schmidt, and Grzetich (2011), students are more likely to engage in a task when they find it rewarding or valuable. With that being said, digital homework
is currently popular in colleges and gaining popularity in K-12 education (Mendicino, Razzaq, & Heffernan, 2009) and research has shown students to be motivated by technology (Chapman, Masters, & Pedulla, 2010). Therefore, technology holds potential to aid students in reengaging with mathematics.

Over the past decade, technology has become an integral part of our lives and has drastically influenced the educational arena (Barak & Ziv, 2013). Tremendous resources are being used to incorporate touch-screen devices into schools in an attempt to integrate technology and initiate creative teaching (Banister, 2010; Lewis, Zhao, & Montclare, 2012). This integration of technology calls for a transformation in teaching to prepare students for higher education and the technology driven global economy (Steinweg, Williams, & Stapleton, 2010), which will require more emphasis on modern teaching and learning theories that incorporate technology (Murray & Olcese, 2011). As new technologies become present in schools (McManis & Gunnewig, 2012), it is imperative teachers determine how to integrate technology effectively when educating students (Steinweg et al., 2010).

Keane, Lang, and Pilgrim (2012) affirm mobile devices are replacing notebooks. These mobile devices, such as tablets and iPads, have the ability to alter the paradigm of traditional education through development of connections between assistive technology (such as calculators and digital books) and instructional technology (such as computer labs and digital whiteboards) (O’Mally et al., 2013). Proponents of technology envision a transformation of education through an increase of active learning and reduction of passive learning (Murray & Olcese, 2011). However, the inclusion of iPads and tablets in schools does not guarantee effective technology integration and shifts in instruction (O’Mally et al., 2013).
This debate over effectiveness of technology in the educational setting is not new. Beginning in the 1980’s, Clark and Kozma disputed whether technology was an effective method of instruction, and the debate continues today. In 1983, Clark published a meta-analysis, which concluded that method of instruction and design were much more important than technology integration. Clark discovered when design was effective, students were more engaged, which increased achievement. Kozma (1991) argued that learners recall more information when images, voices, and sounds are employed.

In our current technology driven society, Moffat (2013) states that learners always have information available at their fingertips and they will look up the answer to their question on the Internet before they consider asking a teacher or peer. Furthermore, Moffat (2013) describes these digital natives as being unfamiliar with a time without the Internet to document their lives via Facebook, Twitter, Instagram, etc. Although teachers can teach students using supplies limited to textbooks and lectures, we are in an era in which learners demand engagement through use of technology inside and outside of the classroom (Becker, 2010).

“The present vision for educational technology imagines technology’s infusion into all aspects of the educational system” (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011, p. 299). Given students’ decrease in motivation throughout middle school, using technology for learning is expected to engage disaffected students and aid them in learning in deep and meaningful ways (Bruce & Reynolds, 2009). As mentioned previously, how technology is used determines its effectiveness. Therefore, although technology is being integrated into education, it is unclear whether it is an effective learning tool (Ertmer & Ottenbreit-Leftwich, 2013). Upon a review of the literature, I found that few studies have been conducted to determine the effectiveness of tablets and iPads on student achievement and even fewer with a focus on
mathematics. Of the studies available, many focus on literacy. Technology related studies conducted in the field of mathematics often focus on applications (apps) and/or games and whether they increase learning. At this time, I have only been able to find a few studies relating to e-textbooks, or digital textbooks, for mathematics, but these tend to focus on primary grades or undergraduate students. There are also very few studies available that focus on technology integrated homework. In addition, I have been unable to locate any research studying interactive textbooks in mathematics for the middle grades.

**Research Purpose**

The purpose of this study was to determine if, when instruction is held constant as much as possible, Grade 6 students’ understanding of rational numbers would be increased through using interactive iBooks for homework rather than static digital PDF oriented homework. A secondary purpose of this study was to determine student perceptions of learning fractions, decimals, and percents with an interactive iBook and whether students feel learning from technology through the use of iBooks enhanced their learning.

As previously mentioned, technology is expected to enhance comprehension through active learning (Murray & Olcese, 2011) and enhancing motivation (Chapman et al., 2010). However, it is unclear whether using interactive elements of technology is an effective method for homework. Clark (1983) states that media “…such as animated motion or zooming, might serve as sufficient conditions to facilitate the learning of students…” (p. 10). Kozma (1991) asserts that using a particular medium and taking advantage of its features may allow students to process information in multiple ways, thereby increasing learning.

In 2012, Apple introduced a program called iBooks Author that allows anyone to author his/her own book through use of the provided templates. Not only does iBooks Author allow digital books to be developed, but it also includes several interactive components. Some of these
components allow users to swipe through pictures, watch videos, connect to websites, and interact with 3D graphics. From an educational perspective, iBooks Author allows the author to include review quizzes. In addition, the iBook can be shared free of charge to Apple devices and updated as frequently as desired.

The iBook I developed provides an interactive format for homework and supplemental learning to the in-class teaching of rational numbers to Grade 6 students. In 2012-2013 and again in 2013-2014, I piloted the iBook with sixth grade students. Through the pilot studies, I was able to work through errors in the iBook and improve instruction of fractions, decimals, and percents prior to conducting the current study, which includes a treatment group in addition to a comparison group.

**Research Questions**

The following three questions focus on student learning based on iBook homework as well as their perceived learning and engagement.

1) When learning fractions, decimals, and percents, in what ways, if any, do students achieve differently on a unit test when using an interactive iBook for homework as compared to students who have access to the same homework questions in an online static PDF format?

2) What are students’ perceptions of completing homework regarding fractions, decimals, and percents with an interactive iBook compared to students who complete homework in an online static PDF format?

3) In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook and a static PDF online assignment?
Delimitations and Significance of the Study

Rational numbers are a key component of elementary and middle school mathematics (Wilson, Mojica, & Confrey, 2013). Though rational numbers are taught throughout elementary and middle school, this study was delimited to focus on the comprehension of fractions, decimals, and percents for regular education sixth grade students through modified homework. In addition, the population of this study focused only on sixth grade students in a charter school that provides iPads to all students. This allowed all students in the study to have equal access to an iPad.

Technology continues to be a presence in schools across the United States (McManis & Gunnewig, 2012). Teaching in this day and age requires teachers to prepare students for careers where technology will be a critical component (Steinweg et al., 2010). Consequently, more governments across the globe emphasize the need for technologically literate graduates to compete in the global economy (Pegrum, Oakley, & Faulkner, 2013). To prepare K-12 students for technologically productive lives in the 21st century, more application of technology is needed using modern teaching and learning theories (Murray & Olcese, 2011). Therefore, many now believe integration of technology into the classroom is a necessity, not a choice (Bruce & Reynolds, 2009).

Because technology is so relevant in society, it is critical students know how to use technology efficiently and effectively. It is also critical that, as researchers, we understand the effectiveness of technology and use it appropriately at all levels. Currently, because iBooks Author is a relatively new program, research is unavailable in regard to middle school students using interactive textbooks for homework to aid in mathematics learning. Therefore, this study
informs researchers on whether iBooks increase achievement with sixth grade students and whether iBooks increase motivation when used to complete homework.

In terms of homework, this study can be used to determine if there is the potential to enhance motivation when completing mathematics homework if homework is given in the format of an interactive book (i.e., an iBook). Student perceptions regarding the iBook can inform future research to determine which aspects of the iBook are useful and those that need more development. In addition, future research can be conducted with a larger population and perhaps in other subject areas.

In the technology arena, this study shows how teachers can give technologically based homework. Data from the focus group showing student perceptions can then inform researchers so they can focus on individual aspects of the iBook technology to enhance the affordances and modify the areas that need improvement. In determining the most effective aspects of technology, more technology can be developed to increase usage in the educational market to influence learning.

**Terminology**

1. digital textbook- an electronic version of a textbook that can be purchased and read on a computer or tablet
2. digital technology- any device that includes a screen, Internet access, and computer-like capabilities
3. iBook- an interactive electronic book downloaded from the Apple bookstore and used on an Apple device
4. iBooks Author- a program for Mac computers that allows one to design an interactive book to be used on an iPad
5. fraction- a ratio of algebraic quantities similarly expressed, a number usually expressed in the form of \( \frac{a}{b} \), where \( b \neq 0 \)

6. rational number- any number that can be expressed as the quotient or fraction \( \frac{p}{q} \) of two integers, with the denominator \( q \) not equal to zero. Because \( q \) may be equal to 1, every integer is a rational number.

7. tablet- an electronic device which functions like a computer and allows the user to connect wirelessly to the Internet, read books, and play games among other features

8. technology- any machine, equipment, or software that incorporates computer-like capabilities in order to function properly
CHAPTER 2: LITERATURE REVIEW

This literature review draws from five bases of literature: rational numbers, homework, technology, e-books, and motivation. The literature review opens with rational numbers. To date, literature surrounding rational numbers covers a variety of areas. However, here I focus on the issues researchers have discovered regarding the instruction of rational numbers and methods to teach rational numbers and their effectiveness.

Homework is the focus of the second section of the literature review. In this section homework effectiveness is considered in terms of achievement. This section discusses how homework is viewed around the world, including the ways in which online and web-based homework are changing perceptions of homework.

The third base of the literature refers to technology. This section of the literature review includes debate on technology’s effectiveness and design elements and a discussion on technology integration in schools with a focus on tablet PCs.

E-Books are the focus of the fourth section of the literature review. This section reviews literature regarding e-books and e-textbooks. Here the benefits of e-books will be reviewed in addition to student perceptions of e-books.

The fifth and final section of this literature review focuses on enhancing learning through motivation. This section discusses how technology influences motivation to increase learning in the context of mathematics. Following this final section of the literature review, I include a section to discuss the conceptual framework for my study.
Method

The literature review began with a search for *rational numbers* research. This topic was included as a part of the literature review to give a basis for the instruction used during this study to ensure current methods were employed throughout instruction. To locate literature on rational numbers, I conducted a search in ERIC using the term *rational numbers*. I then narrowed the search to only include articles from 2006 to reduce redundancy and to include current research, as there is an abundance of research on rational numbers. Finally, I narrowed the search individually using the following terms: *mathematics instruction, middle school*, and *teaching methods*. Literature for the rational number section of the literature review was also found in the *Second Handbook of Research on Mathematics Teaching and Learning*.

Literature regarding homework was located through a search of the ERIC database using the term *mathematics homework* as the primary term. I then narrowed the search by only including articles published since 2006 to focus on current research from the past ten years. Finally, I narrowed the search using the following terms individually: *middle schools* and *mathematics achievement*. To search for information on digital homework, the terms *digital homework* and *online homework* were used. Study titles and abstracts were then reviewed for pertinence to mathematics and middle school students.

Technology related literature was found using the ERIC database. Search terms included: *tablets, learning, eBooks, iPads, technology, education, affordances*, and *hindrances*. Combinations of these words were used in conjunction with and/or narrowing the search to only include articles published after 2006. In addition, several texts from my coursework were reviewed to determine relevance.
Several of the articles from the technology search overlapped with the motivation section of the literature review. Therefore, several articles from the previous searches were used in this section. Additional research on motivation was located through the ERIC database with the primary term being *technology mathematics motivation*. The search was then narrowed to articles published after 2006 to focus on current views of motivation in relation to the present population of students. Other terms used individually and in conjunction with one another included *middle school, student motivation, and teaching methods*.

**Rational Numbers**

The *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics* (NCTM, 2006) emphasize understanding of rational numbers in sixth and seventh grades. However, research has shown that middle school students continue to struggle with understanding of fractions (Mazzocco & Devlin, 2008). Curriculum in textbooks is currently developed to introduce content and sequence skills to increase difficulty and comprehension over time (Stein, Remillard, & Smith, 2007). In addition, students are often not expected to master content when it is introduced, but instead deepen understanding over time as content is revisited (Stein et al., 2007). However, revisiting concepts year after year may cause students to employ rote memorization, which does not allow true understanding of the content (Cooper et al., 2012). Therefore, students may not comprehend early introductions to rational numbers, causing them to employ rote memorization, which may decrease comprehension as rational number concepts become more challenging.

According to Piaget’s theory, ratio and proportion are appropriate topics for middle school adolescents; when curriculum is viewed more closely, indications of rational numbers appear throughout the entire curriculum in forms such as fractions and multiplicative concepts.
(Lamon, 2007). This shows gradual building toward working with rational numbers in middle school. However, Wilson et al. (2013) indicate that developing rational number reasoning is still a monumental challenge when misconceptions, such as multiplying makes numbers larger and dividing makes numbers smaller, continue to be taught in the lower grades. In addition, from their research Seethaler, Fuchs, Star, and Bryant (2011) found students often misapply whole-number concepts to fraction procedures, furthering their confusion.

**Transition from Whole Numbers to Rational Numbers**

An immense amount of time is spent on whole number comprehension in the elementary grades. Although the transition to rational numbers begins in elementary school, it is not a focus until the upper elementary and middle grades. By this time, students have often begun to struggle with rational numbers, especially fractions, causing them to rely on their whole number comprehension (Ni & Zhou, 2010).

Moseley and Okamoto (2008) claim that, “One of the key stumbling blocks in learning mathematics in elementary school years is a transition from whole number to rational number reasoning” (p. 238). In their study, Moseley and Okamoto examined rational number problem solving in average, high, and top performing fourth grade students in several schools in the southeastern United States. Within these schools, 91 students consented to participate. The main task in the study was a card sort activity in which students sorted cards into groups, so that each group had a picture, number and words. In addition, each student took a written test with four computation problems, two visual problems, and two word problems. The results of the study showed students generally do not have a solid understanding of rational numbers. Although the top performing students scored well, students below them struggled with the content. Further investigation caused researchers to hypothesize that teaching part-to-whole constructs put lower
achieving students at a disadvantage because they lack comprehension and flexibility in problem solving.

A study conducted by Clark and Roche (2009) questioned whether students could determine fraction size. The study involved 323 students in grade 6 who were brought to a quiet place in their school and asked to complete a number of tasks. Each student was shown eight fraction pairs and asked which fraction was larger. Students were given as much time as needed, but were only to use mental strategies to solve each problem. The results of the study showed students were able to determine the larger fraction when common denominators were used, which shows that students still use whole number reasoning when working with fractions. However, correct answers decreased when uncommon denominators were used. In addition, most participants attempted to use common denominators to solve each problem, reverting to whole number concepts once again.

Ni and Zhou (2010) claim that insufficient time is devoted to aid children in understanding the new set of numbers embodied in rational numbers. Although years are spent developing whole number reasoning, little time is devoted to helping students acquire rational number reasoning. This causes students confusion as they work with rational numbers, forcing them to rely on rote memorization and procedures. Therefore, it is critical students are exposed to a wide range of representations to aid them in comprehending rational numbers.

**Rational Number Instruction**

Although there is a vast amount of research on rational numbers, particularly fractions, Lamon (2007) states, “there is little research that targets how to teach rational number concepts” (p. 632). The most agreed upon method of rational number instruction is using manipulatives to help students understand rational numbers, which is endorsed by Cooper et al. (2012).
Hiebert, Wearne, and Taber (1991) sought to determine whether using manipulatives with low-achieving fourth grade students would increase their understanding of decimals. The sample consisted of one class of 25 students in a moderately sized city. One researcher taught 11 consecutive daily lessons about decimals using manipulatives such as base-10 blocks. An 18-item test was given prior to each lesson and again at the conclusion of each lesson. After each written test, eight students were interviewed and asked how they knew to solve each problem. The results of the study showed students improved their decimal knowledge, but achieved higher levels of understanding when a compatible physical representation was used. Therefore, using manipulatives and hands-on approaches to teaching may enhance understanding of rational numbers.

Cooper et al. (2012) suggest part-whole partitioning is an effective method for teaching fractions. In a study conducted by Norton and Wilkins (2010), the researchers analyzed test results to determine strategies students used when working through rational number problems. The study included 58 eighth-grade students in the rural Southeast. Students were administered a 22 item test, which was designed to provoke particular strategies of solution. Results showed students most often used part-to-whole reasoning when solving problems.

Lamon (2007) claims, “to understand rational numbers, one must have adequate experience with multiple interpretations, not merely with fractions as objects of computation” (p. 642). However, it seems students often do not have this experience. Cooper et al. (2012) discovered from their study that students were successful in identifying picture representations of fractions, but struggled with multi-step and non-routine problems. In addition, Pagni (2004) hypothesized that students often view fractions and decimals as two separate entities rather than
two representations of the same number. Furthermore, Lamon (2007) claims students are dependent on textbook strategies and struggle with thinking through problems.

NCTM advocates for flexibility between representations and deep understanding of rational numbers (Whitin & Whitin, 2012). However, research shows students struggle to comprehend rational numbers. This may be due to traditional methods of instruction employed in the classroom, such as rote memorization and algorithms (Cooper et al., 2012). Students need to be instructed beyond the part to whole construct (Norton & Wilkins, 2010). In addition, students need to be taught to conceptualize quantities using their own developed constructs of rational numbers prior to learning procedures and algorithms (Pearn, 2007). Because rational numbers are not dependent on the counting algorithm, they must be treated differently during instruction (Pearn, 2007).

**Homework Effectiveness in Mathematics**

“The effectiveness of homework is a prominent topic for debate among educators, politicians, parents, and students” (Minotti, 2005, p. 70). Homework has been described as “tasks assigned to students by school teachers that are meant to be carried out during non-school hours” (Dettmers et al., 2009, p. 376). Educators and parents alike believe homework promotes learning, achievement, work habits, and motivation, which aligns with the mindset that homework should be assigned daily (Kackar et al., 2011). In addition, United States parents expect students to have homework daily across all subjects, especially at the middle school and high school level (Bembenutty, 2011; Weiman & Arbaugh, 2014).

Assigning homework began when rote memorization dominated teaching (Weiman & Arbaugh, 2014). However, “the positive effects of homework on the achievement levels of middle level students have been evidenced worldwide across several cultures” (Minotti, 2005, p. 70).
“Time spent doing homework is tied to academic success and is an important basic expectation in college” (Kackar et al., 2011, p. 71). In addition, many studies have shown that homework does not affect academic achievement in elementary school, but it does in high school (Kitsantas, Cheema, & Ware, 2011).

In a synthesis of research Cooper, Robinson, and Patall (2006) found in studies conducted with elementary and high school students where one group of students receives homework and the other does not, achievement is typically higher in the homework group. In their review of research on homework, Kitsantas, Cheema, and Ware (2011) found homework has been found to be more beneficial for lower-achieving students than higher achieving in mathematics because lower-achieving students often need additional practice. Because homework has a positive relationship with achievement, it has been closely associated with self-regulated learning, which can aid students in creating better study habits and time management (Xu, 2009, p. 28).

**Mathematics Homework in Other Countries**

Around the world, students in most countries are given regular mathematics homework (Dettmers et al., 2009). This may be because “time on homework is generally believed to be associated with greater achievement gains” (Dettmers et al., 2009, p. 376). A study conducted by Dettmers, Trautwein, and Ludtke (2009) used the Programme for International Student Assessment (PISA) data collected in 2003 to determine the effect of homework on mathematics achievement. In the first part of the study, 40 countries were included with over 250,000 students. Students selected for this study were between 15 and 16 years of age. Questionnaires, mathematics achievement tests, and socioeconomic status were used to inform the research. Where the socioeconomic status was higher, researchers found that homework time was longer.
They also found students who had frequent or lengthy homework assignments outperformed their peers with fewer or shorter assignments.

In the second part of the study, Dettmers et al. (2009) reviewed six school systems in depth to determine whether mathematics homework is effective. Again, 2003 PISA results were used, but this time 9th and 10th graders were enrolled in the study. They discovered that, in some countries, longer homework assignments caused students to achieve more in mathematics. However, overall, longer homework assignments in mathematics were shown to negatively effect mathematics achievement.

Another study conducted by Trautwein and Koller (2002) looked at the data from a longitudinal study from Learning Processes, Educational Careers, and Psychological Development in Adolescence and Young Adulthood in Berlin. The study pulled data from 7th grade classes. Participants included 1,976 students to determine whether homework is effective in increasing mathematics achievement. Measures included achievement tests and individual achievement scores, psychometric intelligence, homework variables, quality of exercises, social background, learning motivation, type of secondary school, and region. The results from the study showed that most students received regular mathematics homework. In addition, after controlling for variables in the study, homework was shown to have a positive effect on achievement. Shorter assignments were at least as good as longer assignments and homework had the greatest improvement for lower-achieving students.

Although some research shows that homework increases achievement in mathematics, some still question the length of homework assignments. Studies have documented that the amount of time students spend on homework has a positive relationship with academic achievement (Kackar et al., 2011). A study conducted in Hong Kong addressed the length of
homework assignments; Zhu and Leung (2011) reviewed the relationship between classroom practices on homework and students’ mathematics achievement. Participants included 144 mathematics teachers and 4,972 eighth grade students. Background questionnaires were used to gather data. Results from the study showed 44% of students spent about fifteen to thirty minutes on mathematics homework per night. Most often, students were given problem sets to solve for homework and teachers generally graded homework and gave feedback rather than student correction. Overall, the researchers discovered the more time students spent on homework, the higher they achieved in mathematics.

**Digital Mathematics Homework**

As technology continues to transform education, it is important to consider how homework will be affected by these advances. “Web-based homework is an internet-based accessory to mathematics and science learning that is gaining popularity in the United States” (Hauk et al., 2014, p. 61). In a study conducted by Hauk, Powers, and Segalla (2014), the researchers sought to determine whether web-based homework would increase student learning in a college algebra class over traditional paper and pencil based homework. Participants in the treatment group included 408 students and twelve instructors. In the comparison group, 236 students were included and seven instructors. A software program called WeBWorK replaced homework for students in the treatment group. Students in the comparison group received the same homework assignments, but paper based. A pretest, a posttest, and homework grades were collected as data. The resulting analysis showed that students in both groups increased their understanding of college algebra from pretest to posttest, but there was no difference in gain scores between the groups. Some of the limitations included instructor experience, time of day
the course met, and classroom practices, which the researchers state may have affected the results.

In another study conducted by Leong (2013), online homework was explored in developmental algebra. Participants included 78 students at a community college taking a mathematics prerequisite. Data were collected through a survey completed by the participants. The researcher found study results were mixed in terms of the online homework. Many students liked the web-based homework because it was easily accessible and convenient. Others liked the instant feedback and step-by-step solutions provided for some questions. However, some students struggled when they got a question incorrect and did not know where the error was in the problem. Overall, the researcher found students who were lower achieving had more positive attitudes toward the web-based homework than the higher achieving students.

Nordstrom (2012) conducted a dissertation study to determine the impact of online homework for sixth grade students in language arts. The treatment group included 28 students who were given online assignments through Discovery Education, while the 26 students in the comparison group received pencil and paper homework. During the study, the researcher was also the teacher of the class. Data were collected from the Tennessee Comprehensive Assessment Program (TCAP), attitudinal homework survey, Discovery Education assessments, and the MIDAS online. The researcher found no significant difference between the two groups when an ANOVA was performed on their TCAP from 2010 and 2011. Students in the treatment group indicated they benefitted from the online homework, but linguistic skills had no effect on student learning nor did learning style.

In 2009, Mendicino, Razzaq, and Heffernan published a study to review the differences between paper and pencil homework and online assisted homework in mathematics for fifth
grade students. Four fifth grade classrooms participated in this study, with a total of 92 students. Students from each group completed two identical question sets of ten questions each. One question set focused on Number Sense, while the other focused on a mixture of problems. Because the study was conducted at the end of the year, all questions were review for students. Students in the treatment group used a program called ASSISTment System, which provides hints, instruction, and tutoring to students as they are completing the assignment. In addition, ASSISTment provides the teacher with detailed feedback regarding student progress to modify instruction in the classroom. In contrast, the comparison group was given a worksheet for homework, which was printed from the ASSISTment site to ensure equity of problems. Prior to receiving the homework, students were given a pretest. Then, they were given the homework and a posttest the following day. The researchers conducted t-tests between the groups and found a statistically significant difference between the two groups with a 0.61 effect size favoring the digital homework group.

According to his research, Leong (2013) claims that we can improve homework through web-based homework. He argues that allowing students immediate feedback on homework assignments improved their self-efficacy and the length of time they were willing to spend on an assignment. Kitsantas et al. (2011) add that student support resources such as desks, books, and the Internet helped students with their homework, increasing achievement.

Evolution of Homework

Current research on homework has raised concerns in the education arena causing calls for more, different homework (Trautwein & Koller, 2002). Weiman and Arbaugh (2014) speculate that students complete homework with very little thought, so homework must be engaging and meaningful for students to engage in mathematical thinking. Weiman and Arbaugh
(2014) claim that, “Effective homework supports mathematical learning by including tasks that require students to think about important mathematics” (p. 161). Homework assignments can require more than review of procedures, they can allow students to read, ponder, and reflect (Minotti, 2005, p. 70).

When giving homework, “Teachers must be clear about goals and expectations” (Weiman & Arbaugh, 2014, p.161). Bembenutty (2011) claims that teachers need to assign homework with a clear and meaningful purpose, which are described as tasks “that enrich the in-school curriculum by challenging students to think deeply about important questions, apply their knowledge and skills toward solving genuine problems, and creating authentic products that will be used in meaningful ways” (p. 453).

**Technology Integration**

Technology continues to be a presence in classrooms across the United States (McManis & Gunnewig, 2012). Teaching, in this day and age, requires teachers to prepare students for careers where technology will be a critical component (Steinweg et al., 2010). Consequently, more governments across the globe emphasize the need for technologically literate graduates to compete in the global economy (Pegrum et al., 2013). To prepare K-12 students for the technology productive lives of the 21st century, more application is needed using modern teaching and learning theories (Murray & Olcese, 2011). Therefore, integration of technology into the classroom is a necessity, not a choice (Bruce & Reynolds, 2009).

“The vision for educational technology currently promoted by education leaders, policymakers, and business and community members foresees technology’s incorporation into all aspects of the educational environment” (Shapley et al., 2010, pp. 1-2). Technologies, such as tablets, are viewed as an opportunity to alter the paradigm of education (O’Mally et al., 2013).
This perception has caused public schools to allocate substantial resources to provide K-12 schools with technology to ensure technology access for all students (Ritzhaupt, Dawson, & Cavanaugh, 2012).

Learners who enter today’s classrooms are classified as “digital natives” because they were born into a world actively engaged with technology (Yang, Tzuo, Higgins, & Tan, 2012). These students are comfortable with technology and use prior knowledge to determine how to use new technology they encounter (Blocher, Armfield, Sujo-Montes, Tucker, & Willis, 2011). Because they have grown up with technology, these students expect teachers to use technology and digital media to inform learning (Huang, Liang, Su, & Chen, 2012; Korat & Shamir, 2012). Therefore, it is imperative teachers increase their technology use to deliver content (Steinweg et al., 2010).

Those who support technology suggest it can transform education, but in truth technology integration has become more complicated than expected (Murray & Olcese, 2011; Wright & Wilson, 2011). As schools place tablets in the hands of learners, school leaders ask teachers to develop highly effective instruction with technology, which is a difficult task (Ally & Samaka, 2013). Additionally, many teachers are considered “digital immigrants” who are uncomfortable with technology and unsure of how to use technology for learning purposes (Yang et al., 2012). Therefore, it is critical to review the literature to determine how and under what conditions research has shown tablet PCs or technology to be effective tools for teaching and learning.

**Debate and Design**

In 1983, Clark published a meta-analysis regarding media and its influence on learning. In this article, Clark argued that teaching method has the most influence on learning. He suggested that “the best current evidence is that media are merely vehicles that deliver
instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition” (Clark, 1983, p. 445). Clark also claimed that each new medium develops its own following who support research and learning through media. Although Clark agreed learning may increase with the novelty of the media and studies supported reduced cost of education with media, he believed that there is no research supporting enhanced learning over time (Clark, 1983). In addition, Clark hypothesized that games do not improve education and lecture is just as effective for student leaning.

In 1991, Kozma published a response to Clark’s 1983 article. Kozma argued that “whether or not a medium’s capabilities make a difference in learning depends on how they correspond to the particular learning situation- the tasks and learners involved- and the way the medium’s capabilities are used by the instructional design” (Kozma, 1991, p. 182). He also claimed that media could and should be used as more than a delivery method. In the article, Kozma conducted a literature review, which concluded that media could aid learners who need to process material through a unique experience. In one study, “observations of good readers showed that they spent more time initially looking at the pictures and rarely looked at them once they started reading. Poor readers, on the other hand, frequently moved back and forth between text and pictures” (Kozma, 1991, p. 8). He also claimed that pictures increased recall for poor readers and aided in comprehension of the text (Kozma, 1991).

The debate continued in 1994 with Clark stating media studies were not adequately designed and therefore could not be replicated, causing them to be useless. Clark also claimed that textbooks develop concepts while media often attempt to educate through drill (Clark, 1994). Clark concluded by saying, “we know that the active ingredient in successful media treatments is not the media attributes because in all known attempts to replicate these studies,
different attributes produce similar learning results—provided that the required instructional method is present in the compared versions of the media attributes” (1994, p. 25).

In 1994, Kozma made his final rebuttal by claiming there is no connection between media and learning because we have not made one yet. He continued this argument by saying, “…we will understand the potential for a relationship between media and learning when we consider it as an interaction between cognitive processes and characteristics of the environment, so mediated” (Kozma, 1994, p. 3). He theorized that traditional methods of instruction do not address the complexities of media because they are being looked at through a behavioral lens rather than a constructivist lens (Kozma, 1994). Lastly, he asserted that, “the capabilities of a medium constrain what it is designers can do, as do features of a situation. But these capabilities and features also enable designers; they provide the designer with resources and suggest things that might be done with them” (Kozma, 1994, p. 21).

Though Clark and Kozma argued back and forth, there is no conclusive evidence that one medium is more effective than another (Becker, 2010). It is noteworthy that Clark concluded his research prior to the turn of the century before there were so many monumental advances in digital technology (Becker, 2010). When Clark wrote his article, digital technology was just emerging as a concept in education. However, in today’s technological society, organizations such as the National Council of Teachers of English (NCTE) have embraced this shift towards implementing technology into the classroom (Moffat, 2013). In addition, today technology is viewed as a hub of education and school officials now advocate 1:1 computing, and bring your own device (BYOD) policies (Moffat, 2013).

Although there are many types of technology available for educational use, it is important to consider the students and their needs (Alessi & Trollip, 2011). Alessi and Trollip (2011) state
that there are a variety of design aspects that should be considered in creating technologically enhanced instruction. For instance, similar to print text, authors should use text that includes clear transitions, clarity, appropriate reading level, proper mechanics, and no more text than necessary. When graphics are incorporated, they should be used as cues, organizers, analogies, or include important information. Graphics can be artistic, diagrams, photographs, 3-D images, animated images, or schematics. Alessi and Trollip also promote short videos as another great resource for important information and demonstrating or modeling a skill. In addition, users should be provided with controls for videos to skip, rewind, pause, or restart.

However, Alessi and Trollip (2001) maintain that when using computers for instruction, teachers should not be wasteful with resources. They stressed the inclusion of phases of instruction: presenting information, guiding the learner, practicing, and assessing the learner. Some methods of facilitating learning include: tutorials, drills, simulations, games, tools, and tests. Lastly, it is important the learner know how to control the program, which should be done prior to instruction.

**Tablets for Educational Purposes**

The pervasiveness of digital technologies, such as iPads, tablets, and Kindles, has created an expectation that schools will adopt and implement these devices (Starkey, 2010). Because digital and social media have become a centerpiece of American society, in 2009 President Obama launched the “Educate to Innovate” campaign, which focused on Science, Technology, Engineering, and Mathematics (STEM) programs (Pelusa, 2012). Since then, educational settings have been provided with more digital technologies (Pelusa, 2012). Currently, most educational facilities encourage technology use to enhance student knowledge with computers (Lewis et al., 2012).
As technology is introduced to schools, there is hope teachers will innovate with technology to engage students and encourage them to learn on a more personal level to understand that knowledge can be socially constructed (Berson, Berson, & Manfra, 2012; Bruce & Reynolds, 2009). However, at present, technology integration falls short of what is anticipated (Murray & Olcese, 2011). This may be due to the new skills required of teachers and students in order to effectively use technology in the classroom (Berson et al., 2012).

**Tablet PCs**

Tablet PCs have been available since the 21st century began, but have yet to be fully investigated to determine their educational potential (Galligan, Loch, McDonald, & Taylor, 2010). Currently, there are calls for mobile devices to be placed in the hands of each student, especially because the cost of these devices has dropped significantly and their ease of use has increased over time (Martinez & Schilling, 2010; Murray & Olcese, 2011). Mobile technologies introduced to the classroom are small and take up little space, which allows them to be less disruptive and more likely to become a life-long learning tool (Loo et al., 2009). Tablets are being incorporated into more schools because of the price, size, storage, Wi-Fi connectivity and a myriad of other features (O’Mally et al., 2013). The lightweight devices are also advertised as an opportunity to revolutionize learning (Carr, 2012).

The unique capabilities of the tablet allow students to use the tablet as a computer and access more applications than available on a computer (Hutchinson, Beschorner, & Schmidt-Crawford, 2012). Most tablets grant access to PDF files, video files, e-books, Internet, USB ports, and cameras (Berson et al., 2012; Steinweg et al., 2010). In addition, tablets have the capability to replace textbooks, games, and musical instruments (Murray & Olcese, 2011).
Advantages of tablet PCs.

One-to-one technology has been shown to enhance student motivation, and mobility allows students to learn at any time, which reinforces learning as a part of daily life (Keane, Lang, & Pilgrim, 2012; Li & Pow; 2011). Because these devices are often personalized, they encourage ownership of learning and more learner-centric experiences (Loo et al., 2009). Consequently, students with tablets read, write, create, share artifacts, and have online discussions more often than students who do not have regular access to tablets (Li & Pow, 2011; Loo et al., 2009).

Students often need little instruction prior to using a tablet because tablets are intuitive and engage kinesthetic learners because of their touch screen (Bennett, 2011). Some of the advantages of tablets include their size, battery life, price, Internet connectivity, and video and audio capacity (Crichton, Pegler, & White, 2012; Martinez-Estrata & Conaway, 2012; Warden, Standworth, Ren, & Warden, 2013). Students and teachers can access digital resources individually and quickly, which allows for an immediate response to any question (Banister, 2010; Galligan et al., 2010). Tablet PCs have also been found to transform lectures through projection of the tablet screen onto a Smartboard, which allows teachers to face students to interact and answer questions as they write on their device (Galligan et al., 2010).

E-Books

Electronic books, or e-books, are common among adults and children (Shamir & Baruch, 2012). Daniel and Woody (2013) state:

Since April of 2011, e-book sales have outsold printed books on Amazon.com and continue to grow throughout the marketplace. Yet, e-textbook sales have yet to take-off at the college level (p. 18)
Digital forms of text continue to replace print (Taylor, 2012). However, many e-textbooks are static and do not make use of technology, which would allow text to be flexible and engaging (Huang et al., 2012).

**Functions of E-books**

E-books have the ability to change the way learners interact with text because of their additional functions (Franklin, 2011). For young children, e-books include multimedia, written text, oral reading, music, sound effects, and animations (Felvegi & Matthew, 2012; Korat & Shamir, 2012; Shamir, 2009; Shamir & Baruch, 2012; Shamir, Korat, & Shlafer, 2011). Because of the digital interface, e-books can also define unfamiliar words or read aloud all or portions of a story (Korat & Shamir, 2012).

E-books often cost less than traditional paper texts (Woody, Daniel, & Baker, 2010). In addition, they offer greater flexibility than paper texts because of their ability to include audio, video, animation, etc. (Woody et al., 2010). E-books also allow students to manipulate text, in terms of font size, color, and brightness, to fit their needs (Hutchinson et al., 2012).

However, there are still challenges to consider when incorporating digital books into the classroom. A study conducted by Lee, Messom, and Yau (2013) addressed challenges in incorporating digital textbooks into K-12 schools. The researchers conducted a literature review in phase one and interviewed a convenience sample of 20 teachers and 180 students in phase two. They uncovered problems downloading digital textbooks, time restrictions for use with downloaded books, and bandwidth issues. In addition, many students did not consider purchasing e-books if the savings was only minimal.
Students’ Perceptions of E-books

Currently, the face of education is being modified as publishers develop digital texts (Martinez-Estrada & Conaway, 2012) because school districts are interested in digital versions of textbooks in conjunction with or to replace traditional textbooks (Felvegi & Matthew, 2012). However, in their research Woody, Daniel, and Baker (2010) discovered teachers and students did not use e-books as frequently for educational purposes at the university level as traditional texts. The goal of their study was to determine student preferences between printed textbooks and e-books. Participants included 91 undergraduate students taken from a convenience sample. Each participant completed a Likert scale questionnaire that focused on his or her individual technology use. Although students stated they felt comfortable using e-books, the researchers found that students were more comfortable with printed textbooks and preferred to spend more money on a traditional textbook than a less expensive e-book.

When undergraduates used an e-reader, they were more engaged and read for longer periods of time (Martinez-Estrada & Conaway, 2012). However, Felvegi and Matthew (2012) found undergraduates preferred a textbook to skim or read in depth because of difficulty reading from an e-reader. Additionally, students who had used e-textbooks often chose traditional texts on future textbook purchases (Daniel & Woody, 2013). However, while undergraduates may prefer printed textbooks, Martinez-Estrada and Conaway (2012) found from their study that undergraduates enjoyed the portability of an e-textbook.

Young children have shown interest in reading e-books and traditional books to promote language and literacy skills (Ciampa, 2012; Taylor, 2012). Ciampa (2012) claims that seven year olds enjoyed reading online because of the variety of books. Huang, Liang, Su, and Chen (2012) discovered that elementary students felt e-books were easy to use and were satisfied with the
graphics and engagement. Korat and Shamir (2012) found that kindergarten students were more likely to comprehend text when a digital dictionary was available in the e-book. Additionally, Shamir (2009) observed increased vocabulary in kindergarten low SES students who read e-books, which included a digital dictionary.

E-books have become popular around the world. Their flexibility of format and inclusion of dictionaries, animation, and sound allow young readers to read independently. Research shows young readers enjoy reading e-books and can increase their comprehension and vocabulary. However, college students disliked using e-textbooks to study. Although some of these studies focus on literacy, many of the features they discuss can be translated to a mathematics e-book. Allowing students to have access to a dictionary when they do not understand a word could aid students in greater mathematics comprehension. In addition, including additional features such as videos and websites in a mathematics e-book may allow students greater flexibility in learning, which could allow students to increase their mathematical understanding.

**Methods of Using Technology to Enhance Learning and Motivation**

“Researchers and educators alike are concerned with the problems of declining scholastic motivation and achievement, increasing students’ alienation and elevated rates of high school dropout” (Raufelder, Jagenow, Drury, & Hofreichter, 2013a, p. 89). Research has shown that scholastic motivation loses momentum from elementary to middle school (Bobis et al., 2011), then continues to decline throughout the first three years of high school (Raufelder, Drury, Jagenow, Hofreichter, & Bukowski, 2013b). “Now more than ever, in a climate of high-stakes accountability, educators need to better understand why young adolescents do and do not achieve” (Daniels, 2011, p. 32).
Chapman, Masters and Pedulla (2010) claim technology can improve student attitudes and achievement with appropriate pedagogy and curriculum design. However, the way students learn changes and becomes complicated with the use of technology because students collaborate, individualize their instruction, and have continuous access to material (Franklin, 2011). The current generation of students is technology focused (Carr, 2012). Therefore, it is critical to maximize learning experiences through technology (Martinez & Schilling, 2010). When technology is integrated, researchers believe it should be used to emphasize problem solving and enhance usefulness for daily life (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012).

Ertmer and Ottenbreit-Leftwich (2013) hypothesize educators understand the importance of technology; they just lack a clear vision of how technology should be implemented to reform education. In addition, “recent evaluation studies suggest that instructional technology is thriving and can also make teaching more effective” (Raines & Clark, 2011, p. 2). Though concerted efforts have been made to achieve meaningful technology integration, schools are far from transforming teaching and learning (Ertmer & Ottenbreit-Leftwich, 2013; Shapley et al., 2010). Therefore, unless technology is used to its fullest potential, its true effectiveness will remain unknown (McManis & Gunnewig, 2012).

**Technology to Enhance Learning**

The inclusion of technology for learning will not transform learning alone, but technology can serve as a conduit to build a community (Berson et al., 2012). Mobile technology allows learners to extend their learning outside of the classroom, which amplifies their learning potential (Rossing, Miller, Cecil, & Stamper, 2012). Tablet PCs have been the most popular game-based learning devices since 2010 (Carr, 2012). In recent years, cell phones have become
more common which allows parents to teach their children informally through educational cell phone applications (Franklin, 2011). Carr (2012) describes applications as game-like features, which could be used to revamp learning. However, many applications available require recall rather than develop creative thinking (Carr, 2012).

Murray and Olcese (2011) discovered a variety of applications available for tablets, but found from their research that few are taken advantage of by teachers. When Berson, Berson, and Manfра (2012) reviewed applications, they discovered 90,000 education applications available, but most focused on drill and repetition rather than innovative learning experiences. Although students report positive experiences with technology (Rossing et al., 2012), it is unclear whether technology improves teaching through student-centered learning or is a replacement for traditional methods (Pelusa, 2012).

“Technology can allow students to interact with virtual representations of difficult concepts, to stimulate and model physical phenomena, to engage with educational content in new ways, and to connect and collaborate with students around the world” (Chapman et al., 2010, p.239). Applications available for educational purposes include Evernote, whiteboard apps, Garageband, and iMovie (Berson et al., 2012; Pegrum et al., 2013).

To implement technology effectively will require a paradigm shift in education, which has the potential to fundamentally change learning (Robledo, 2013). According to Rossing, Miller, Cecil, and Stamper (2012), when teachers implement new technology there will be a learning curve, but teachers should endure the challenges to incorporate technology efficiently to enhance learning. As teachers learn to integrate technology to increase student achievement, research has shown direct instruction is used less, students collaborate more often, and learning is more student-centered (Shapley et al., 2010).
Enhancing Motivation

Ross and Bergin (2011) discovered from their research that students are more likely to put forth effort when they are provided with an optimal level of difficulty and knowledge they can succeed. In addition, research has shown that when students are actively involved in their learning, there were increased levels of student learning, persistence, grades and questioning (Raines & Clark, 2011). Allowing students to work with peers increases social engagement, which has been shown to enhance motivation (Raufelder et al., 2013a; Raufelder et al., 2013b).

Keane et al. (2012) found students were engaged when mobile devices were used across the curriculum. In their study, they observed a school implementing iPads. Over the course of the year, the researchers recorded how teachers and students used the iPads in the classroom in two different schools. Although the focus of the study was on implementation, researchers noted increased motivation in the students. Through use of questionnaires, the researchers claim student interest increased when teachers implemented the iPad in the classroom over teachers who did not use the iPad as often.

Students report they enjoy using the iPad in class to locate information, but discovered that social media and the Internet were a distraction (Rossing et al., 2012). In addition, research has shown students learn best when they are highly motivated and self-confident (Carr, 2012; Hartnell-Young, 2009). Technology can also support meaningful and relevant intellectually stimulating work, which expands learning (Shapley et al., 2010). In addition, students in technology integrated programs consistently outperformed students in traditional classes on standardized tests and assessments (Potter & Rockinson-Szapkiw, 2012).

For digital natives, technology is not only a tool to find and share information, but it also allows them to collaborate, share interests, organize, and socialize (Martinez & Schilling, 2010). However, students may arrive in school with varying levels of technology expertise (Franklin,
When students learned to use tablets, they often were confused at first, but enjoyed the futuristic feel (Rossing et al., 2012). Rather quickly, students learn to use tablets and become comfortable navigating them (Berson et al., 2012).

**Using Technology toEnhance Learning in Mathematics**

“Technology’s success as a learning and instructional tool depends upon it being integrated into a meaningful curricular and instructional framework, and it should be used only when it is the most appropriate means of reaching an instructional goal” (Guerrero, 2010, p. 135). Often teachers are being pushed to incorporate technology into education at times at the cost of pedagogy due to a shift in focus from content to technology (Pegrum et al., 2013). Technology should enhance pedagogy, not replace active forms of exploration (Shifflet, Toledo, & Mattoon, 2012), although it is clear technology motivates and engages students (McManis & Gunnewig, 2012). However, technology should be developmentally appropriate for the age of the student and take into consideration the interests of the child (McManis & Gunnewig, 2012).

In the traditional mathematics classroom, lectures are common with examples of problems written on a whiteboard (Galligan et al., 2010). When technology is appropriately implemented into mathematics education, it can promote deep conceptual understanding through allowing students to problem solve, reason, and make decisions with calculators, computers, and visual representations that can be manipulated (Guerrero, 2010). However, many teachers are reluctant to incorporate technology into mathematics instruction (Raines & Clark, 2011). This is unfortunate because “technology has considerable impact on the development and expansion of new and existing mathematical concepts and applications for the past few decades” (Guerrero, 2010, p. 133). Additionally, studies have shown students become increasingly active participants...
in the mathematics classroom when technology is included in the lesson (Loch, Galligan, Hobohm, & McDonald, 2011).

Researchers are encouraging technology integration in mathematics education (Carr, 2012). Raines and Clark (2011) believe the incorporation of technology allows for unlimited potential in teaching mathematics in addition to a positive impact on students’ mathematical understanding. However, Lantz-Andersson, Linderoth, and Saljo (2008) suggest not enough research has been conducted to determine the impact of technology on mathematical learning.

Guerrero (2010) suggests that, in mathematics, technology should be used to formulate mathematics in meaningful ways for students to understand and demonstrate its applications. One way to increase mathematical understanding in the K-12 setting is to make mathematics relevant in the classroom through active engagement and a learner-centered approach (Loch et al., 2011). Currently, several types of technologies have been incorporated into mathematics education to help enhance learning and engagement with varying levels of success (Raines & Clark, 2011). However, although teachers are incorporating technology more often, research shows technology still plays a marginal role in mathematics education across the globe (Bennison & Goos, 2010).

Studies have found tablets increase learning in conjunction with purposeful instruction (Pegrum et al., 2013). Tablets have been shown to help improve writing and organization in high school, and increase engagement and writing in elementary and middle school (Couse & Chen, 2010). Teachers have reported tablets to be less cumbersome than laptops, but difficult to use during lessons (Galligan et al., 2010). However, there are still gaps in the research related to how tablets affect learning.
A meta-analysis conducted by Cheung and Slavin (2011) sought to determine whether technology applications improve mathematics achievement in K-12 classrooms as compared to traditional teaching methods. Of the 700 studies reviewed, 74 studies were included in the analysis focusing on three categories: computer-managed learning, comprehensive models, and supplemental computer assisted instruction (i.e., CAI technology). All included studies were required to have a comparison and treatment group. The analysis included 55 studies that focused on supplemental technology programs, which produced the largest effect size (+0.19). All grade levels were found to have a positive effect (+0.16) on mathematics achievement throughout K-12.

I CAN Learn is one technology-based program, which can be implemented in the classroom or via online instruction on a computer or mobile device (I Can Learn Education Systems, 2014). The program allows students in middle school, algebra or college opportunities to engage with mathematics to develop understanding (I Can Learn Education Systems, 2014). A typical lesson consists of a pretest, review, lesson presentation, guided practice, post lesson quiz, and a cumulative review (What Works Clearinghouse, 2004). During lessons, a cyber-teacher aids the student through the lesson, assessing the errors and helping students understand why they made mistakes (What Works Clearinghouse, 2004). This research-based program is aligned to Common Core (I Can Learn Education Systems, 2014). The goal of this program is to help students in large urban districts improve their mathematical understanding (What Works Clearinghouse, 2004).

Studies show students are more engaged when technology is used to promote learning. Researchers state technology should be used in the mathematics classroom to enhance
understanding of mathematical concepts. Through using technology to increase learning students may find it less challenging to learn difficult concepts.

**Motivation in Mathematics**

As mentioned previously, student motivation often decreases from elementary to middle school, which has become troublesome in middle school mathematics because of the increased cognitive load (Kasmer & Merlino, 2011). Difficulty in teaching middle school continues to increase as teachers are asked to teach facts, procedures, and conceptual understanding (Schunk & Richardson, 2011). Teachers cannot force students to become motivated, but they can create a stimulating learning environment (Daniels, 2011).

NCTM’s *Principles and Standards for School Mathematics* (2000) underlying message supports building student motivation and confidence in mathematics. This message directly connects to the work of Schunk and Richardson (2011), which promotes development of student self-efficacy. Schunk and Richardson (2011) define self-efficacy as the belief one can learn what to do. They assert that increased self-efficacy promotes motivation and increased interest in classroom activities. In addition, the researchers found when students are interested in an activity motivation increases, which can improve understanding and self-efficacy.

In 2013, Riconscente conducted a study to determine if an app called Math in Motion would improve fourth grade students’ fraction comprehension and self-efficacy. Math in Motion was designed to improve student understanding of the relationship between fractions, proportions, and percentages in comparison with the number line. Participants included 122 fifth grade students in two schools in southern California. A repeated measure crossover design was used for this study; students from Group 1 participated as the treatment the first week and the control the next, switching with Group 2 to ensure all students had equal access to Math in
Motion. Data were collected for the study through a pretest, posttest, and midtest using a paper test and/or a test on an iPad. At the midtest, students in Group 1 (who had access to Math in Motion first) showed a significantly higher average than Group 2 with an effect size of 1.27 and 0.20 respectively. However, at the end of the study, there were no significant differences between the groups, with both groups showing increased understanding of fractions from pretest to posttest. In addition, student attitudes and self-efficacy regarding fractions improved and students’ engagement increased through use of the game application.

According to NCTM’s *Principles and Standards for School Mathematics* (2000), students’ intrinsic motivation to learn mathematics can be increased by building on students’ natural curiosity and questioning of mathematical content. Using group work and cooperative learning not only fosters peer relationships (Ross & Bergin, 2011), but also increases the possibility for discussion and comprehension. In addition, students enjoy the opportunities to work together and interact with their peers (Schunk & Richardson, 2011).

**Conclusion**

Though research is abundant in the field of rational numbers and there are many theories for teaching rational numbers, an all-inclusive effective teaching method has yet to be agreed upon. However, many researchers claim use of manipulatives and part-to-whole are useful methods to teach rational numbers, though Moseley and Okamoto (2008) hypothesize using part-to-whole models may put lower-achieving students at a disadvantage. Therefore, these methods will be incorporated into lessons implemented during the course of this study.

Technology use is expected in today’s society and today’s digital natives need to understand technology to compete in the global economy. However, there is little research proving the effectiveness of technology to enhance learning. Although some studies are available
showing technology driven homework enhances, or at least allows, students to learn as well as traditional methods, these studies focus on undergraduate students.

As technology integration is expected in the K-12 arena, it is clear research is needed to determine whether technology driven homework aids students in the middle grades. In addition, although many studies focus on e-textbooks for student use, no studies have been conducted including the interactive elements of the iBook. Also, available studies regarding e-books focus on undergraduate students and elementary students with undergraduates disliking e-books and elementary students liking e-books. To fill the gap, this study will address middle grades students using digital textbooks.

Although studies have been conducted about attitudes, few studies determine whether middle school students’ mathematical understanding is increased while using technology for homework. Because rational numbers are such a difficult topic for students to learn, enhancing the content with interactive technology may be beneficial to learning. In addition, being able to interact with the content may increase student motivation, in turn enhancing learning.

Within my study, I will address some of the gaps I have discovered in the literature. These gaps include whether an interactive digital book increases achievement when used for homework, how middle school students perceive digital books with interactive elements and how middle school students perceive an iBook to complete homework. By developing a digital interactive iBook to supplement rational number instruction, I expect to increase student comprehension. Students will have access to dictionaries, interactive features, applications, videos, and reviews. Through the layers of interactivity, I expect students to report in the focus group that they were engaged with the material more than they might have been with a traditional textbook.
Conceptual Framework

The 2013 US Census Bureau report P20-569 reveals that 71.7% of households had Internet access as compared to 54.7% in 2009. Because the current generation has grown up with technology, they are more engaged when technology is used and expect more use of technology while learning (Huang et al., 2012). The work of De Abreu (2010) has shown connections between student motivation and technology, revealing increased motivation when technology is used in the classroom. Because technology is expected to enhance motivation, I have chosen it as the medium to examine the effects of students learning rational numbers through the use of iBooks. iBooks are digital textbooks, which allow for interactive elements in their design. I believed the interactive elements available in iBooks would enhance motivation, and therefore, increase understanding of rational numbers. Therefore, I suspected middle school students’ engagement could be promoted through technology integration in the classroom.

With that in mind, I developed part of my conceptual framework from the Technology Integration Matrix (Florida Center for Instructional Technology, 2013) in Appendix A, which combines levels of technology integration into the curriculum and characteristics of the learning environment. In addition, I drew from the work of Clements (2007). Clements (2007) designed a method for developing technology-based curriculum, which I followed in designing the iBook. More of this is discussed in Chapter 3 when I discuss my iBook development.

Shapley, Sheehan, Maloney, and Caranikas (2011) indicate that many educators, policymakers, and business leaders recognize technology’s persuasive presence in individuals’ daily lives and its ties to future opportunities for students who will compete in a global, knowledge-based economy. For this reason, technology use has become highly recommended in
classrooms. Therefore, the final basis of my conceptual framework is based on the work of Shapley et al (2011).

Shapley et al. (2011) present their findings of a three-year study incorporating technology into classrooms in Texas middle schools. Their study focused on four aspects of technology immersion: a comprehensive approach, increased access and support for technology, professional development, and technology based curriculum. Previous research shows one-to-one computer access increases technology use, proficiency, and engagement. Shapley et al. (2011) appears to be the first study on a large-scale to determine if their technology framework increased student academic achievement.

Shapley et al. (2011) conducted a study including a total of 42 middle schools with half in the control group and half in the treatment group. In treatment schools, all teachers and students were provided with a laptop. Control schools were not provided with additional technology. Prior to conducting the study, an analysis was done to confirm student demographics and achievement were similar across treatment and control schools. Data were collected through a technology survey, disciplinary action reports, school attendance, and the Texas standardized assessment (TAKS). Results at the end of the study showed students in the treatment schools were more technology proficient, had higher attendance, and fewer disciplinary actions than students in the control schools. In terms of academic achievement, no statistical significance was found between the treatment and control group.

Though the results presented by Shapley et al. (2011) were not statistically significant for mathematics, their model for technology immersion does seem appropriate for use in my study. The framework of Shapley et al. (2011) has been used successfully to show increased proficiency with laptops and technology infusion to modify teaching methods. The proposed
study includes similar inputs and outputs in the model to determine outcomes of the iBook on student achievement and attitudes with rational numbers when used for homework. The model I have developed (seen in Chapter 3) has been modified from a technology immersion model in Figure 1 from Shapley et al. (2011) and the technology integration model provided through the Technology Integration Matrix (Florida Center for Instructional Technology, 2013). The overall goal of my study is to determine if providing an iBook for homework enhances learning of fractions, decimals, and percents.
The purpose of this study was to determine whether an iBook is an effective technology to provide homework for fractions, decimals, and percents to sixth grade students. This is a topic of importance because it is clear that technology will continue to be a presence in classrooms around the country (Ritzhaupt et al., 2012). In Chapter 1, I developed an argument, which supports technology as an integral part of our daily lives. A transformation in school technology is apparent and the expectation is for teachers to enhance learning through the use of technology (Banister, 2010). However, it is unclear how technology should be used to enhance learning and if the inclusion of technology truly increases learning.

Currently, students in the middle grades continue to struggle with understanding rational numbers. Therefore, it is critical to determine effective methods of increasing comprehension. With the influx of technology in schools, it seems logical to consider whether technological advances can increase student comprehension of rational numbers through the use of an interactive text, such as an iBook, for homework.

Additionally, studies have shown student motivation to increase when technology is incorporated to enhance learning (Lamon, 2007). Therefore, student success with rational numbers could be improved through the use of technology driven homework, potentially increasing motivation and therefore mathematical comprehension. Figure 2 shows the model I have modified from Shapley et al. (2011) for the conceptual framework of my study with the goal of using student perceptions of digital books with interactive elements as a vehicle to enhance achievement.
Figure 2. Conceptual Framework Model. Adapted from “Effects of Technology Immersion on Middle School Students’ Learning Opportunities and Achievement” by K. Shapley et al. (2011), *The Journal of Educational Research, 104*, pp. 299-315.
The goal of the current study was two-fold. The first goal was to determine how student learning compares when completing homework related to fractions, decimals, and percents with an interactive iBook compared to static digital PDF oriented homework. Determining student perceptions of learning fractions, decimals, and percents with an interactive iBook and whether students feel learning from technology through the use of iBooks enhanced their learning was the second goal.

Prior to this study, two pilot studies were conducted. The results of the two pilot studies showed students had significant gains from pretest to posttest. However, no comparison group was used in either pilot study. Based on the results of the pilot studies, I determined a treatment and comparison group would be necessary for further studies. In addition, I used a pre/posttest design that included a focus on homework and mini quiz results to review multiple aspects of comprehension. This design allowed me to examine changes in rational number knowledge through the implementation of interactive iBook based homework and static digital PDF homework available online when instruction between the two groups remained the same.

A Likert-Scale questionnaire, which also included six open-ended questions, was used with both the treatment and comparison group to determine student perceived learning and engagement in regard to using the interactive iBook for homework or the static digital PDF based homework. The Likert-Scale questionnaire, which focused on homework and textbook/iBook effectiveness, comprehension, and perceived learning was modified from an instrument used by Rossing et al. (2012). Finally, a focus group was conducted with each group using a semi-structured interview format modified from the dissertation of Bloemsma (2013), which focused on effectiveness of homework, to determine students’ perceived learning and engagement.
iBooks and iBooks Author

iBooks are the Apple version of e-books. They are available for a variety of Apple products through the Apple bookstore. These iBooks function similarly to e-books in terms of dictionary features, font size, functionality to read aloud, etc. According to Huang et al. (2012), the current e-book industry is focused on digitalizing printed works rather than developing new technology to support learning. Apple has begun to change this trend with the release of a program called iBooks Author, which allows anyone with a Mac to create an interactive book.

iBooks Author is a user-friendly program free to Mac users. The program includes a variety of templates to choose from in a landscape or portrait format. Text, videos, music, and photos can easily be added to the book by dragging and dropping them where the author wishes them to be located. In addition to text, video, music, and photos, iBook Author allows many other options for interactivity with the reader. iBooks Author refers to these interactive features as widgets, which include photos, 3-D images, PowerPoints, websites, scrolling sidebars and reviews.

These options greatly enhance an otherwise static textbook. 3-D images allow the reader to spin an object to see the front, back, or sides. Scrolling sidebars allow readers to screen additional text underneath an object so the text does not take up space on the screen. Reviews allow the author to insert quizzes at various junctures in the book for the reader to self-check. Overall, the expectation is that these features will engage readers permitting them to gain deeper understanding from the text than they would from a traditional textbook or e-textbook.

Conceptual Framework for Development of my iBook

After learning about the features available from iBooks Author and the movement towards e-textbooks, I began researching in this area to understand middle school students’
reactions to e-textbooks and their effects on students’ mathematical knowledge. Insufficient
literature was available on the topic of e-books, especially in the middle grades, but there was
information regarding rational numbers. After reviewing the research, I learned rational numbers
are the most difficult topic for middle school students to master (Whitin & Whitin, 2012).
Therefore, as a sixth grade mathematics teacher, I chose the topic of fractions, decimals and
percents, which is chapter four from my Glencoe McGraw-Hill *Math Connects Course 1*
textbook.

Originally when I wrote the iBook, it was to mirror the content of the textbook. One of
the reasons for doing so was to ensure to school officials that I was addressing the adopted
curriculum. The textbooks were aligned to Common Core and about a year old, therefore, we
were required to use them. Consequently, I felt it was critical to use similar material in designing
my iBook to ensure the curriculum was being covered to the expectations of school officials. As
I designed the iBook, I chose to write problems similar to the textbook, some being word
problem based while others were procedure based, to ensure doing a pilot study would not
conflict with the existing curriculum. However, as I became more knowledgeable about
conceptual learning, and my principal become more confident in allowing me flexibility with the
curriculum, I made modifications to include higher-order thinking questions in the iBook to
increase conceptual learning as much as possible given the constraints of the iBook.

Developing the iBook took approximately three months. During this time, I followed the
outline of the textbook. This guided my curriculum design for the chapter in conjunction with the
research of Clements (2007), which discusses the process of designing technology-based
curriculum. Clements recommends considering the following when designing curriculum:
subject matter, philosophies, and pedagogy. While using Clements as a basis, I also drew upon
research from the Florida Center for Instructional Technology. In 2013, they developed a Technology Integration Matrix (Florida Center for Instructional Technology), as seen in Appendix A, which focuses on assisting teachers with technology integration in the classroom. The Technology Integration Matrix (Florida Center for Instructional Technology, 2013) recommends learning be active, collaborative, constructive, authentic, and goal directed.

As I designed my iBook, I began by considering the subject matter, as recommended by Clements (2007). I conducted some research to determine the recommended methods to teach rational numbers. I discovered subject matter, pedagogy and philosophy were deeply intertwined. Therefore, much of my research for the iBook overlapped within these areas. As I investigated, I discovered some researchers recommended partitioning, while others recommended part to whole. Overall, manipulatives and part-to-whole seemed to be commonly recommended, which is why I used these methods in designing the iBook and lessons to teach the content.

The next step Clements (2007) recommends is looking at the learning model. The learning model includes activities and concept development. Activities in this study were typically review of material covered to alert the instructor to anyone who was struggling with the content. This would allow the instructor to give those students additional support.

Based on the research of Huang et al. (2012), I added graphics and interactions to help satisfy learners. These were included in the form of interactive galleries, which showed students how to solve problems visually while allowing them to swipe through the graphics. I also included the review feature to aid students in immediate feedback of their learning in addition to another interaction with technology. Finally, I chose to include a dictionary because, according to Ciampa (2012), this is a useful tool for students as they work with technology.
As I developed the iBook, I also considered how to incorporate other characteristics of learning from the Technology Integration Matrix (Florida Center for Instructional Technology, 2013). Table 1 shows how various features of the iBook relate to the Technology Integration Matrix (Florida Center for Instructional Technology, 2013).

Table 1

*iBook Elements in Relation to the Technology Integration Matrix*

<table>
<thead>
<tr>
<th>iBook Element</th>
<th>Entry</th>
<th>Adoption</th>
<th>Adaptation</th>
<th>Infusion</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td></td>
<td>Computational homework questions</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Collaborative</td>
<td></td>
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</tr>
<tr>
<td>Constructive</td>
<td></td>
<td>Reading the iBook</td>
<td>Students choose tools to aid them in the iBook (Galleries, videos, websites)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authentic</td>
<td></td>
<td>Real-World homework questions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal Directed</td>
<td></td>
<td>Review</td>
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Computational homework questions were considered active at the entry level because they focused on drill and practice. Reading the iBook was considered constructive at the entry level because students are receiving information from the iBook. Choosing the tools to gain more understanding was considered constructive at the adaption level because students were given the option of which tools they preferred to enhance learning. Real-world homework questions were considered authentic at the adoption level because students had opportunities to use integrated tools to answer these questions. Finally, the review feature was considered goal directed at the
adoption level because the review allowed students to monitor their progress. Although several characteristics of the learning environment were included (active, constructive, authentic, goal directed), more modification is needed to evolve from entry toward transformation.

In the development phase, I began with development of the text and problem sets. Throughout the design, I was careful with the words chosen and attempted to use simple language when possible to help students grasp the concepts (see Appendix B). Next, I added graphics. This included graphics from websites, but mostly I developed my own. To create my own graphics and visuals, I used my Smartboard. For problem sets, I wrote each step of a problem onto a Smartboard. After each step, I took a photograph. Next, I took the photographs and uploaded them to my computer and then the iBook in a Gallery (see Appendix B). A Gallery in an iBook is a group of photos, which can be swiped through to add meaning to the content. As I added each photo, I added text to explain each step of a problem.

Though adding graphics and text aided in many instances, pictures and graphics were not effective in all cases. One particularly difficult concept in this chapter is working with percents above 100% and below 1%. Upon an Internet search, I was unable to find videos or websites that gave context to percents above 100% or below 1%. Therefore, I developed a video of myself teaching the content to enhance student understanding of the included graphics and text. To do this, I first recorded the problems being solved on the Smartboard using Smart Technologies. I then added a voice over using Garage Band so students would have audio for the video. The video was then converted to a QuickTime file prior to being uploaded to the iBook.

After creating the graphics and videos, the next step was to search online for activities to include in the iBook. These activities included videos, games (which were difficult to find as many websites do not run on an iPad because iPads are not compatible with Flash), apps students
could download, and activities for students to complete together outside of the iBook. Upon finding games and websites that covered the content being introduced, I included the site or game within interactive features (see Appendix B) in the iBook. The Interactive feature allows students to click on the link from the iBook and be transported to the website or game.

Another feature I added to the iBook was a Review (see Appendix B). Review allows the author to add questions in a variety of formats such as multiple choice, picture, or true/false. At the end of each lesson, I crafted questions to review the content covered. The Review allows students to answer questions and receive immediate feedback for them to determine how well they understand the content in the lesson. When the book was completed, I added a glossary and table of contents for ease of use.

As I created my iBook, I struggled with some of the features of the iBook. Although the program is interactive and has many features to engage the learner, I found it difficult to incorporate conceptual learning within the confines of the design. Therefore, I consider this a first step toward inclusion of technology for homework.

**Implementation of the iBook**

Once the curriculum has been developed, Clements (2007) recommends conducting market research. In this phase, research is conducted to determine what consumers want in the product you are developing. Therefore, I conducted two pilot studies prior to the third iteration, the dissertation study.

During iteration one, I used the iBook as a stand-alone resource and allowed students to work through the iBook during class time. However, I realized that although students were engaged with the iBook they struggled to understand some of the more challenging concepts because of the lack of conceptual modeling in the iBook. With that in mind, I determined the
best course of action would be to modify the iBook in an attempt to incorporate more conceptual learning. In addition, I chose to modify the study to incorporate the iBook for homework while still providing students opportunities to learn conceptually with classroom instruction. Throughout the first pilot study in 2012-2013, students would point out errors, website issues, or places where the wording was unclear. After the first pilot study, I made modifications to the book to ensure accuracy and readability for students.

For the second pilot study in 2013-2014, I incorporated the iBook as homework. I found students struggled less with understanding content within the iBook after receiving in-class instruction. A few problems were discovered with the iBook when applications or websites could not connect because of problems with Flash. However, the problems were alleviated after the second study concluded. I also modified the study to include mini-lessons, which incorporated activities and conceptual learning. These mini lessons often included conceptual modeling to allow the students to make connections between the conversions before learning the procedural methods.

Through my previous two iterations of this study, I discovered students like the interactivity in the iBook. After conducting some research and speaking to students, I discovered undergraduate students in addition to middle school students did not like most e-textbooks because they were static (Woody et al., 2010). Therefore, when I developed my iBook, I included many interactive features such as reviews, videos, games, resources, and images.

Currently, I am in the pilot phase of Clements (2007) development theory. As mentioned previously, I conducted two pilot studies with small groups, one in 2013 and the other in 2014. Neither group had a comparison group because I was concerned with modifying the iBook to be as effective as possible. In this third iteration, taking place in 2014-2015, I have both a
comparison and treatment group to determine effectiveness of the iBook for learning rational numbers.

Conclusion

Digital textbooks are still relatively new to education. Therefore, many are still being revised to meet student needs, with the iBook I developed being no different. Thompson and Senk (2008) indicate that curriculum has a strong influence on student learning. Therefore, it is critical that curriculum be effective for teaching and learning. Because of the issues that arose in using the iBook as a stand-alone resource, I chose to incorporate the iBook as homework. This allows students to receive conceptually based learning in the classroom with at-home reinforcement through the iBook for homework.

Thompson and Senk (1998) state that, “homework assignments in which students are expected to work on problems related to the content provide opportunities for students to assess their understanding and generate questions to clarify understanding” (p. 6). Therefore, I felt students could use the iBook as an opportunity to increase understanding, but still bring in any questions to class the following day. In addition, homework should not be seen as a punishment, but rather a positive experience to extend learning (Ongun, Altas, & Demirag, 2011). The interactive features included in the iBook would allow for increased positive experiences with homework and possibly increase engagement and understanding.

Content Analysis of the iBook

The iBook I designed was developed for traditional students, meaning students who are on level academically and native English speaking. The iBook does not support English Language Learners (ELL) or English as a Second Language (ESOL) students. To determine if the content of my iBook was age appropriate and in line with state standards for sixth grade
students, I asked three experts to evaluate the iBook. The experts included a middle school mathematics teacher with 12 years experience, a sixth grade assistant principal who is also a mathematics education doctoral student with one year of experience as an administrator and six years experience as a mathematics staff developer, and a professor of elementary education in her first tenure-track university position though she has taught for several years at the university level and taught middle school mathematics for five years.

The evaluation tool (see Appendix C) used by the experts was modified from a tool used by Sealy (2013). Currently, the evaluation tool has four dimensions that include iBook design and content, alignment with mathematical standards, students’ learning experience, and overall rating. The tool includes a six point Likert scale, but also allows for open-ended responses. Each expert was given a copy of the evaluation tool and sent a copy of the iBook to review.

When I reviewed the results from the iBook evaluation tool, I developed a frequency table for each dimension. I then reviewed each table to ensure that the majority of the ratings were agree or strongly agree. If there were ratings below agree, I reviewed the open-ended comments to determine why the rating was low and how the issues could be addressed.

Table 2 shows the frequency distributions for the first dimension- design and content. Within this dimension, the majority of the feedback showed raters agreed or strongly agreed that the content and design of the iBook were appropriate for 6th grade students. However, in four categories raters rated the iBook below agree. Therefore, I reviewed the open-ended feedback to determine the areas that needed improvement. The reviewers stated that the interactive features were engaging and felt students would enjoy the interactivity available in the text. However, the reviewers believed more word problems were needed, the book was too procedure based, and some of the graphics in the galleries were blurry. This feedback was noted and
Table 2

*iBook Design and Content: Frequency Table of Evaluator Ratings*

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>The iBook is well organized, flows logically and is easy to navigate.</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook graphics are appropriate and contribute to the learning experience.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The websites included in the iBook are appropriate and contribute to the learning experience.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook reviews at the end of each lesson are appropriate and contribute to the learning experience.</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook videos are appropriate and contribute to the learning experience.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The language used is appropriate for typical 6th grade students.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook is professionally presented to a standard expected of a learning resource for middle grades students.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook content reflects a contemporary (current) command of the field.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook content provides clear evidence of structural alignment with the standards.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook assessment items in the reviews provide clear evidence of structural alignment with the iBook content.</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook self-directed learning tasks provide clear evidence of structural alignment.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook intended learning outcomes provide clear evidence of structural alignment.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, the iBook is a suitable learning resource.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* SA- Strongly Agree, A- Agree, N- Neutral, D- Disagree, SD- Strongly Disagree, C- No Comment.

Modifications were made to include more word problems, more conceptual understanding, and modified graphics.

Alignment to the standards was the second dimension. In Table 3, the frequency distribution of evaluators’ ratings is shown. Within the eight areas, the majority of the feedback showed the reviewers agreed or strongly agreed with the alignment to standards. The exception to this was the last statement where one of the raters provided neutral feedback. When I reviewed
the written feedback, the reviewers stated the iBook had high interactivity and effective graphics. However, the stated objectives and standards were not listed. Therefore, I modified the iBook to include all applicable standards and objectives.

Table 3

iBook Alignment with Mathematical Standards: Frequency Table of Evaluator Ratings

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>The iBook promotes understanding of fractions.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook promotes understanding of decimals.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook promotes understanding of percent.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook contributes to knowledge of converting fractions, decimals, and percents from one mode to another.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook aids students in accessing and using fractions, decimals, and percents in real-world scenarios.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook gives students experience with converting fractions, decimals, and percents from one mode to another.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The iBook aids students in recognition of how fractions, decimals, and percents can be used in the real-world.</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, the iBook meets mathematics standards for the course topic.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* SA- Strongly Agree, A- Agree, N- Neutral, D- Disagree, SD- Strongly Disagree, C- No Comment.

The third dimension focused on student learning experiences. In Table 4, the frequency distributions of evaluator ratings are shown. In all categories the majority of the feedback was between agree and strongly agree. However, three categories had feedback below agree from one of the reviewers. To determine how to resolve the issues, I reviewed the open-responses. The reviewers described the iBook as accessible to sixth grade students, allowing for increased independence, and good for giving immediate feedback. Other comments focused on including more journaling and more conceptual learning. Due to the feedback, I modified the conceptual learning by including more concrete examples to express to students why various fractions, decimals, and percents are equal and through adding more complex questions in student reviews.
to aid students in making deeper connections. I also included more journaling pieces to gain more feedback from students regarding the iBook and their learning throughout the process.

Table 4

*iBook Student Learning Experience: Frequency Table of Evaluator Ratings*

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>The iBook provides students with a stand-alone learning resource for learning about fractions, decimals, and percents.</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>The iBook provides students with a sufficient number and variety of opportunities to undertake self-directed learning about the relationships among fractions, decimals, and percents.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>The iBook provides students with information and examples that are relevant to the real-world.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>The iBook provides students with the opportunity to use technology to learn mathematics.</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>The iBook has made effective use of technology and provides opportunities for students to engage with technology in learning about fractions, decimals, and percents.</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>The iBook has made effective use of and provides opportunities for students to engage in resource-based learning about fractions, decimals, and percents.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Overall, this iBook is likely to provide an authentic, real-life based and meaningful learning experience for learning about fractions, decimals, and percents.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note.* SA- Strongly Agree, A- Agree, N- Neutral, D- Disagree, SD- Strongly Disagree, C- No Comment.

*iBook Textbook Comparison*

To determine differences and similarities between the iBook and the textbook, I did a comparison between the two. To conduct the comparison, I looked at several aspects of the book. These included the number of pages per lesson, number of examples, number and type of questions, activities, and additional resources and games. To help conduct this comparison, I used the framework developed by the Wisconsin Center for Education Research called SEC K-12 Mathematics Taxonomy (Appendix D). This framework looks at the cognitive demand of mathematical questions through five categories: memorization, procedures, understanding
mathematical ideas, analyzing, and non-routine problems (referring to problems that were beyond traditional computation or justification, such as showing students a shaded region and asking them to determine the percent shaded).

To conduct this analysis, a research assistant and I coded both the textbook and iBook; the research assistant has three years of teaching experience and a degree in architecture. Prior to training my research assistant, I counted the pages per lesson, number of examples and number of questions (Appendix E). Then, I developed a spreadsheet for both of us to code the examples and questions independently. To train the research assistant, I discussed the criteria for each example and question. Then, together we coded examples and question from two lessons in another chapter to ensure we both had a similar understanding of the codes prior to coding independently. After coding independently, we then reviewed the results. Of the 668 items we coded, we had 96% reliability. On items where we had a difference of opinion, we met and discussed the differences, similar to the research of Thompson, Senk, and Johnson (2012), until we were able to come to agreement on a code.

The results showed the iBook had more pages per topic; although the iBook had more examples, it had fewer real-world examples. However, while the textbook included more real-world examples, the examples used a word problem format, but the scenarios did not necessarily connect mathematics to the real-world. Table 5 summarizes the comparisons.

Table 5

<table>
<thead>
<tr>
<th></th>
<th>Pages per Topic</th>
<th>N</th>
<th>Percent Real-World</th>
<th>Percent Conceptual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook</td>
<td>2.9</td>
<td>39</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>iBook</td>
<td>3.5</td>
<td>56</td>
<td>11</td>
<td>52</td>
</tr>
</tbody>
</table>

*Note. N represents the number of examples.*
Based on the comparative information in Table 6, the iBook has been developed to focus more on conceptual understanding of mathematics. In addition, three features the iBook has that the textbook does not are videos, embedded links, and embedded quizzes (reviews). In the section on percents above 100% and below 1%, the iBook has two embedded videos to allow students to watch someone work through solving problems with these percents. Throughout the iBook, there are also many web resources and games to support learning of the material. In addition, the reviews allow students to check their own progress because the iBook will tell them if the answer they have chosen is the correct solution. Although the textbook includes several activities to support conceptual learning, it does not include methods to evaluate learning progressions. In contrast, the mini lessons assist students with conceptual learning and the iBook whole group activities help demonstrate to me, as the teacher, how students are progressing with the material.

Table 6

*Textbook and iBook Comparison: Number of Questions and Percent of Each Type*

<table>
<thead>
<tr>
<th></th>
<th>Textbook</th>
<th>iBook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Questions</td>
<td>458</td>
<td>115</td>
</tr>
<tr>
<td>Memorization</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Procedural</td>
<td>90</td>
<td>65</td>
</tr>
<tr>
<td>Understanding of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematical Ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjectures</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>Non-Routine Problems</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Pilot Studies Related to the iBook**

**Iteration 1**

During the first iteration of this study, the purpose was to review learning gains when using an iBook for instruction and to establish how students perceived the iBook to determine whether the endeavor was worthwhile to pursue. Therefore, in this first iteration, a comparison group was not included. Prior to the start of the study, I gained IRB approval through my
university and the county in which I was conducting the research. I sent out emails to parents about the study and maintained openness to any questions or concerns. An open house was held for parents to ask any questions prior to students’ involvement in the study. I explained to parents the model of the study and that all students would participate in mathematics instruction with the iBook. However, data would only be collected if both student and parent consented to participate in the study.

Of the 44 students I taught, only 13 chose to participate in the study. Two reasons for low participation may have been that I did not effectively promote the study and many parents may have forgotten to return the consent forms. The model I used included a pretest and posttest and an open-ended questionnaire. During this iteration of the study, I used the iBook as a stand-alone resource. Daily, I assigned pages for the students to complete in class. Pages that were not completed in class would become homework. Students worked individually, in pairs, or small groups. As they worked, I circulated the classroom and aided students.

Early on, it became clear that some students struggled with the content. When students struggled, I began to pull small groups to increase understanding. This seemed to help students, but I felt the method of instruction was not working well with the iBook. At the end of each section, there were group activities that the students completed, which allowed me to determine growth and understanding.

As we went through the chapter, students found errors in the iBook and brought them to my attention. Some of these included spelling mistakes, others included mathematical errors I had overlooked. I noted these errors and modified them prior to the second iteration of the study.

At the conclusion of the study, students completed the posttest, which was identical to the pretest. The pretest and posttest had a Cronbach Alpha internal consistency of 0.73 and 0.97,
respectively. The pretest mean was 23.08 out of 100 with a standard deviation of 15.93 and the posttest had a mean of 61.49 out of 100 with a standard deviation of 19.25. When compared, the means between the pretest and posttest showed an average of a 39 point difference from pretest to posttest with a standard deviation of 15.82. In comparing the pre and posttest, the $p$ value was below 0.001, showing the results are unlikely due to chance. The effect size between the pre and posttest was 2.4 according to Cohen’s $d$.

Students involved in the study also completed an open-ended questionnaire. The questionnaire covered a variety of topics that related to the iBook and mathematics, some positive and others negative. However, for the most part, students were excited to use the iPad in mathematics class and felt they learned more when they engaged with the iPad in class. Most students were comfortable using the iPad and found they paid more attention when they learned via the iBook. The students enjoyed the games embedded in the iBook, but did not like the assignments and writing required from the iBook. All students preferred instruction in mathematics to include iPad use.

**Iteration 2**

Prior to the second iteration, I updated the student questionnaire to include a Likert Scale, which I modified from the research of Rossing et al. (2012) to elicit student perception in regard to completing homework with an iBook. I also developed a second questionnaire for a comparison group. In addition, because I did not feel I captured the entire picture of how students felt regarding the iBook, I added a focus group modeled after the research of Bloemsma (2013).

During this iteration, the purpose was to determine whether using the iBook for homework purposes was effective. For the second iteration, I had a small comparison group of
five advanced students who learned the same concepts as their classmates, but on an alternative curriculum from the textbook rather than using the iBook. Students in this group did not have their data collected. They were only used as a test group for the questionnaire because their work was from the homework whereas the rest of the class was given the iBook. During this iteration, I focused on what was working with the interventions and what needed improvement. Again, I gained IRB approval from my university in addition to the county in which the school is located. Prior to the study I sent out an email to the parents, which explained that I planned to invite them to an open house to discuss the study. In the email, I included as much information as possible in the event parents would be unable to attend. At the meeting, I answered all questions parents had about the study. Parents who were unable to attend the meeting were able to ask questions via email or phone.

After the meeting, I sent home paperwork in a manila envelope with each student. Each envelope had the student’s name on the front so I could determine who returned the envelope. In this iteration, I also changed the enrollment process. Regardless of participation, students were asked to return the envelope with either the consent paperwork signed or the non-participation form. I received most envelopes from the students in a sealed manila envelope to ensure I, as the teacher and researcher, was unaware of who was a participant in the study. This was done to protect the confidentiality of the students; in addition, this helped me to remain unbiased to ensure equity in instruction to all students. As a result of the modified enrollment process, 31 of 44 students participated in the study.

Prior to the start of chapter four, the students took a pretest. I also conducted a focus group in regards to the iPad. Mostly, this was to help students become comfortable with the questions for the end-of-unit focus group. A colleague chose four students who were
participating in the study to be a part of the focus group to ensure most participants remained anonymous. I will state the results of the post focus group only, because the results were so similar to the pre-study focus group. In addition, I do not believe conducting a focus group prior to the treatment was effective because the students provided the same information in the pre and post focus groups. Also, generally a focus group prior to treatment is meant for someone who does not have a relationship with the students. Because I was the teacher, I already had a relationship with the students and they were comfortable speaking with me.

During this iteration, we had some technical difficulties downloading the iBook and therefore started a few weeks later than anticipated. However, the students seemed to enjoy working with the iBook once we were able to begin the lessons. In this iteration, I also changed the lesson format. Each day, I would conduct mini-lessons with the class in regards to the content (Appendix F). The mini-lesson would often include an activity to help students grasp the concepts. Once the mini-lesson was completed, students would be released to work on their iBook assignments.

When students worked on their iBook assignments, they were able to work in pairs, groups, or individually. Often, if students had questions, this would be the time for me to work with them individually or in a small group. If students did not have questions, I would walk around the room to ensure students were on task and understanding the material. Each day we would review the previous day’s content and ensure there were no questions before moving forward. At the end of each iBook section, we still conducted a group activity in class so I could determine how well the students understood the content.

At the end of the study students took a posttest, which was identical to the pretest. The pretest and posttest had a Cronbach Alpha internal consistency of 0.75 and 0.82, respectively.
For the pretest, the mean was 23.23 out of 100 with a standard deviation of 14.81. The posttest had a mean of 61.84 out of 100 and a standard deviation of 19.15. When compared, the means between the pretest and posttest showed an average of a 38 point improvement from pretest to posttest with a standard deviation of 14.71. When comparing the pre and posttest, the p value was below 0.001, showing the results are unlikely due to chance. The Cohen’s d effect size between the pre and posttest was 2.6.

Students who participated in the study also participated in a questionnaire at the end of the treatment. Questions on the questionnaire fell into two categories: how much students felt they had learned and how they felt about the intervention. Because a Likert Scale was used, I translated the letters to numbers, with 1 being strongly agree, 2 agree, 3 neutral, 4 disagree, and 5 strongly disagree. Therefore, the lower the score the closer it is to strongly agree.

In terms of what students felt they had learned, the questionnaire showed an internal consistency of 0.75 using Cronbach Alpha. The mean for each question (see table 7) ranged from 2 to 2.23, which shows most students agreed that they learned from using the iBook. The items scored for how students felt about the intervention showed a reliability of 0.91. In addition, mean item scores (see table 8) ranged from 2.06 to 3.29, which shows students had a positive to neutral reaction to the intervention.

Although there was no true comparison group in this study, there was a group of five students within the classroom that worked independently using the textbook and did not participate with the iBook. Therefore, they were asked to complete the comparison group questionnaire. The comparison group questionnaire had eight questions and was broken into two categories: how much the student learned and how much homework/the textbook had a positive
impact. The first group of questions focused on how much the student learned; the Cronbach Alpha for the questionnaire showed a 0.70 reliability. In terms of responses, the comparison

Table 7

*Mean and Standard Deviation for Student Responses to Questionnaire Items about Learning from the iBook*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The iBook helped me understand fractions to solve problems.</td>
<td>2.00</td>
<td>0.86</td>
</tr>
<tr>
<td>The iBook helped me understand decimals to solve problems.</td>
<td>2.00</td>
<td>0.63</td>
</tr>
<tr>
<td>The iBook helped me understand percents to solve problems.</td>
<td>2.00</td>
<td>0.82</td>
</tr>
<tr>
<td>The iBook helped me understand fractions, decimals, and percent.</td>
<td>2.23</td>
<td>0.96</td>
</tr>
</tbody>
</table>

*Note.* N = 31 Students; 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree.

Table 8

*Mean and Standard Deviation for Student Responses to Questionnaire Items about Responding to the Treatment*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The iBook helped me develop confidence in mathematics.</td>
<td>2.35</td>
<td>1.05</td>
</tr>
<tr>
<td>The iBook motivated me to learn fractions, decimals, and percent more than regular mathematics activities.</td>
<td>2.55</td>
<td>1.18</td>
</tr>
<tr>
<td>I participated more in class when using iBooks than during activities that did not use iBooks.</td>
<td>3.23</td>
<td>1.33</td>
</tr>
<tr>
<td>I paid more attention when using the iBook than regular math activities.</td>
<td>3.29</td>
<td>1.44</td>
</tr>
<tr>
<td>The iBook was more convenient compared to a regular textbook.</td>
<td>2.06</td>
<td>1.75</td>
</tr>
<tr>
<td>It was easier to work in a group using the iBook than in other group activities.</td>
<td>2.52</td>
<td>1.82</td>
</tr>
</tbody>
</table>

*Note.* N = 31 Students; 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree.

questionnaire also used a Likert scale and questions were coded with the same number system as for the treatment questionnaire. The means of each question (see table 9) ranged from 1 to 2, which shows students agreed or strongly agreed they learned. In terms of using the textbook and
homework, the reliability between student responses was 0.96, showing high agreement. Means for the questions (see table 10) ranged from 2.33 to 3.67, which shows students did not generally enjoy using the textbook as much as they did the iBook.

Table 9

*Mean and Standard Deviation for Student Responses to Questionnaire Items about How Much Students Felt they Learned*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I understand how to convert fractions to decimals and percents.</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I understand how to convert decimals to fractions and percents.</td>
<td>1.33</td>
<td>0.52</td>
</tr>
<tr>
<td>I understand how to convert percents to fractions and decimals.</td>
<td>1.50</td>
<td>0.84</td>
</tr>
<tr>
<td>The homework helped me learn fractions, decimals, and percents.</td>
<td>2.00</td>
<td>1.10</td>
</tr>
</tbody>
</table>

*Note. N = 5 Students; 1= Strongly Agree, 2= Agree, 3= Neutral, 4= Disagree, 5= Strongly Disagree.*

Table 10

*Mean and Standard Deviation for Student Responses to Questionnaire Items about Learning from Homework and the Textbook*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The homework helped me understand fractions, decimals, and percents.</td>
<td>2.33</td>
<td>1.86</td>
</tr>
<tr>
<td>The homework helped me develop confidence in mathematics.</td>
<td>2.67</td>
<td>2.25</td>
</tr>
<tr>
<td>The homework motivated me to learn fractions, decimals, and percents more than regular mathematics activities.</td>
<td>2.67</td>
<td>2.73</td>
</tr>
<tr>
<td>Using the textbook is convenient.</td>
<td>3.67</td>
<td>2.94</td>
</tr>
</tbody>
</table>

*Note. N = 5 Students; 1= Strongly Agree, 2= Agree, 3= Neutral, 4= Disagree, 5= Strongly Disagree.*

Lastly, I conducted a final focus group with the four students I had previously spoken with regarding the iPad and iBook. This discussion included questions about what had worked well and what had not, and whether the iPad was a better tool for learning than teacher
instruction. Results from the focus group showed students enjoyed the technology aspect and the application. However, they did not like when there were glitches on the iPad or other technical issues. Two of the students voiced they preferred to write notes rather than use the iBook, but enjoyed using the iBook overall. All found the iPad easy to use. In terms of learning preferences, the results showed all students enjoyed using the iBook, but liked to have access to the teacher as well to ask questions or go over concepts they struggled to understand. Overall, they all enjoyed using the iPad and iBook during math instruction.

**Iteration 3: The Dissertation Study**

In this section, I discuss the details of the current study. These include participants, intervention, instrumentation development, and data collection methods. IRB approval was submitted to the researcher’s university and to the county where the middle school is located (see Appendix G).

**Methodology**

**Participants**

Participants for this study included 30 sixth grade students from a charter school in South West Florida. At the school, 80% of students are White, 12% are Hispanic, 3% are Asian, and 3% are Black; all sixth grade students are native English speakers (Great Schools, 2015). The distribution of gender is approximately equal, and 13% of students are eligible for free or reduced lunch.

The school was chosen for the study as a convenience sample, because the researcher works at the school. Prior to being accepted to the school, students are required to test and earn a specific level of achievement. The school has two classes per grade level and is rated an A school in Florida. In addition, the middle school has been ranked within the top three in the
county according to 2012-2013 and 2013-2014 Florida Comprehensive Assessment Test (FCAT) scores.

To determine that the ability levels of the two classes were equivalent prior to conducting the study, a comparison of participating students was conducted based on 5th grade FCAT scores (see Table 11) and first quarter math grades from the 6th grade (see Table 12). As seen in Table 11, far more participating students in the treatment group scored higher on the FCAT than the participating students in the comparison group. A Chi Squared test provided a Cohen’s $d$ of 0.36, showing a small effect size between the two groups. However, when reviewing Table 12, grades were similar between participants within both groups. Therefore, although there is a difference in FCAT scores, it is expected students will act similarly during the treatment as the assignments will be typical class assignments rather than a standardized test. In terms of personality, the treatment group was much more talkative than the comparison group. Therefore, although both groups have similar ability levels, I, as the teacher, found it is more difficult to keep the treatment group on task than the comparison group.

Table 11

<table>
<thead>
<tr>
<th>Score</th>
<th>Comparison N</th>
<th>Treatment N</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

*Note. One student in the treatment group did not have an FCAT score*
Table 12

Comparison and Treatment Group 1st Marking Period Grades of Participating Students

<table>
<thead>
<tr>
<th></th>
<th>Comparison</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Average: 90% 90%

Given the small sample size ($N = 30$) and the small effect size expected between groups (0.10), the power for the study would be 0.094 (see Table 13). Because the power for this study is so low, this study will be used as a first step in reviewing the success of an interactive digital textbook for homework for fractions, decimals, and percents.

Table 13

Necessary Sample Size for Repeated Measures ANOVA Between Factors

<table>
<thead>
<tr>
<th>Effect Size</th>
<th>Alpha</th>
<th>N</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.05</td>
<td>30</td>
<td>0.094</td>
</tr>
<tr>
<td>0.25</td>
<td>0.05</td>
<td>30</td>
<td>0.333</td>
</tr>
<tr>
<td>0.40</td>
<td>0.05</td>
<td>30</td>
<td>0.685</td>
</tr>
</tbody>
</table>

I participated as the teacher in this study. To determine which group would be the comparison and treatment, a coin was tossed after assigning one homeroom to heads and the other tails. Students in homeroom 6A became the comparison group and students in homeroom 6B became the treatment group. All students were provided with an iPad at the start of the school year and instruction in regards to how to use the iPad. The students had the iPads for approximately 2-3 months before the start of the study. This in conjunction with their technology rich home lives allowed the novelty effect to have worn off. The 15 students in the treatment...
group received the iBook homework intervention; the other 15 students in the comparison group received textbook and static digital PDF homework available online. Students had access to download additional applications to their iPad with the appropriate care plan, but students in the comparison group were unable to download the iBook.

Both classes received comparable instruction, which was verified through analysis of audio recordings of each lesson. Students in both groups received similar homework, but the treatment group had additional resources. Treatment students read from the iBook nightly and answered the homework questions within the iBook. Comparison group students were assigned readings from the textbook and answered the same questions that were in the iBook, with the exception of iBook related questions (i.e.-Has using the iBook helped you learn how fractions and decimals relate?), in a static digital PDF format available online. This static digital format included all of the same questions as the treatment group retyped into a Microsoft Word document, with the exceptions listed above. The Microsoft Word document was then converted to a PDF. Therefore, these students only had access to the questions in a digital PDF format and the textbook, whereas treatment group students had access to the questions in a digital format that included descriptions, interactive graphics, web links, videos, and game links.

Previously in the school year, students were given workbook homework. However, the homework was always scanned and posted to Edmodo (which is a learning management system that allows documents to be uploaded and accessed in a static PDF format without interactivity). Therefore, this format for the comparison group was something the students had used prior to this study. Because of this, their static PDF online homework will be considered traditional. For the treatment group, the iBook allowed for interactive exploration of the problems while the textbook for use by the comparison students does not; except for this interactive aspect, the
homework problems were identical. This approach controls for content, making the interactive aspects of technology in the iBook the variable.

With the added features of the iBook, students may have spent more time on homework than they might otherwise. Therefore, to determine length of time spent on homework, all students were asked prior to the study to answer the following questions.

1. What has your experience been with math homework?
2. How long does homework typically take you?
3. Do you use any resources when you get stuck? If so, what are they?
4. How difficult do you regularly find homework?

At the conclusion of the study, students were asked to respond to these questions again in regard to study related homework. This information was reviewed to determine average time spent on homework to determine whether time spent is a factor in achievement.

Prior to the study, lesson plans were designed to follow throughout the study. Although the lessons were previously written, some modifications were made based on the students and their needs. To ensure equality of instruction, I kept a journal documenting my journey as a teacher. I also audio recorded all lessons for both classes and analyzed the recordings to ensure I taught in the same manner, as much as possible.

**Intervention**

Students in the treatment group had a copy of the iBook I developed on their iPad. During class, I conducted mini lessons with hands-on activities to help develop rational number constructs. Mini lessons were the same for both groups (Appendix H). However, student questions caused some variations in the classes, but I attempted to ensure equitable instruction for both classes as much as possible. At the end of each “chapter” of the iBook, students
participated in group activities so I could evaluate their progress (Appendix I). Homework was
given nightly. Students in the treatment group were required to read the iBook pages assigned
and answer all questions.

Students in the comparison group also had an iPad, but did not receive a copy of the
iBook and did not have the ability to download it. To ensure equity, students in the comparison
group were offered the iBook at the conclusion of the study. Students in the comparison were
taught using the same lesson plans as the treatment group. They too completed hands-on
activities and group activities to determine knowledge gains. The difference was in homework
assignments. Students in the comparison group were assigned textbook pages to read and
completed identical questions from the iBook in a static digital PDF online format.

Both the treatment and comparison group were provided instruction based on the content
of chapter four of the 2011 Glencoe McGraw-Hill *Math Connects Course 1* textbook. Classes
were 50 minutes long and occurred five times per week. Students in both the comparison and
treatment group received nightly assignments, which were reviewed in class daily. Homework
was almost identical with the exception that comparison students were reading the textbook and
treatment students read the iBook and were expected to comment on the iBook features as part of
their homework.

**Research Procedures**

Prior to this quasi-experimental study, all students and parents were provided with
information about the study. At least 30 days before the study began, an email went out to all
parents with an explanation of the study and the paperwork to determine whether their child
would participate or not. An open house was conducted to allow any and all parents to come and
ask questions of the researcher. At the open house, parents were informed that their child would
receive the study instruction whether or not they chose to participate. The signed consent form would only permit the researcher to collect data from their child, but regardless of consent, all students in the treatment class would receive iBook related homework.

After the open house, paperwork was sent home with each child in a manila envelope in regards to the study. Parents and students were asked to sign the consent forms, or return the forms unsigned if they elected not to participate. I asked for all paperwork to be returned in a sealed envelope regardless of participation to ensure anonymity and reduce bias for myself as the researcher and teacher. Once all paperwork was returned, the study commenced. Any and all paperwork that needed to be reviewed prior to the conclusion of the study was reviewed by a colleague of the researcher at the charter school, which kept the participants anonymous to the researcher until the conclusion of the study.

Before the teaching of chapter four began, a pretest was given. All students participated in the pretest so I could review what they already knew and what content they still needed to learn. If a student was absent on the day the pretest was given, he or she was required to make up the pretest when he or she returned to school. At this point, the comparison group began chapter four instruction. Students in the treatment group began with a tutorial on how to use the iBook. They spent time learning to navigate the iBook with me to answer any questions they had. Once they learned to navigate the iBook they began instruction similar to the comparison group. During the study, the treatment group encountered technical difficulties. Some of these included iPads breaking and loaner iPads being given out, glitches in the iBook, and difficulty swiping. However, these issues were beyond the control of the researcher and were handled on a case-by-case basis.
Both groups proceeded to learn chapter four material using daily hands-on mini lessons to illustrate content. Students in the comparison group received nightly homework consisting of static digital PDF homework online and textbook pages to read, which reviewed material learned in class. Treatment group students reviewed the content learned in class by reading the interactive iBook nightly and answered questions in the iBook including questions regarding use of the iBook. Upon completion of each section of the chapter, both classes participated in small group or whole group activities. These activities allowed me to determine who understood the content and who continued to struggle. In addition, Mini Quizzes (which are short 4-6 question procedural driven quizzes) were given periodically throughout the study. These Mini Quizzes were used to determine student understanding and to determine if students needed more work with the content.

At the conclusion of chapter four, which took about four weeks to teach, a posttest was administered, which was identical to the pretest. These tests were collected by the researcher and scored using the developed rubric. Students participating in the study completed a questionnaire with Likert scale questions and open-response questions. Also, at the conclusion of the chapter, the researcher conducted a focus group after school hours with six students from the treatment group and another with six students from the comparison group. During the focus group, the conversation was audio recorded and field notes were taken. The discussion focused on the content of the chapter and ease of learning, resources used at home, homework, and the textbook or iBook depending on the group.

**Instrumentation Development**

The following section discusses the instruments developed for this study, their reliability and validity.
Pre and posttest.

The Glencoe McGraw-Hill *Math Connects Course 1* textbook comes with online teacher resources, which can only be accessed by the teacher. One of the online resources is an e-assessment tool. The e-assessment tool allows users to pull questions from a bank of developed questions to create a test. Within the e-assessment tool, the user can modify questions, choose question types, and determine the length of a test.

To develop the assessment for this study, I used the e-assessment tool. As I began, I knew I wanted at least one question covering each topic the students covered in chapter four. When I entered the e-assessment tool, I reviewed all of the available items for chapter four. Some of the items I chose asked students to change a fraction to a percent, or something similar. Other questions asked students to use the knowledge they gained to answer multiple step problems.

To determine if test questions were procedural or conceptual, all questions were analyzed based on the Levels of Cognitive Demand (Appendix J) by Stein, Smith, Henningsen, and Silver (2009). Table 14 provides the data from this analysis showing equity between conceptual and procedural questions.

Table 14

<table>
<thead>
<tr>
<th></th>
<th>Conceptual</th>
<th>Procedural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Questions</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Question Numbers</td>
<td>2, 3A, 4, 6, 7, 8, 10, 13, 14, 15, 16, 17, 19, 20b</td>
<td>1, 3B, 5, 9a, 9b, 11, 12, 18a, 18b, 18c, 18d, 20a</td>
</tr>
<tr>
<td>Percentage</td>
<td>54%</td>
<td>46%</td>
</tr>
</tbody>
</table>

The test (see Appendix K) was administered in the spring of 2014 to a group of 15 students to determine reliability. The test had a Cronbach Alpha internal consistency of 0.782. To review validity, two middle school teachers were asked to review the test to ensure it was
appropriate for middle school students. Both teachers found the test acceptable for students learning fractions, decimals, and percents in sixth grade. However, three questions were found more logic based than mathematically relevant and were therefore removed.

**Rubric.**

A rubric allows student work to be evaluated using a specific guideline for grading (Goomas & Weston, 2014; Thompson & Senk, 1998). In mathematics, teachers have often awarded partial credit, however, using a rubric allows for consistent grading across all items (Thompson & Senk, 1998). Therefore, to score each test I developed a rubric (see Appendix L) on a two to three point scale (depending on the question).

Rubrics for each question differ based on the type of question and how many steps it takes to answer the question. This was done to ensure points were awarded for appropriate steps taken to solve the problem. Various levels of points are awarded to each student depending on how much of the problem they have completed correctly. At times, students use unique methods to solve problems or are between point values. In these cases, I have adopted the framework provided by Thompson and Senk (1998), in which the rater considers whether the error is conceptual or computational. When errors are computational a higher score is given, but when errors are conceptual a lower score is given.

In 2014, three raters scored student tests to evaluate the reliability of the rubric and to determine inter-rater reliability. Prior to scoring the tests, the raters participated in a brief training. During the training session, the researcher discussed how the rubric should be used. Any and all questions the raters had were answered. Together, the raters and researcher scored several questions on a blinded test to ensure they were using the scale properly. Each rater then
individually rated six blinded tests. The inter-rater reliability was 88%, which shows a high reliability for using the rubric to grade the tests.

**Mini quizzes.**

Mini quizzes consisted of brief four to six question procedural based quizzes to help me determine how well students understood the content. Throughout the study, five mini quizzes were conducted. All mini quizzes were given as a review of the previous night’s content and/or homework with the exception of one that included additional questions regarding percents above 100% and below 1% due to students struggling with that content. All questions on mini quizzes were procedural driven to quickly check student comprehension of content.

**Questionnaires.**

Questionnaires were given to both the treatment and comparison groups to elicit perceptions of completing homework with an iBook or textbook in regard to the content of fractions, decimals, and percents. The questionnaires (see Appendix M) were modified from the framework seen in Rossing et al. (2012) who used a Likert-scale questionnaire in their study of iLearning. Rossing et al. (2012) validated their questionnaire through review by several students and an expert panel to determine whether the questions were understandable and in a logical format.

To validate the modified version of the questionnaire, I asked 10 students to review the wording of the questionnaires to ensure the questions are understandable. In the spring of 2014, I also had 30 students complete the treatment questionnaire and five complete the comparison questionnaire. Of the 10 students I asked, each student said the wording was easy to understand and they did not have any questions. Several of the students felt one question was redundant and
therefore it was removed. The Cronbach Alpha reliabilites for the treatment and comparison questionnaire were 0.871 and 0.903, respectively.

**Focus group interviews.**

Questions for the semi-structured focus group (see Appendix N) have been modified from Bloemsma’s (2013) dissertation, which focused on transformation of learning with iPads. Because no reliability or validity measures were listed in Bloemsma’s dissertation, in the spring of 2014, I asked the six students to review the language of the questions to ensure they were easily understandable. Each student stated the questions and language used were appropriate for sixth grade students.

In the spring of 2014, a group of four students volunteered to participate in the focus group to determine validity. After the focus group was conducted, I transcribed the interview and reviewed it for themes. Four themes emerged from the transcription: dislikes about the iPad, positive feelings toward the iPad, learning mathematics, and learning to use the iPad. I coded the interview using these themes. Then, I asked a recent Ph.D. graduate from my university to review the transcription using my themes to determine if we found the same patterns. When I reviewed her results, I discovered the same patterns and themes emerged.

**Data Collection**

Throughout this study several forms of data were collected for analysis. Pretests, posttests, mini quizzes, homework, homework perceptions, questionnaires, and lesson recordings were collected as quantitative data. Focus group data and a teacher journal were collected as qualitative data. Table 15 shows how data were analyzed in response to each research question.
Table 15

*Data Analysis by Research Question*

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Used for Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>When learning fractions, decimals, and percents, in what ways, if any, do students achieve differently on a unit test when using an interactive iBook for homework as compared to students who have access to the same homework questions in an online static PDF format?</td>
<td>Pretest and Posttest</td>
</tr>
<tr>
<td></td>
<td>Mini Quizzes</td>
</tr>
<tr>
<td></td>
<td>Lesson Length</td>
</tr>
<tr>
<td></td>
<td>Teacher Journal</td>
</tr>
<tr>
<td>What are students’ perceptions of completing homework regarding fractions, decimals, and percents with an interactive iBook compared to students who complete homework in an online static PDF format?</td>
<td>Homework Perceptions</td>
</tr>
<tr>
<td></td>
<td>Activity Responses</td>
</tr>
<tr>
<td></td>
<td>Questionnaires</td>
</tr>
<tr>
<td></td>
<td>Focus Group</td>
</tr>
<tr>
<td>In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook and a static PDF online assignment?</td>
<td>Homework Accuracy</td>
</tr>
<tr>
<td></td>
<td>Homework Responses</td>
</tr>
<tr>
<td></td>
<td>Number of Homework Problems Reviewed</td>
</tr>
<tr>
<td></td>
<td>Amount of Time Spent Checking Homework</td>
</tr>
</tbody>
</table>

**Pretest and posttest.**

Prior to the introduction of Chapter 4, students in the treatment and comparison group took a pretest. At the conclusion of Chapter 4, students in both the treatment and comparison group took a posttest identical to the pretest to determine growth.

**Mini quizzes.**

Throughout the study, students from both groups were periodically given mini quizzes to determine their understanding of the content. Five mini quizzes (Appendix O) were conducted using anywhere from four to six procedural questions. Students were awarded one point for each correct answer. Half credit was given if there were mathematical errors, or students forgot to simplify an answer.
**Homework.**

Students in both groups were assigned nightly homework with the exception of Friday nights, per school policy. Each night students from both groups were either assigned problems to complete, or were asked to respond to an activity conducted in class. Eight of the assignments were completing problems, while three of the assignments were responses to activities. Daily, assignments were reviewed when students were assigned problems. The researcher collected each homework assignment for analysis.

**Lesson recordings.**

Daily, lessons for the comparison group and treatment group were recorded to ensure equity of instruction between classes. Throughout the study, the researcher and a research assistant, who has a Bachelor’s degree in psychology and Master’s degree in education in addition to two years of teaching experience, reviewed recordings (Appendix P) to ensure similar instruction length, examples, and methods for solving problems. Recordings were also analyzed for time spent on mini quizzes, reviewing homework, questions asked about homework, and number of students asking questions.

**Homework perceptions.**

Prior to the study and at the conclusion of the study, students were asked to respond to several questions regarding perceptions of homework. These were collected to determine if homework length changed prior to the study and during the study in addition to surveying students regarding challenges with assignments.

**Questionnaires.**

At the conclusion of the study, all students from both groups completed a Likert-scale questionnaire to help determine how students perceived their instruction. The treatment student
questionnaire covered effectiveness of homework to learn fractions, decimals, and percents, and effectiveness of the iBook and iPad. The comparison group questionnaire covered effectiveness of homework to learn fractions, decimals, and percents, and effectiveness of the textbook.

**Focus groups.**

Six students from each group participated in a focus group. A research assistant, who is a teacher with a Bachelor’s and Master’s degree with nine years of teaching experience, randomly chose these students from the consent forms. The goal of the focus groups was to gather more in-depth information about students’ perceptions of learning fractions, decimals, and percents. In addition, students were asked to comment on the textbook and/or iBook depending on their group.

**Teacher journal.**

During the study I kept a journal. In this journal, I noted any differences or similarities on a daily basis seen between the groups and their instruction. The journal also included personal thoughts or feelings that occurred during the study regarding the iBook, differences between the classes, unplanned events, interruptions or any other information I determined was pertinent.
CHAPTER 4: RESULTS

In this chapter, I present the results from the third iteration of this study focusing on the use of an iBook for homework in a unit on fractions, decimals, and percents. Analyses were conducted on the following data: 1) pretest and posttest, 2) lesson recordings, 3) mini quizzes, 4) homework, 5) questionnaires, 6) focus groups, and 7) teacher journal. In Chapter 5, I interpret the results and discuss implications for research and practice.

During this study, students were divided into treatment and comparison groups. Students in the treatment group were provided with an interactive iBook for homework. Comparison group students were provided with the same homework questions as the treatment group in a static digital PDF format. Originally, comparison group students were to receive a hard copy of the homework, but due to a copier malfunction at the school, I was required to provide digital access to the homework for the comparison group on a website the class uses called Edmodo. As mentioned previously, students were familiar with Edmodo as their assignments were available on the site digitally throughout the year. Therefore, comparison group homework will be considered traditional homework given the parameters of the study. Treatment group students only were provided with the interactive iBook; comparison group students had access to a static digital PDF version of homework. The study was guided by the following questions:

1) When learning fractions, decimals, and percents, in what ways, if any, do students achieve differently on a unit test when using an interactive iBook for homework as compared to students who have access to the same homework questions in an online static PDF format?
2) What are students’ perceptions of completing homework regarding fractions, decimals, and percents with an interactive iBook compared to students who complete homework in an online static PDF format?

3) In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook and a static PDF online assignment?

**Documenting Comparability of Instruction Across Groups**

A key aspect of this study revolves around instruction being constant across groups as much as possible. Therefore, analysis of comparability will be discussed prior to study results to ensure instruction was comparable. Several measures were taken to ensure instruction was comparable. The measures used to document comparability include lesson recordings and the teacher journal. Analysis of recordings includes number of strategies used, length of instruction, number of students who asked questions, and lesson length.

**Lesson Recording Analysis**

During the study, all lessons were audio recorded to ensure both groups received comparable instruction, as much as possible. Instruction began on October 31st and concluded on November 18th. Throughout the instruction, three lessons were not audio recorded. On November 7th, the treatment group was not recorded. At the beginning of the lesson, the recording was started, but paused due to a fire drill. Upon returning to the classroom, I forgot to begin the recording again. On November 11th, the lessons for both groups were not recorded as I was out due to illness. On November 13th, the comparison group was recorded, but there was an error with the recorder and the treatment group was not recorded.
Throughout the study, the researcher and a research assistant listened to four recordings for each group. The recordings were reviewed as follows: November 5\textsuperscript{th} was listened to on November 5\textsuperscript{th}, November 12\textsuperscript{th} was listened to on November 13\textsuperscript{th}, November 14\textsuperscript{th} was listened to on November 17\textsuperscript{th}, and November 17\textsuperscript{th} was listened to on November 20\textsuperscript{th}. While listening to these recordings, the researcher and research assistant were documenting the length of teacher directed instruction, number of questions asked by students, how many students asked questions, the level of difficulty of the questions, the number and type of problems reviewed during the lesson, and the number of strategies taught during each lesson. Recordings were listened to as the study was being conducted to ensure equity of instruction between groups. Any differences between the researcher and research assistant were discussed; if we were unable to reach an agreement, counts of number of questions asked by students, homework questions reviewed, strategies taught, or number of problems reviewed were averaged.

After the study concluded, the researcher listened to the remaining recordings to ensure the instruction continued to be similar. In general, the results show the instruction to be the same in terms of examples used and strategies taught. Lesson length varied to some degree with the largest difference being nine minutes and the smallest difference being ten seconds. There were, however, some differences in homework problems reviewed and number of questions asked by students per lesson. More detail about each of these areas of instruction is reported in the following sections.

**Analysis of Teacher Directed Instruction by Lesson**

While teaching each lesson, I was cautious to prepare problems before classes began that would reflect the topic being taught. Considerable thought was given to how lessons would be taught and the conceptual understanding supported. On average, the length of teacher instruction
was similar between groups, with instruction in the treatment group being a mean of 22 minutes and 48 seconds; for the comparison group, mean instructional time was 22 minutes and 13 seconds. As seen in Figure 3, teacher directed instruction varied between classes to some degree, but overall the amount of time spent instructing students was similar.

![Figure 3. Length of Teacher Directed Instruction by Class Period and Group.](image)

**Note.** Time is measured in minutes.

**Analysis of Teacher Directed Instruction by Strategy**

In terms of how lessons were taught, consideration was given to how topics would be taught in each lesson. As shown in Figure 4, in almost all lessons an equal number of strategies were used to instruct the given topic. The one exception to this was on November 14\(^{th}\). During this lesson, a student gave an alternative solution in the comparison group. This allowed the comparison group to see one additional strategy than the treatment group. From reviewing the recordings, the researcher and research assistant noted that the same exact strategies were used in each lesson to ensure comparable instruction between groups.
Analysis of Teacher Directed Instruction by Example

The number of examples per lesson was also reviewed during the recordings. As shown in Figure 5, an equal number of examples were used in both classes with the exception of November 14th. During the November 14th lesson, which focused on percents of a number, a student in the comparison group asked if 60 is 60% of 60. To answer the student’s question, I posed the problem to the students who solved the problem and found that 60% of 60 is not 60, but 36. Therefore, because of this question an additional question was reviewed with the comparison group. However, overall the number of examples reviewed per lesson was equal.

Analysis of Questions Asked by Students

In terms of questions asked by students during each lesson, there were some differences between groups (Figure 6). During several lessons, the treatment group asked several more questions than the comparison group, although on some occasions the comparison group asked slightly more questions than the treatment group. Overall, the comparison group asked on
Figure 5. Number of Examples Reviewed per Lesson by Group.

Figure 6. Number of Questions Asked and Number of Students Who Asked Questions by Group and Date.
average approximately 4.88 questions per lesson, while the treatment group asked on average about 5 questions per lesson.

**Analysis of Teacher Journal**

In reviewing the teacher journal, there was little variation between treatment and comparison groups. Students struggled with the same topic, percents above 100% and below 1%, and seemed to do well with other topics. Within each group, one or two students continued to come up as struggling and needing additional support.

The main difference between the classes based on researcher notes was the attitude of the treatment group. Based on the teacher journal, the treatment group seemed much less interested in learning. Often, they attempted to “guide me off track” and would rather talk than focus on the lesson. About five students in the treatment group enjoy being the center of attention. Therefore, students often make comments unrelated to the content to receive attention. I noted that this has been a theme throughout the year. However, the journal also indicated that I attempt to monitor this and try to keep this from occurring.

In line with the comparison group being more focused on learning, they seemed to ask more questions about homework on several occasions. There are a few notes about the treatment group not asking very many questions about homework, worrying me. At times, I even found myself asking about specific questions, which I noted I should not have done and attempted not to do in the future in an effort to keep from biasing results.

In regards to the lessons, I wrote that there were often comments from students stating they finally understood the connection between whole numbers and decimals or whole numbers and fractions. This understanding allowed students to make connections between rational numbers while still comprehending they can be smaller than one whole. For example, after
seeing how fractions and decimals were connected using a hundreds chart, students showed more confidence in using the decimal places to convert decimals to fractions. These connections continued to develop as instruction was provided on percents and how they related to decimals and fractions. Once students gained a concrete understanding of the numbers, algorithms were provided for the students to use if they preferred algorithms over alternative methods. They would then work with these algorithms to determine the solution was the same as the conceptual model.

For example, prior to teaching students that decimals can be turned into percents by multiplying by 100, we used a hundreds chart to demonstrate the connection. The lesson began by reviewing one column in a hundreds chart is equivalent to 0.1 and one block in a hundreds chart is equivalent to 0.01. Then, the class discussed what they knew about percents. Students stated they knew percents are out of 100. They then discussed how the hundreds chart is also out of 100 and therefore each box is equivalent to 1% and one column would then be 10%. Students then began converting percents to decimals and decimals to percents. They wrote several on the board and students were asked to discuss what they noticed. Several students discovered the decimal moved two places to the right or left. Only then were algorithms introduced so that students understood the reasoning behind the algorithm prior to using the algorithm.

Overall, the notes paint a picture of very similar instruction between groups. Struggles and successes were noted in similar areas. The main difference observed in the notes was the work ethic between classes and the variation in questions from homework reviewed. Also, I wondered if students in the treatment group would have responded better if their math period were earlier in the day rather than third period as compared to the first period math class of the comparison group.
Conclusion

Analysis of the teacher journal and lesson recordings showed comparability between instruction of the comparison group and treatment group. Because of the similarities in instruction, we can assume students received similar information provided in the same manner. Therefore, differences in instruction were unlikely to have caused any major differences in opportunity to learn between the two groups.

Comparability of Homework and Mini Quizzes

During the study, each lesson began with either bell work or a mini quiz. Mini quizzes were four to six procedural questions students completed independently to help me gauge how well students understood various topics. Next, homework was reviewed if assigned the previous night. Homework was not checked on Mondays, as students were not assigned homework over weekends per school policy. In addition, homework was not reviewed the day after an activity was conducted; on these three days homework consisted of students responding to questions regarding the activity rather than working on problems. After reviewing homework, I would commence the lesson for the day. This might include teaching a new concept as a whole group, or introducing an activity for students to complete during class.

Mini Quizzes by Topic and Group

Throughout the study, five mini quizzes were administered (see Appendix N). Topics for the mini quizzes included: equivalent fractions; converting fractions and decimals; converting fractions, decimals, and percents; converting percents above 100% and below 1%; and finding a percent of a number. Students who were present in class participated in mini quizzes. If a student was absent they were not required to make up the mini quiz, therefore, there is some variation in Table 16. Though five mini quizzes were conducted, the amount of time spent on each mini quiz
was only collected from four mini quizzes due to my absence for one of the quiz days. As seen in Figure 7, students spent similar amounts of time on the mini quizzes. On average, the treatment group spent 10 minutes and 47 seconds on mini quizzes while the comparison group spent 10 minutes and 52 seconds on mini quizzes.

![Time Spent Completing Mini Quizzes](chart)

*Figure 7. Student Time Spent on Mini Quizzes.*

*Note.* Time is measured in minutes.

### Table 16

**Mean Score and Standard Deviation for Mini Quizzes by Group**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Comparison</th>
<th>Treatment</th>
<th>( t )</th>
<th>df</th>
<th>( p )</th>
<th>Cohen’s ( d )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent Fractions (3)</td>
<td>13</td>
<td>14</td>
<td>0.96</td>
<td>25</td>
<td>0.35</td>
<td>0.37</td>
</tr>
<tr>
<td>Fraction/Decimal Conversion (4)</td>
<td>14</td>
<td>15</td>
<td>0.46</td>
<td>27</td>
<td>0.65</td>
<td>0.17</td>
</tr>
<tr>
<td>Fraction, Decimal, Percent,</td>
<td>14</td>
<td>13</td>
<td>0.50</td>
<td>25</td>
<td>0.62</td>
<td>0.19</td>
</tr>
<tr>
<td>Conversions (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 100% and Below 1% (6)</td>
<td>14</td>
<td>13</td>
<td>-0.31</td>
<td>25</td>
<td>0.76</td>
<td>-0.12</td>
</tr>
<tr>
<td>Percent of a Number (4)</td>
<td>14</td>
<td>15</td>
<td>-0.90</td>
<td>27</td>
<td>0.38</td>
<td>-0.33</td>
</tr>
</tbody>
</table>

*Note.* Numbers in parenthesis represent number of questions per quiz, scores are out of 100 percent.
In scoring mini quizzes, each question was worth one point. Half credit was given if students used the correct process and made a mathematical error, or gave a fraction answer (when requested) that was not simplified. As shown, in Figure 8, students in the comparison and treatment group scored similarly on mini quizzes. Table 16 reports descriptive statistics for each mini quiz. On average, students in the comparison group scored a 73%, while the treatment group students a 72%. The topic of percents above 100% and below 1% was particularly challenging for students. Therefore, two of the four questions on the subsequent percents of a number mini quiz were related to percents above 100% and below 1%.

![Figure 8. Mean Scores for Mini Quizzes Across Groups.](image)

*Note.* FDP (Fractions, Decimals, and Percents), Scores are out of 100 percent.

When reviewing student scores overall, some surprising findings arose. In the comparison group, the scores of students who typically perform well (scoring above 85% on
tests) in mathematics were scattered. Although some continued to excel, others struggled with some of the topics. Overall, these students struggled most with percents above 100% and below 1%. Students in the comparison group who typically struggle (scoring below 65% on tests) continued to struggle with the content. Although all students in the comparison group scored 100% on the equivalent fractions mini quiz, many struggled with conversions and percents above 100% and below 1%.

In the treatment group, students who typically perform well (scoring above 85% on tests) in mathematics continued to perform well on the mini quizzes. Half of the students who typically perform well in mathematics struggled with percents above 100% and below 1%, but seemed to improve with additional practice. Students in the treatment group who typically struggle (scoring below 65% on tests) continued to struggle in this chapter. Although students improved throughout the chapter, all still struggled with percents above 100% and below 1%.

T-test results show no significant difference in achievement between the groups on any topic. Therefore, the null hypothesis was not rejected, indicating no difference in achievement between groups.

**Homework by Topic and Group**

Throughout the fifteen days of the study, homework was assigned eleven times. Of those eleven assignments, three were responses to activities and were, therefore, not reviewed during class time. The other eight assignments were computation driven. All of these assignments were reviewed during class and collected to determine accuracy, but only five were audio-recorded for the purpose of verifying comparable instruction. One was not recorded due to a recorder malfunction, another was not recorded because I was absent, the third was not recorded because of a fire drill and I forgot to start the recording after the fire drill was complete. Therefore, the
data in Figures 9 and 10 reflect homework problems reviewed and time spent checking homework for the five homework assignments that were recorded and reviewed during class. Figure 11 and Table 17 reflect scores from all eight reviewed and collected computational assignments, which were reviewed for accuracy.

On average, the length of time spent reviewing homework assignments was 11 minutes and 12 seconds for the comparison group and 7 minutes and 9 seconds for the treatment group. As seen in Figure 9, on November 4th, the comparison group spent a much longer period of time reviewing homework than the treatment group; on November 6th the treatment group spent a much longer period of time reviewing homework than the comparison group.

Figure 9. Time Spent Checking Homework by Group.
Note. Time is measured in minutes.

November 4th was the first day students were reviewing homework for this chapter. The comparison group struggled with reviewing the homework and how to determine whether questions were correct or incorrect. Extra time was spent explaining how to look over solutions for the homework. In addition, the comparison group had questions on three of the multiple-
choice questions, which they did not have the solutions to, but the treatment group did because of the iBook. Therefore, additional time was spent reviewing homework that day.

On November 6\textsuperscript{th}, the homework topic was converting fractions to decimals and decimals to fractions. During this lesson, students in the treatment group had many more questions than the comparison group. Although fewer problems from the homework were reviewed from the treatment group, see Figure 10, the students in the treatment group struggled with the concept and, therefore, more time was spent answering questions and reviewing the homework assignment from the previous night.

On average, the treatment group asked approximately 3.2 questions about homework per session reviewing homework, while the comparison group asked an average of 4 questions. Overall, as seen in Figure 10, students in the comparison group often had more questions about the homework than the treatment group.

![Figure 10. Number of Homework Problems Reviewed by Group.](image)
Homework Accuracy by Topic and Group

During the course of the study, all homework assignments were collected and reviewed for accuracy. Homework was broken into eight categories: equivalent fractions; decimal fraction conversions; fraction-decimal conversions; fraction, decimal, percent conversions; percents above 100% and below 1%; compare and order fractions, decimals, and percents; percents on a number line; and percents of a number. All constructed response word problems (in which students were required to supply the answer) were used to calculate homework correctness. Multiple-choice questions were removed from calculations because the treatment group had the solutions to these problems, as part of the iBook, while the comparison group did not have access to the solutions until reviewed in class. Numbers of items per homework topic are listed in Table 17. Also, all open response opinion questions about activities were reviewed separately due to their opinion based nature.

As shown in Figure 11, students’ mean scores on homework were similar between both groups. Descriptive statistics are shown in Table 17. On average, the comparison group scored 74% and the treatment group scored 75% on homework.

In terms of individual student success, the students in the comparison group who are typically high achievers (scoring above 85% on tests) in mathematics continued to excel on homework assignments. Throughout the assignments, four students struggled with fractions, decimals, and percents on a number line, three struggled with conversions, and one struggled (scoring below 65% on tests) with percents above 100% and below 1%. However, overall, these lower performing students in the comparison group scored above average on their homework assignments. Students in the comparison group who typically underperform (scoring below 65% on tests) in mathematics struggled with the homework. However, there were some areas in which
these students excelled. Two students were very successful with placing fractions, decimals, and percents on a number line, three excelled with conversions, and one excelled with equivalent fractions.

Table 17

*Mean and Standard Deviation for Homework Topics by Group*

<table>
<thead>
<tr>
<th>Topic</th>
<th>Comparison</th>
<th>Treatment</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>( \overline{X} )</td>
<td>SD</td>
<td>N</td>
<td>( \overline{X} )</td>
<td>SD</td>
</tr>
<tr>
<td>Equivalent Fractions (3)</td>
<td>15</td>
<td>77.67</td>
<td>34.99</td>
<td>15</td>
<td>95.47</td>
<td>3.09</td>
</tr>
<tr>
<td>Decimal-Fraction Conversions (13)</td>
<td>15</td>
<td>78.93</td>
<td>18.78</td>
<td>15</td>
<td>74.40</td>
<td>17.70</td>
</tr>
<tr>
<td>Fraction-Decimal Conversions (6)</td>
<td>15</td>
<td>69.40</td>
<td>31.93</td>
<td>14</td>
<td>65.00</td>
<td>20.70</td>
</tr>
<tr>
<td>Fraction, Decimal, Percent Conversions (10)</td>
<td>14</td>
<td>83.21</td>
<td>11.37</td>
<td>15</td>
<td>83.33</td>
<td>12.34</td>
</tr>
<tr>
<td>Above 100% and Below 1% (9)</td>
<td>15</td>
<td>71.27</td>
<td>23.42</td>
<td>15</td>
<td>63.00</td>
<td>18.36</td>
</tr>
<tr>
<td>Compare and Order Fractions, Decimals, and Percents (4)</td>
<td>15</td>
<td>76.67</td>
<td>27.50</td>
<td>15</td>
<td>90.00</td>
<td>18.42</td>
</tr>
<tr>
<td>Fractions, Decimals, and Percents on a Number Line (3)</td>
<td>15</td>
<td>69.73</td>
<td>32.34</td>
<td>15</td>
<td>68.60</td>
<td>32.14</td>
</tr>
<tr>
<td>Percent of a Number (5)</td>
<td>14</td>
<td>73.57</td>
<td>19.06</td>
<td>14</td>
<td>65.00</td>
<td>26.24</td>
</tr>
</tbody>
</table>

*Note.* Numbers in parenthesis represent number of questions per category; scores are out of 100 percent.

Interestingly, comparison students who typically excel in mathematics (scoring above 85% on tests) struggled with placing fractions, decimals, and percents on the number line. This is noteworthy as this was a very visual activity and may have aided less successful mathematics students in understanding the content.
For the treatment group, most of the students who are typically high achievers in mathematics (scoring above 85% on tests) continued to excel on homework assignments. However, these students did have some areas of weakness. Two students struggled with percents above 100% and below 1%, four students struggled with conversions, and one student struggled with placing fractions, decimals, and percents on the number line. Students in the treatment group who typically underperform in mathematics (scoring below 65% on tests) continued to struggle on homework. However, they were successful in a few areas. Four students excelled in finding equivalent fractions, three students excelled in comparing and ordering fractions, decimals, and percents, three students excelled in conversions, and one excelled in finding a percent of a number.

The results from the $t$-test showed no significant differences in scores for any assignments. Therefore, the null hypothesis was not rejected, indicating no difference in achievement on homework assignments.
Student Learning of Fractions, Decimals, and Percents

Test score means (Table 18) for both the treatment and comparison groups were similar for the pretest and posttest with a small effect size of 0.05 according to Cohen’s $\hat{f}$. Posttest means were a C average for both groups, showing neither group gained mastery of the content. Within the comparison group and treatment group, 27% (four students) and 33% (five students), respectively, gained mastery, which is defined as scoring 85% or better. Of the 15 students in each group, 27% (four students) in the comparison group and 53% (eight students) in the treatment group did not master the content, scoring below a 75% on the posttest.

Table 18

_Means and Standard Deviations from Pretest and Posttest by Group_

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest $\bar{X}$</th>
<th>Pretest SD</th>
<th>Posttest $\bar{X}$</th>
<th>Posttest SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison</td>
<td>27.60</td>
<td>22.19</td>
<td>75.47</td>
<td>13.18</td>
<td>-7.18</td>
<td>28</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Treatment</td>
<td>28.13</td>
<td>20.73</td>
<td>73.20</td>
<td>17.18</td>
<td>-6.48</td>
<td>28</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

*Note.* Test scores are out of 100 percent; test consisted of 25 items.

Overall, both groups made significant achievement gains from pretest to posttest. Although the comparison group’s mean posttest score was higher than the mean posttest score of the treatment group, there was not statistical significance between the groups when looking at the interaction between groups and time ($F=0.14; p < 0.71$). In addition, there was a smaller standard deviation among the posttest scores for the students in the comparison group than among the scores for the students in the treatment group (Figure 12), indicating the achievement scores for the comparison students were more closely clustered than for students in the treatment group. The null hypothesis was not rejected, indicating no significant difference in achievement on posttests.
Figure 12. Distribution of Scores on Pretest and Posttest by Group.

Note. The shading represents the interquartile range. The lighter shading represents the second quartile, while the darker shading represents the third quartile.

To determine if there were any differences between the treatment and comparison group in terms of gain scores from pretest to posttest, I conducted a *t*-test as seen in Table 19. The gain scores show there is no significant difference between the groups and the effect size is small, showing we fail to reject the null hypothesis and there is no difference in pretest and posttest gain scores between groups.

Table 19

<table>
<thead>
<tr>
<th></th>
<th>Comparison</th>
<th>Treatment</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td>46.87</td>
<td>44.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>19.97</td>
<td>20.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain Score</td>
<td>0</td>
<td>0</td>
<td>0.40</td>
<td>28</td>
<td>0.69</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Comparing Top and Lower 20% of Students Based on Pretest Scores

To get a deeper sense of student gains from pretest to posttest, six students were chosen from each group, three as the top 20% and three as the lower 20%. Students were chosen based on their pretest scores. Therefore, the three students from each group with the lowest pretest scores were the lower 20% and the three students from each group with the highest pretest scores were considered the top 20%.

From pretest to posttest, all lower 20% students increased their scores (Table 20). One student from the treatment group and another from the comparison group made such large increases from pretest to posttest scores that they were able to earn B averages (i.e., a score between 80% and 89%) on the posttest. Although other students increased their scores, one student in the comparison and one in the treatment group still failed the posttest (i.e., a score below a 60%). In addition, the student in the treatment group who failed the posttest had very small gains, with a 26% increase and a score of 35% overall showing the student did not gain mastery of the content. One student from the comparison group and one from the treatment group earned a D average on the posttest (i.e., a score between 60% and 69%).

Table 20

*Pretest and Posttest Scores for the Lower 20% of Students in Each Group*

<table>
<thead>
<tr>
<th></th>
<th>Comparison</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>Student 1</td>
<td>7</td>
<td>67</td>
</tr>
<tr>
<td>Student 2</td>
<td>7</td>
<td>82</td>
</tr>
<tr>
<td>Student 3</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>Overall $\bar{x}$</td>
<td>4.67</td>
<td>68.00</td>
</tr>
<tr>
<td>Overall SD</td>
<td>4.04</td>
<td>13.53</td>
</tr>
</tbody>
</table>

*Note.* Test scores are out of 100 percent; test consisted of 25 items.
An ANOVA was used to analyze the scores. Results showed no significant differences between the two groups when looking at the interaction between groups and time \((F=0.17, p < 0.71)\). Therefore, although all students improved their scores, their improvements were not significantly different from one another, showing no difference in achievement between students in the lower 20% of each group.

Students in the top 20% based on pretest scores also improved from pretest to posttest (Table 21). On the posttest, two students in the high achieving treatment group earned A’s (i.e., of at least 90%) on the posttest and one earned a D (i.e., a score between 60% and 69%). Students in the top 20% in the comparison group all earned B’s (i.e., a score between 80% and 89%) on the posttest. Results from an ANOVA show no significant differences between groups when looking at the interaction between groups and time \((F=0.02, p < 0.90)\). Therefore, we fail to reject the null hypothesis showing there was no difference between the two groups from pretest to posttest.

Table 21

<table>
<thead>
<tr>
<th></th>
<th>Comparison</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>Student 1</td>
<td>65</td>
<td>87</td>
</tr>
<tr>
<td>Student 2</td>
<td>51</td>
<td>84</td>
</tr>
<tr>
<td>Student 3</td>
<td>69</td>
<td>85</td>
</tr>
<tr>
<td>Overall (\bar{X})</td>
<td>61.7</td>
<td>85.3</td>
</tr>
<tr>
<td>Overall SD</td>
<td>9.45</td>
<td>1.53</td>
</tr>
</tbody>
</table>

*Note.* Test scores are out of 100 percent; test consisted of 25 questions.

**Content Analysis of Pretest and Posttest Items**

Prior to conducting the study, pretest/posttest questions were clustered into categories by concept. The largest cluster of questions related to conversion among fractions, decimals, and
percents because that was the major topic of this chapter. Smaller clusters included comparing fractions, decimals, and percents; percents above 100% and below 1%; and finding a percent of a number. Each cluster was analyzed individually, to compare the achievement of comparison and treatment groups, with t-tests used to compare achievement for each question.

**Conversions of fractions, decimals, and percents.**

There were two items addressing converting decimals to percents. As shown in Figure 13, both groups scored higher in this area on the posttest than the pretest. There was not a significant difference between the two groups on either item, as shown in Table 22.

![Figure 13. Comparison of Mean Scores for Questions Converting Decimals to Percents by Pretest, Posttest, and Group.](image)

*Note.* Questions are on a two point scale.

For questions 18a and 18c, students were asked to convert decimals directly to percents from a table. On question 18a, 100% of the comparison students received full credit for the question on the posttest while 93% of the treatment group received full credit. For question 18c, 93% of students in the comparison group received full credit, while 73% of the students in the
Table 22

*Pretest and Posttest Means and Standard Deviations of Questions Converting Decimals to Percents by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>18a. Write the amount of trees at Trevor Farms as a percent (0.21).</td>
<td></td>
<td></td>
<td>1.07 1.03</td>
<td>2.00 0.00</td>
<td>0.80 0.26</td>
<td>1.87 0.52</td>
<td>0.48 28</td>
<td>0.71 1.00</td>
<td>14 0.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18c. Write the amount of trees at East Apple Valley as a percent (0.1).</td>
<td></td>
<td></td>
<td>0.67 0.98</td>
<td>1.87 1.52</td>
<td>0.53 0.92</td>
<td>1.47 0.92</td>
<td>0.39 28</td>
<td>0.70 1.47</td>
<td>22.09 0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td>0.87 0.28</td>
<td>1.94 0.09</td>
<td>0.67 0.19</td>
<td>1.67 0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
treatment group received full credit on the posttest. The value being converted for question 18a was 0.21, which can easily be converted to 21%, but the value being converted for question 18c was 0.1 causing some students to provide 1% as their solution rather than 10%. In comparing converting fractions to percents, both groups showed increases from the pretest to posttest (Figure 14).

![Figure 14. Comparison of Mean Scores for Questions Converting Fractions to Percents by Pretest, Posttest, and Group.](image)

*Note.* Questions are on a two point scale.

Table 23 shows no significant difference between groups on any of the four questions addressing conversion of fractions to percents. However, students in the treatment group earned full credit more often than the comparison group on three of the four questions. On question 9a, 73% of the comparison group earned full credit, while 80% of the treatment group earned full credit. For questions 13 and 19a, 73% and 47% of the comparison group earned full credit, while 86% and 60% of the treatment group earned full credit.
There were two questions that focused on rewriting percents as fractions. Figure 15 shows students increased their scores from the pretest to posttest. When looking at individual items, Table 24 shows no significant difference between the two groups. Most students who did not earn full credit on these items did not simplify their fraction to lowest terms, causing them to earn one point instead of two.

Two questions focused on rewriting decimals as fractions. According to Figure 16, students scored similarly on the posttest. However, Table 25 shows no significant differences between the two groups. In addition, as mentioned above, students often did not earn full credit on this question because they did not simplify their answer. Therefore, once again, they earned only one point instead of two.

![Figure 15. Comparison of Mean Scores for Questions Converting Percents to Fractions by Pretest, Posttest, and Group. Note. Questions are on a two point scale.](image)

Two questions on the test focused on converting percents to decimals. Figure 17 shows students in both groups increased their performance from pretest to posttest on these two
Table 23

*Pretest and Posttest Means and Standard Deviations for Questions Converting Fractions to Percents by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
<td>X</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b. Which teen in the Landen family has the smallest percent of incoming calls?</td>
<td>1.20 1.01  1.73 0.70</td>
<td>1.47 0.92  1.73 0.70</td>
<td>-0.76 28 0.46</td>
<td>0 28 1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9a. On Mr. Rheinhard’s history test what percentage of the questions are true or false?</td>
<td>0.53 0.92  1.53 0.83</td>
<td>0.40 0.83  1.67 0.72</td>
<td>0.68 28 0.68</td>
<td>-0.47 28 0.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. At a cookware party, 7 of the 25 items are made of glass. What percent of the cookware items are glass?</td>
<td>0.67 0.98  1.60 0.83</td>
<td>0.67 0.98  1.73 0.70</td>
<td>0.00 28 1.00</td>
<td>-0.48 28 0.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Write the percent of dogs of each size that were at the dog park at 2 p.m.</td>
<td>0.40 0.83  0.93 1.03</td>
<td>0.40 0.83  1.30 1.01</td>
<td>0.00 28 1.00</td>
<td>-0.71 28 0.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>0.70 0.35  1.45 0.35</td>
<td>0.74 0.51  1.61 0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
Table 24

*Pretest and Posttest Means and Standard Deviations for Questions Converting Percents to Fractions by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th></th>
<th>Treatment</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td></td>
<td>( \bar{X} )</td>
<td>SD</td>
<td>( \bar{X} )</td>
<td>SD</td>
<td>( \bar{X} )</td>
<td>SD</td>
<td>( t )</td>
<td>df</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9b. On Mr. Reinhardt’s history test, what fraction of the questions will be essay?</td>
<td>0.33</td>
<td>0.72</td>
<td>1.80</td>
<td>0.41</td>
<td>0.20</td>
<td>0.56</td>
<td>1.67</td>
<td>0.62</td>
</tr>
<tr>
<td>11. In simplest form, what fraction of Lacey’s DVDs are comedies?</td>
<td>0.73</td>
<td>0.88</td>
<td>1.60</td>
<td>0.63</td>
<td>0.73</td>
<td>0.88</td>
<td>1.73</td>
<td>0.46</td>
</tr>
<tr>
<td>Overall</td>
<td>0.53</td>
<td>0.28</td>
<td>1.70</td>
<td>0.14</td>
<td>0.47</td>
<td>0.37</td>
<td>1.70</td>
<td>0.04</td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
Table 25

*Pretest and Posttest Means and Standard Deviations for Questions Converting Decimals to Fractions by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$t$</td>
<td>df</td>
<td>$p$</td>
<td>$t$</td>
<td>df</td>
<td>$p$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mitch’s little brother is 2.75 years old. Write his age as a fraction in</td>
<td>1.07</td>
<td>0.96</td>
<td>1.87</td>
<td>0.35</td>
<td>1.47</td>
<td>0.92</td>
<td>-1.17</td>
<td>28</td>
<td>0.25</td>
<td>0.39</td>
<td>28</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>simplest form.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Express the total amount of blocks Josh walked today as a mixed number</td>
<td>1.07</td>
<td>0.88</td>
<td>1.47</td>
<td>0.83</td>
<td>1.00</td>
<td>0.93</td>
<td>0.20</td>
<td>28</td>
<td>0.84</td>
<td>-0.46</td>
<td>28</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in simplest form.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>1.07</td>
<td>0.00</td>
<td>1.67</td>
<td>0.28</td>
<td>1.24</td>
<td>0.33</td>
<td>1.70</td>
<td>0.14</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
Figure 16. Comparison of Mean Scores for Questions Converting Decimals to Fractions by Pretest, Posttest, and Group.

Note. Questions are on a two point scale.

Figure 17. Comparison of Mean Scores for Questions Converting Percents to Decimals by Pretest, Posttest, and Group.

Note. Questions are on a two point scale.
questions. On question 18b, there was a statistical significance between the comparison and treatment group (Table 26), with the comparison group having a higher mean than the treatment group. Although all students in the comparison group earned full credit for question 18b, only 73% of students in the treatment group earned full credit.

Although the results for question 18d are not significant, the treatment group still showed an overall mean score lower than the comparison group. These results show it may be necessary to review the iBook and how it presents converting percents to decimals to ensure treatment students are receiving proper instruction in this area.

Two questions focused on converting fractions to decimals. As shown in Figures 18 and 19, both groups increased their scores from pretest to posttest. The $t$-test (Table 27) revealed no significant differences between groups. This finding suggests there is no difference in achievement between groups when converting fractions to decimals.

Figure 18. Comparison of Mean Scores for Questions Converting Fractions to Decimals by Pretest, Posttest, and Group for Questions on a Two Point Scale.
### Table 26

*Pretest and Posttest Means and Standard Deviation of Questions Converting Percents to Decimals by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>18b. Write the amount of trees at Hartford as a decimal. (34%)</td>
<td>0.40</td>
<td>0.83</td>
<td>0.80</td>
<td>1.01</td>
<td>1.47</td>
<td>0.92</td>
<td>-1.18</td>
<td>28</td>
<td>0.25</td>
<td>1.18</td>
<td>0.25</td>
<td>2.26</td>
<td>14</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18d. Write the amount of trees at West Apple Valley as a decimal. (9%)</td>
<td>0.27</td>
<td>0.70</td>
<td>0.27</td>
<td>0.70</td>
<td>1.07</td>
<td>1.03</td>
<td>0.00</td>
<td>28</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>2.07</td>
<td>28</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>0.34</td>
<td>0.09</td>
<td>1.87</td>
<td>0.19</td>
<td>0.54</td>
<td>0.37</td>
<td>1.27</td>
<td>0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
Table 27

**Pretest and Posttest Means and Standard Deviations for Questions Converting Fractions to Decimals by Group**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Pretest</th>
<th>Posttest</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Ana, Barney, and Chloe are using various amounts of flour in their recipes. As a decimal, who uses the least flour?</td>
<td>1.07 1.39 2.07 1.10</td>
<td>0.67 1.23 2.33 1.05</td>
<td>0.83 28 0.41</td>
<td>-0.68 28 0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20a. Write $\frac{1}{6}$ as a decimal.</td>
<td>0.00 0.00 1.40 0.91</td>
<td>0.20 0.56 1.40 0.91</td>
<td>-1.38 14 0.19</td>
<td>0.00 28 1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>0.54 0.76 1.74 0.47</td>
<td>0.44 0.33 1.87 0.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale with the exception of question 6, which is on a three point scale.
Comparing fractions.

Two questions addressed comparing fractions with other fractions. As shown in Figure 20, students increased their performance from pretest to posttest in this area. Table 28 shows there were no statistical differences between the groups on the posttest. Both groups showed greater comprehension of the content of question 2 than of question 17. This may have been because students were required to construct a graph on which to place fractions for question 17. Although students there was no significant difference between groups, both groups scored lower than anticipated showing a greater focus on constructing number lines with fractions may be necessary in the future.

Comparing fractions, decimals, and percents.

Three questions on the test focused on comparing fractions, decimals, and percents. Figures 21 and 22 show increases from the pretest to posttest for all questions. As shown in Table 29, there were no significant differences between the groups on any of the three questions.
Figure 20. Comparison of Mean Scores for Questions Comparing Fractions by Pretest, Posttest, and Group.

Note. Questions are on a two point scale.

Figure 21. Comparison of Mean Scores for Questions Comparing Fractions, Decimals, and Percents on a Two Point Scale by Pretest, Posttest, and Group.
Table 28

*Pretest and Posttest Means and Standard Deviations for Questions Comparing Fractions by Group*

| Questions | Comparison | | | Treatment | | | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest |
|-----------|------------|-----------------|-----------------|-------------|-----------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|
|           | Pretest    | Posttest       | Pretest | Posttest | t | df | p | t | df | p |
| 2. If Jennifer spends \( \frac{5}{7} \) of her allowance on clothes and \( \frac{3}{4} \) on CDs, on which did she spend more money? | 1.60 | 0.83 | 1.67 | 0.72 | 1.20 | 1.01 | 1.73 | 0.70 | 1.18 | 28 | 0.25 | -0.26 | 28 | 0.80 |
| 17. Plot the fractions on a number line. | 0.40 | 0.83 | 1.00 | 1.00 | 0.80 | 1.01 | 1.20 | 1.01 | -1.18 | 28 | 0.25 | -0.54 | 28 | 0.96 |
| Overall | 1.00 | 0.85 | 1.33 | 0.47 | 1.00 | 0.28 | 1.47 | 0.37 |

*Note.* Questions are on a two point scale.
Table 29

Pretest and Posttest Means and Standard Deviations for Questions Comparing Fractions, Decimals, and Percents by Group

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>t</td>
<td>df</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$\bar{X}$</td>
<td>SD</td>
</tr>
<tr>
<td>3a. Who has the smallest percent of incoming calls from the Landen family?</td>
<td>1.33 0.98</td>
<td>2.00 0.00</td>
<td>1.47 0.92</td>
<td>2.00 0.00</td>
<td>-0.39</td>
<td>28 0.70</td>
<td>0.00</td>
<td>28 1.00</td>
</tr>
<tr>
<td>7. Two students ranked the following numbers from smallest to largest. Decide who is correct.</td>
<td>0.20 0.77</td>
<td>1.00 1.31</td>
<td>0.00 0.00</td>
<td>1.20 1.52</td>
<td>1.00</td>
<td>14 0.33</td>
<td>-0.39</td>
<td>28 0.70</td>
</tr>
<tr>
<td>20b. Which is more candy, $\frac{1}{6}$ or 0.15?</td>
<td>0.27 0.70</td>
<td>1.73 0.59</td>
<td>0.40 0.83</td>
<td>1.27 0.88</td>
<td>-0.48</td>
<td>28 0.64</td>
<td>1.70</td>
<td>28 0.10</td>
</tr>
<tr>
<td>Overall</td>
<td>0.60 0.63</td>
<td>1.58 0.52</td>
<td>0.62 0.76</td>
<td>1.49 0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Questions are on a two point scale with the exception of question 7, which is on a three point scale.
Figure 22. Comparison of Mean Scores for Questions Comparing Fractions, Decimals, and Percents on a Three Point Scale by Pretest, Posttest, and Group.

All students from both groups received full credit for question 3a, but received much lower scores for questions 7 and 20b.

On question 3a, students were asked to convert fractions to percents and compare the percents. However, questions 7 and 20b were more challenging with 20% and 80% of students in the comparison group receiving full credit on the questions and 40% and 53% of students in the treatment group receiving full credit, respectively. On question 7, students were asked to review the order two students placed numbers in and determine which was correct. Then, on question 20b, students were asked to compare a fraction and a decimal when the fraction has a repeating decimal representation. Therefore, although students scored similarly, students may need more instruction comparing fractions, decimals, and percents in the future.

Finding percent of a number.

There were five questions that focused on finding a percent of a number. However, they have been divided into two groups here based on their point value, which was determined by the
number of steps required to solve the problem. Two of the questions only required one step, while three of the questions required more than one step. Questions with one step were given a value of two points whereas questions requiring more than one step were given a value of three points. Therefore, the questions have been separated into two different figures and tables.

Figure 23 shows students from both groups increased achievement from pretest to posttest on questions 4 and 14. Table 30 shows no significant difference between the comparison and treatment group for either question. On question 4, 67% of students from both groups earned full credit; 7% of treatment students earned partial credit, while 33% of comparison students earned partial credit. For question 14, 67% of the students from the comparison group earned full credit, while 80% of students from the treatment group earned full credit.

![Figure 23. Comparison of Mean Scores for Questions Finding Percent of a Number with a Single Step by Pretest, Posttest, and Group.](image)

*Note.* Questions are on a two point scale.
Table 30

Pretest and Posttest Means and Standard Deviations for Questions Finding Percent of a Number with a Single Step by Group

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. There are 200 students in sixth grade. If 72% participated in the fundraiser, how many students participated?</td>
<td>0.40</td>
<td>1.67</td>
<td>0.49</td>
<td>0.83</td>
<td>0.27</td>
<td>1.40</td>
<td>0.91</td>
<td>0.70</td>
<td>0.48</td>
<td>28</td>
</tr>
<tr>
<td>14. People spend about 30% of their lives sleeping. By age 60, how many years are spent sleeping?</td>
<td>0.13</td>
<td>1.47</td>
<td>0.83</td>
<td>0.52</td>
<td>0.27</td>
<td>1.60</td>
<td>0.83</td>
<td>0.70</td>
<td>-0.59</td>
<td>28</td>
</tr>
<tr>
<td>Overall</td>
<td>0.27</td>
<td>1.57</td>
<td>0.14</td>
<td>0.19</td>
<td>0.27</td>
<td>1.50</td>
<td>0.14</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Questions are on a two point scale.*
Figures 24 and 25 also show improvement for both groups from the pretest to posttest on questions 10, 15, and 16. Of the three questions in this section, none showed a significant difference between groups (Table 31). Both questions 10 and 15 had two steps. Students were required to find the discount and add or subtract it from the total. On question 16, students were required to find the discount, find the new cost, and then determine the change one would receive.

![Graph showing comparison of mean scores for questions finding percent of a number with multiple steps on a two-point scale by pretest, posttest, and group.](image)

*Figure 24. Comparison of Mean Scores for Questions Finding Percent of a Number with Multiple Steps on a Two Point Scale by Pretest, Posttest, and Group.*

**Percents above 100% and below 1%**.

Because percents above 100% and below 1% were only a small portion of the unit, only two questions focused on this topic. Figure 26 shows students in both groups improved from pretest to posttest. There was no statistical significance between groups, as shown in Table 32. When reviewing the questions more closely, it is noteworthy that no students from either group earned full credit on question 5, which addressed percents smaller than 1%. Partial credit was
### Table 31

**Pretest and Posttest Means and Standard Deviations for Questions Finding Percent of a Number with Multiple Steps by Group**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison Pretest Mean (X) &amp; SD</th>
<th>Pretest Posttest Mean (X) &amp; SD</th>
<th>Treatment Pretest Mean (X) &amp; SD</th>
<th>Posttest Mean (X) &amp; SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. A jacket was priced at $80. What is the price if the sale price is 35% of the original price?</td>
<td>0.00 0.00</td>
<td>1.60 0.63</td>
<td>0.00 0.00</td>
<td>1.13 0.74</td>
<td>0.00</td>
<td>28</td>
<td>1.00</td>
</tr>
<tr>
<td>15. Dillon’s bill at a restaurant is $14.36. If he leaves a 20% tip, how much money will he leave?</td>
<td>0.07 0.26</td>
<td>1.20 0.77</td>
<td>0.00 0.00</td>
<td>1.40 0.83</td>
<td>1.00</td>
<td>14</td>
<td>0.33</td>
</tr>
<tr>
<td>16. A jacket costs $58, but is 50% off. If you have $34, how much change will you receive?</td>
<td>0.40 0.83</td>
<td>2.47 1.06</td>
<td>0.93 1.03</td>
<td>2.73 0.46</td>
<td>-1.56</td>
<td>28</td>
<td>0.13</td>
</tr>
<tr>
<td>Overall</td>
<td>0.16 0.21</td>
<td>1.76 0.64</td>
<td>0.31 0.54</td>
<td>1.75 0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale except question 16, which is on a three point scale.
earned full credit on question 5, which addressed percents smaller than 1%. Partial credit was earned by 47% of the comparison group and 53% of the treatment group. Question 12 addressed percents above 100%; 87% of the comparison group and 80% of the treatment group earned full credit.

Giving further consideration to these questions, question 5 asked students to convert a fraction into a percent, whereas question 12 asked students to turn a percent into a decimal. This information may show students are either more comfortable with percents above 100% than below 1%, or that they are more confident in working with percents than fractions.

**Summary of Content Analysis**

Overall, students performed similarly on most questions as evidenced by the percent of students receiving full credit or partial credit. This analysis has shown that further consideration
Table 32

*Pretest and Posttest Means and Standard Deviations of Questions Using Percents Above 100% and Below 1% by Group*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Comparison</th>
<th></th>
<th>Treatment</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>t</td>
<td>df</td>
<td>p</td>
<td>t</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>SD</td>
<td>$\bar{X}$</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Kristin lost an earring in the hayloft. She has a $\frac{1}{2,000}$ chance of finding it. What is $\frac{1}{2,000}$ as a percent?</td>
<td>0.13</td>
<td>0.52</td>
<td>0.60</td>
<td>0.63</td>
<td>0.07</td>
<td>0.26</td>
<td>0.53</td>
<td>0.62</td>
</tr>
<tr>
<td>12. Scientists say an oak tree is 365% of its original size. What is the decimal equivalent of 365%?</td>
<td>0.13</td>
<td>0.52</td>
<td>1.73</td>
<td>0.70</td>
<td>0.40</td>
<td>0.83</td>
<td>1.67</td>
<td>0.72</td>
</tr>
<tr>
<td>Overall</td>
<td>0.13</td>
<td>0.52</td>
<td>1.17</td>
<td>0.80</td>
<td>0.24</td>
<td>0.23</td>
<td>1.10</td>
<td>0.81</td>
</tr>
</tbody>
</table>

*Note.* Questions are on a two point scale.
Comparison of Mean Scores for Questions Finding Percents Above 100% and Below 1% by Pretest, Posttest, and Group.

Note. Questions are on a two point scale.

should be given to converting decimals to percents, percents to decimals, constructing number lines, and percents smaller than 1% in the iBook.

Analysis of Student Perceptions

In addition to achievement, student perceptions were also a key aspect of this study. In the following section, student perceptions will be reviewed through homework written responses, activity responses, homework perceptions, questionnaires, and focus groups.

Student Perceptions of Homework by Group

Prior to conducting the study, the researcher asked students to give their perceptions of homework. Students were asked the following questions:

1. What has your experience been with math homework?
2. How long does homework typically take you?
3. Do you use any resources when you get stuck? If so, what are they?
4. How difficult do you regularly find homework?

At the conclusion of the study, students were asked to respond to these same questions, but only considering the homework during the study.

**Comparison group perceptions of homework.**

Prior to the study, students had a range of opinions regarding their experience with homework. Although 55% of students found homework easy, 36% of students sometimes found homework easy and other days difficult, and 9% stated homework was pointless. Homework length was typically between ten and twenty minutes prior to the study; if students were stuck, 50% of students often turned to the Internet or their parents.

All questions regarding student perceptions of homework were open-ended. In terms of perceptions about homework during the study, 85% of students stated that homework was good and easy. Length varied some, but 57% of students spent somewhere between ten and twenty minutes on homework. When students became stuck, 38% of students asked their parents for help with study related homework.

**Treatment group perceptions of homework.**

Before the study began, 55% of students in the treatment group stated their experience with homework depended on the topic, ranging anywhere from easy to frustrating, 6% claimed homework was hard, and 39% said homework was easy. Typical homework times matched the comparison group with 71% of students spending between ten to twenty minutes on homework. When these students were stuck on homework problems, 75% of them sought help from parents, the Internet, or the textbook.

During the study, 76% of students stated they generally had a good experience with the math homework. Sixty-two percent of students in the treatment group spent between ten and
twenty minutes on homework, similar to the comparison group. However, 38% of students in the
treatment group spent more than twenty minutes on homework, which was much higher than the
comparison group, showing some students may have spent more time working with features in
the iBook. During the study, when students struggled with homework questions 52% of students
asked parents, or looked at the iBook for help. In terms of difficulty, 52% of students found the
homework easy while 5% found it challenging, with the remainder of students in the middle.

Written Homework Responses by Group

During the study, students were often asked to write a short written response in regards to
the topic they were studying (see Appendix O). Often, the question asked if they understood the
topic, or which method they preferred to solve a problem. In addition to these questions, the
treatment group was asked to give feedback about the iBook as well. Responses were not shared
in class, but given to me so I could review them in private at a later time.

Comparison group homework responses.

Overall, students stated that they understood the content as they were working through
the assignments. The one exception was when working with percents above 100% and below
1%. Responses in this category were mixed, with about half of the students saying they
understood the topic and the other half saying they needed additional support. Having this
feedback allowed me to give students additional practice in this area to further their
understanding during class time.

Other information of interest that arose from the responses included how students liked
solving problems, what they learned, and what was difficult. For example, when working with
fractions larger than one whole, students preferred dividing the numerator by the denominator to
find the decimal equivalent though other options were given. When learning about percents,
most students stated they did not know percents were out of 100 or that percents were related to decimals. Finally, students stated finding common denominators was most difficult when comparing fractions and placing them on a number line. They preferred working with decimals or percents instead.

**Treatment group homework responses.**

Results for the treatment group were similar to the comparison group in terms of understanding the content. Students stated they understood topics as they were completing their homework. Again, results were mixed on percents above 100% and below 1%. Therefore, additional support was given during class to the treatment group as well to aid their understanding.

Interestingly, comments were also similar regarding what students learned, how they solved problems, and what they found difficult. When asked about their preferred method of turning a fraction larger than one whole into a decimal, students in the treatment group had mixed opinions, with about half reporting they preferred dividing the numerator by the denominator while the other half preferred turning the fraction into a mixed number (i.e., \( \frac{12}{5} \) becomes \( 2\frac{2}{5} \) first, then dividing the \( \frac{2}{5} \) and adding the 2 to create a decimal. In learning about percents, students in the treatment group also did not know that percents and decimals were connected. These students also mentioned that they did not know percents could be larger than 100% and smaller than 1%. Lastly, when asked about ordering fractions, the treatment group agreed that finding a common denominator was the most challenging part and that they preferred using decimals and percents.

In terms of the iBook, most comments were positive, though there was one student who continually stated the iBook was not useful and preferred homework assignments prior to this
study. Jayme (All names are pseudonyms), “I like learning on the iBook.” Ginger enjoyed homework on the iBook “because it is fun and interactive,” Ruby said the iBook helped me more “because it’s easier. It’s more impressive professional.” Some of the reasons students liked the iBook included: interactivity, the fact that it showed the steps, it was fun and easy, and convenient. Mike stated I like the iBook “because it tells you games to help.” Jasmine said the iBook “is good to see it on a screen because I am a visual person also it is good at explaining.” When learning percents above 100% and below 1% the iBook helped one student “especially the videos.” Finally, Ginger stated the iBook was useful “because it teaches you.”

**Activity Responses by Activity and Group**

During the course of the study, several activities were conducted in class. These activities were typically in the form of a game and related to the content that had most recently been taught. The goal of these activities was to allow me to determine how well students understood the concepts as they were playing games. After each activity, students were asked to complete written responses for homework regarding their understanding and feelings toward the game.

**War activity by group.**

The first game students were asked to participate in was called War. Pairs of students were given a stack of fractions. They were to divide the cards evenly between themselves, then flip over the first fraction. The person with the larger fraction kept both fractions. If the fractions were equivalent, students would then line three fractions face down and lay a fourth one face up. The student with the larger fraction won all of the cards. At the end, the student with the most cards won.

In the comparison group, 60% of students stated they found it easy to determine which fraction was larger. Twenty percent of students found it difficult because they struggled finding a
common denominator. Sixty percent of students said they found the game easy to play, but 13% said that the directions were initially a bit confusing. Overall, the students stated they felt confident comparing fractions and finding equivalent fractions.

In the treatment group, 60% of students found the game easy, several stating they simplified the fractions then compared them. Twenty percent of students found the game difficult because they had trouble finding common denominators. Again, 60% of students did not find the game difficult, but similar to the comparison group, three were confused at first by the directions. The treatment group overwhelmingly stated they felt confident comparing fractions and finding equivalent fractions.

**Memory activity by group.**

The second game students were asked to participate in was based on the game Memory. In pairs, students were given a stack of cards with fractions on some and decimals on others. They placed the cards face down and then one student would pick two cards. The goal was to find a matching pair, with one being a fraction and the other being a decimal. At the end of the game, the person with the most matches won.

Students in the comparison group largely found this game easy. However, a few students stated that converting mixed numbers or working with uncommon fractions (such as \(\frac{10}{12}\) or \(\frac{17}{23}\)) was a bit difficult. Most students found converting fractions and decimals an easy task and were comfortable converting fractions to decimals and decimals to fractions.

Treatment group students also found this game relatively easy. Again, some students stated difficulties, such as working with uncommon fractions and working with fractions whose denominator would not easily be converted to 100. One student even commented he/she found
the game fun. These students found converting decimals to fractions and fractions to decimals easy.

**Fractional clothesline activity by group.**

The third activity allowed students to work with fractions, decimals, percents, and a number line. In groups of four to five, students were given cards with fractions, decimals, and percents. They were also given tape and a long piece of string. The goal was for students to work as a team to create a number line to place their fractions, decimals, and percents onto.

Students in the comparison group were in agreement that this activity was easy and that they enjoyed working in groups, though one student wished the groups were smaller. The students stated they felt the activity helped them increase their understanding, especially with the location of numbers on the number line and converting fractions, decimals, and percents.

Treatment group students had mixed feelings about the activity. Although 50% of the students found the activity easy, the other half found some aspects easy and others difficult. Again, students enjoyed working in groups with their peers and felt the activity aided their understanding. Overall, students felt the activity helped them gain deeper understanding of converting fractions, decimals, and percents.

**Analysis of Student Perceptions Through Questionnaire Data**

At the conclusion of the study, questionnaires (see Appendix L) were given to all participating students in both the treatment and comparison groups. Both questionnaires asked 15 questions of the students. The first nine questions used a five point Likert scale and the last six were open ended, asking students about the resources they used for homework, amount of time spent on homework, topic difficulty, and mini lesson feedback. Content of the questions was
similar for both groups as much as possible, though a few questions asked directly about the textbook or iBook.

A $t$-test was used to compare the data from the questionnaires. No statistically significant differences were found between the groups. For the Likert scale questions, a mean closer to zero means students felt unfavorably, while a mean closer to five indicates stronger favorable feelings. A mean of 2.5 would mean students were neutral on the topic.

**Conversion of fractions, decimals, and percents by group.**

Table 33 shows the means for the questionnaire regarding student perceptions of how well they learned fraction, decimal, and percent conversions. No statistically significant findings occurred between the groups in this area. However, the results show an average 3.5, which leans toward agree.

Table 33

<table>
<thead>
<tr>
<th>Topic</th>
<th>Comparison</th>
<th>Treatment</th>
<th>$t$</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractions to Decimals and Percents</td>
<td>15 3.67 0.23</td>
<td>15 3.53 0.27</td>
<td>0.37</td>
<td>28</td>
<td>0.71</td>
</tr>
<tr>
<td>Decimals to Fractions and Percents</td>
<td>15 3.93 0.21</td>
<td>15 3.60 0.31</td>
<td>0.90</td>
<td>28</td>
<td>0.37</td>
</tr>
<tr>
<td>Percents to Fractions and Decimals</td>
<td>15 3.67 0.21</td>
<td>15 3.47 0.32</td>
<td>0.52</td>
<td>28</td>
<td>0.61</td>
</tr>
</tbody>
</table>

*Note.* Each topic represents one individual question.

Table 34 displays student perceptions of learning fractions, decimals, and percents with either the textbook (for the comparison group) or the iBook (for the treatment group). Again, there were no statistically significant differences between the groups. However, the results show students in the treatment group found the iBook helped them learn fractions, decimals, and percents as much as the comparison group found the regular textbook helpful.
Table 34

*Questionnaire Means and Standard Deviations Regarding Student Perceptions of Learning Fractions, Decimals and Percents by Group*

<table>
<thead>
<tr>
<th>Topic</th>
<th>Comparison</th>
<th>Treatment</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helped Learn Fractions Decimals and Percents</td>
<td>15 3.73 0.25</td>
<td>15 3.33 0.29</td>
<td>1.05</td>
<td>28</td>
<td>0.30</td>
</tr>
<tr>
<td>Connect Ideas about Fractions, Decimals and Percents</td>
<td>15 3.53 0.24</td>
<td>15 3.20 0.28</td>
<td>0.91</td>
<td>28</td>
<td>0.37</td>
</tr>
<tr>
<td>Understand Fractions, Decimals, and Percents</td>
<td>15 3.73 0.27</td>
<td>15 3.80 0.24</td>
<td>-0.18</td>
<td>28</td>
<td>0.85</td>
</tr>
</tbody>
</table>

*Note.* Each topic represents one individual question.

Table 35 reviews student feelings toward mathematics. There was one statistically significant result. Although there was no difference between groups in terms of mathematical confidence or motivation, convenience was significant. Students in the treatment group found the iBook much more convenient than the comparison group did with the textbook.

Table 35

*Questionnaire Means and Standard Deviations Regarding Student Feelings Toward Mathematics Descriptive Statistics by Group*

<table>
<thead>
<tr>
<th>Topics</th>
<th>Comparison</th>
<th>Treatment</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Confidence in Mathematics</td>
<td>15 3.60 0.24</td>
<td>15 3.33 0.27</td>
<td>0.74</td>
<td>28</td>
<td>0.46</td>
</tr>
<tr>
<td>Motivated me to Learn</td>
<td>15 3.27 0.34</td>
<td>15 3.00 0.28</td>
<td>0.60</td>
<td>28</td>
<td>0.55</td>
</tr>
<tr>
<td>iBook/Textbook more Convenient</td>
<td>15 2.33 0.30</td>
<td>15 3.73 0.36</td>
<td>-2.98</td>
<td>28</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Note.* Each topic represents one individual question.

**Student perceptions of mini lessons by group.**

Six open-ended questions were asked at the end of the questionnaire. Answers in this section were reviewed and categorized to determine overall feelings toward various questions.
Several of these questions addressed mini lessons, which are defined as 15-20 minute increments of instruction providing students with hands-on experience with the content.

*Comparison group open-ended responses.*

When asked if the mini lessons were useful, 60% of the students found them helpful. Several stated the mini lessons made the topics easy to understand and they would not have been able to complete their homework without the lessons. When students were asked which topics were difficult and which were easy, opinions differed by topic. Although five students found converting easy, five also found this difficult. Four students stated that none of the topics were challenging and three stated they all were challenging. Therefore, it was difficult to gauge the topics that students struggled with in the comparison group.

*Treatment group open-ended responses.*

In the treatment group, 60% of the students found the mini lessons useful. Twenty percent of students stated they would have had difficulty with the homework without the lessons. Two students said the lessons were easy to understand. In terms of ease or difficulty with topics, the treatment group opinions were also mixed. Six students found converting fractions, decimals, and percents difficult while four found it easy. Four students found everything challenging while four students found nothing challenging. Therefore, as with the comparison group, it was difficult to determine which areas students struggled with most.

**Analysis of Student Perceptions Through Focus Group Data**

Two 30-minute focus groups were conducted after the study, with six students from the treatment group and another with six students from the comparison group. Students appeared to be at ease with me as I was the interviewer, making jokes and talking amongst their friends,
which led me to believe they would give honest feedback. Questions asked to both groups were similar, with the exception of iBook questions being asked to the treatment group.

**Analysis of comparison group focus group.**

Upon reading the transcript from the interview three times using open coding, two initial topics were discovered, technology and mathematics. When looking at these topics further, I continued to use open coding within each theme to decipher themes in the focus group. Further reading and combing through the transcript provided four more themes. Two of the topics were technology related and two mathematics related (Table 36).

**Table 36**

*Comparison Group Focus Group Themes*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude toward technology</td>
<td>Feelings toward mathematics</td>
</tr>
<tr>
<td>Technology use in school</td>
<td>Feelings regarding mathematics homework</td>
</tr>
</tbody>
</table>

**Technology related themes.**

When speaking about technology with the students, the first theme that arose was their attitude toward technology. Students seemed to be indifferent towards technology. Although three mentioned they were excited about using the iPad at school, five students said they typically used their iPad at school and for homework. Dora (pseudonym’s used for all students) said,

> On the weekends sometimes when I wake up and I don’t feel like going downstairs I’ll use my iPad to watch um like a show in my bed and the only game I play on my iPad is Clash of Clans, but then I use it I like to use Microsoft Word to type like stuff for school, but I use my iPad to do the math homework.
Each student had an array of technology at home with Garrett stating “Well, I got, I got, 3 TVs, uh, 2 uh 3 and a half computers including my dad’s iPad mini it’s kind of a computer. Then, right now, 5 iPads including the schools.” In addition, all students stated they used their personal technology for recreation rather than the iPad.

As we discussed using technology in school, students had mixed feelings, which became the second theme regarding technology. All of the students appreciated the convenience of the iPad in the classroom to quickly look something up or for the apps, but three of the students strongly preferred to use paper to the iPad for their work. Garrett stated “I learned it better on the iPad since since Adobe Reader has become so advanced I put it in microscopic form then expand it afterward when you need it the most.” Karen said, “Yeah, I like the electronic version I just like the paper to write the answers down and do the work.”

When discussing previous homework assignments from the workbook and the assignments uploaded to Edmodo for chapter four, two students stated they preferred the workbook. Two students stated it was difficult to show work on the iPad and took more time than using the traditional paper method. Four of the students did not like reading the problems from the iPad. They struggled with reading from the iPad and transcribing their mathematics procedures to paper. The overall consensus was that students preferred to write their homework on paper rather than the iPad.

*Mathematics related themes.*

The first theme that arose from our focus group regarding mathematics was that students had mixed feelings toward mathematics. Although four students liked mathematics and found it easy, two students stated they sometimes liked math and at other times did not. Four students stated they enjoyed the multiple options for solving problems given by me. They felt this allowed
them to find a method that they were comfortable with to solve problems without frustration. However, three students stated that finding a percent of a number was particularly challenging and one student stated he did not like working with fractions at all; truly, it depended on how much they understood the topic as to whether they liked math or not.

Five of the six students in the focus group stated that mathematics was their favorite subject. Dora commented, “Math is the only subject I like.” Garrett stated, “I like this subject cause there’s uh I’m happy that there’s more than one way to solve a certain question. So that’s what makes me happy and that’s why I like it.” Two of the students said they just found math easy and wished it would be even more challenging.

The second theme surrounded mathematics homework and feelings about mathematics homework. Students all had fairly positive attitudes about mathematics homework. They stated that it typically did not take very long and that they generally enjoyed completing the work. Two said that they struggled with some problems, but used resources when they could not solve a problem. Resources students often used when they struggled with problems included parents, friends, and the Internet. Two students said if they got stuck they asked a parent for help. One student mentioned another student by name that she asks for help when she does not understand. One stated he would look online for help if he found something he did not understand.

When asked about textbook use as a resource, four students said they did not like the textbook. Mark stated he read the textbook and it was confusing, “because it didn’t really show the ways that we did it in class.” Alison said the textbook “had a lot of steps.” Students stated the textbook was confusing and often showed example after example with little text explaining the process. Garrett stated, “This is my thing I think I think that it gave me like a preview of what we were going to be doing in the in like the assignments so it actually helped me a little bit.”
Overall, four students did not like the textbook and found it confusing for them to read and review.

In terms of this chapter, students said the homework was easy. They stated that conversions were simple and they had little trouble with them. Two challenges they encountered were ordering fractions and finding discounts. Alison stated, “Umm I think the beginning part and then it got a little harder when umm we learned like about like the discount and all the dividing and multiplying and stuff like that. But I thought converting was easier.” She said she understood them now, but she needed more practice in class. The student who mentioned ordering fractions said he had trouble finding common denominators and that he could do it, but that it was time consuming.

**Analysis of treatment group focus group.**

After transcribing the focus group I began coding the data using open coding. After reading the transcription through twice, three initial categories emerged. These categories were technology, mathematics, and the iBook. Because much of the data overlapped, I continued to use open coding within each theme to determine sub themes. This allowed me to divide these three larger categories with five smaller themes emerging as I read through the transcription. One theme emerged in technology, two about the iBook, and two about mathematics (Table 37).

Table 37

*Treatment Group Focus Group Themes*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Attitude toward technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technology use in school</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Learning styles</td>
</tr>
<tr>
<td></td>
<td>Difficulties with chapter 4 content</td>
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<tr>
<td>iBook</td>
<td>iBook advantages</td>
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<td>iBook disadvantages</td>
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Technology related themes.

Similar to the comparison group, the theme of attitude toward technology emerged in this focus group. Students in this group had mixed feelings toward technology. Four of the students were excited about using technology, while the other one was indifferent. Janice stated, “Well, like technology is like really confusing.” Students agreed that using the iPad was convenient, but two students still preferred traditional methods of instruction and the use of paper and pencil.

In terms of availability of technology, all students had an array of technology at home. These items ranged from iPods and Kindles to computers and televisions. Four students also had several gaming systems at home. Students in this group typically used their school iPad for schoolwork and their personal devices for recreation. Lilly commented, “But I pretty much like I use, I don’t use the iPad to like play games. Like I use like my phone for pretty much all that I only use the iPad for school.” However, a few who used their own iPads at school used them to play games on at home.

All students agreed that the iPad was a convenient tool. They stated they would sometimes forget their mathematics workbooks at school, but they would never forget their iPad. Gina commented,

I like it cause you don’t waste trees as much cause if you needed to like cause most of what we learn is really homework, but like obviously you couldn’t just print all of that out for everyone that’d be like it was like it was like 7 pages a night for 44 kids I can’t even do that math in my head but it’s a lot.

Lilly chimed in saying,
We are killing trees and I don’t like killing trees. Umm. I like it because it’s like convenient like cause sometimes like I forgot to like bring my math workbook home and like you like bring your iPad home every day.

*Mathematics related themes.*

Two themes emerged relating to mathematics in this focus group. The two themes were learning styles and difficulties related to chapter four content. The first theme emerged as we began to discuss how students felt about mathematics. Three of the students stated they enjoyed mathematics, while two of the students stated they disliked mathematics with Janice stating,

Math is my least favorite subject cause like umm I don’t know it’s just like boring. Some topics in math are actually kind of interesting like fractions to percents, that was my favorite, but like I really didn’t like it in particular.

Students who disliked mathematics said it was often challenging for them, while students who enjoyed mathematics said mathematics came easy to them.

When comparing the iBook to the lessons in class, five students stated they preferred the instruction in class as compared to the instruction in the iBook. Students said they preferred to interact with an instructor to have their questions answered rather than reading from a book. All students said they enjoyed the mini lessons and found them helpful in understanding the content for the chapter. The students stated the iBook was convenient, but that they did not learn anything from reading it.

Students also stated that they preferred using paper to using technology for mathematics. Clara commented, “it’s not like I have any problems like it’s not like that kind of problems I would just personally rather do it on paper.” Similar to the comparison group, students stated they liked to do their work out on paper and found it challenging to complete work on the iPad.
Although they said it was possible to show work on the iPad, five students said it was difficult to write on and more time consuming than paper.

In terms of the second theme, students stated several topics that were challenging for them during this chapter. Some of these topics included converting with fractions, percents above 100% and below 1%, and finding discounts, tax and tips. Students stated that converting with fractions was often challenging for them, but not necessarily difficult. They struggled with the division of the numerator and denominators. Two students said they struggled with percents above 100% and below 1%. Gina said, “Percents that were larger than 100 that was tough,” while Lilly stated, “yeah, percents that were less than 1 was really hard.” They struggled to comprehend something so large or so small. Lastly, students said discounts, tax and percents were difficult because they had to remember whether to add or subtract the discount, tax or percent.

*iBook related themes.*

When reviewing the transcript, advantages and disadvantages of the iBook emerged as themes. When asked, students had mixed reviews of the iBook. They said some things frustrated them, while others were helpful. Therefore, more questions were asked to determine exactly what was useful and what was not useful.

Students stated that while they preferred the workbook, which had been used in previous chapters, to complete their homework, they preferred the problems in the iBook. Lilly stated, “Like I can do it either way, but I would rather do the workbook.” Janice said, “Yeah and like underlining things I like being able to do that and stuff even though you can do that in the iBooks, it’s just a lot easier on paper.” Upon probing further, two students stated they now feel more confident solving word problems because of the problems in the iBook. Clara stated,
Well I do better with word problems than I do with just regular 2 + 2. I had two Apples and two oranges, how many are there. I do better with word problems than with regular just plain old questions. So, that’s why I like the iBook.

Students also stated that they liked several of the features of the iBook. These features included the galleries, text, videos, games, and links to Khan Academy. Lilly said, “Like you can go back if you get confused and stuff.” Lilly also commented, “I just liked your videos that you made.” Although students stated they preferred mini lessons and did not feel they learned from the iBook, they did like the iBook as a resource for homework help. Three students said they liked looking at the galleries with the step-by-step instructions that went along with each step of the problem with Gina stating, “Yeah they were on there and were easy to just get to like that were already on there like the gallery where it went like step by step.” Three students said they enjoyed the videos embedded into the iBook and the videos on Khan Academy. They stated it was convenient to find the video and saved them time from having to find the video on their own. In terms of the text, students stated the text was simple and easy to read, which allowed them to understand the content. Lastly, students enjoyed the game because they reinforced the topics, but in a fun fashion.

Some of the dislikes of the iBook were the glitches and the errors in spelling and with two of the incorrect answers on the review questions. One of the students relayed frustration about how slow the iBook was. Hannah stated, “When I turned the page it would like stop, freeze my screen and then that’s it.” In terms of the errors, four spelling and grammar mistakes were found in the book throughout the study. In addition, two problems had incorrect solutions causing confusion for some of the students. Lastly, all of the students found the iBook was a
great resource, but not something to learn from. They said they did most of their learning in class and that the iBook did not reinforce that knowledge.

**Conclusion**

Overall, students had positive perceptions regarding homework. Across both groups students seemed to enjoy having the freedom to choose their preferred method of solving a problem. In addition, students enjoyed the activities provided throughout the unit. Students responded positively toward instruction. In both groups, some students expressed comfort with using paper and pencil for assignments. However, there were also students who preferred working digitally. In terms of the iBook, treatment group students seemed to respond well to the interactive features. However, they did find several glitches that made using the iBook frustrating at times. As a whole students had positive perceptions toward the unit.
CHAPTER 5: DISCUSSION

In this chapter I discuss the interpretations and implications of the results presented in Chapter 4. To achieve this, I have divided this chapter into five sections. First, I address the research questions from Chapter 1 and how the results from Iteration 3 answered these questions. Second, I discuss the literature review and how the results in Chapter 4 add to the literature base. Third, I provide implications for research and practice. Also, in this section I will discuss implications for curriculum designers and technology designers. Fourth I will discuss some of the limitations regarding this study and the iBook. Fifth, I discuss how this study might be used to guide future research. Finally, I provide some concluding statements.

Achievement, Perceptions and Resources: iBook vs. Comparison

Three research questions guided the design for iteration 3, which was the dissertation study. These questions were:

1) When learning fractions, decimals, and percents, in what ways, if any, do students achieve differently on a unit test when using an interactive iBook for homework as compared to students who have access to the same homework questions in an online static PDF format?

2) What are students’ perceptions of completing homework regarding fractions, decimals, and percents with an interactive iBook compared to students who complete homework in an online static PDF format?
3) In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook and a static PDF online assignment?

These questions are addressed in order and discussed in relation to the results presented in Chapter 4. However, first I will discuss how comparability of instruction across groups was ensured.

**Comparability of Instruction Across Groups**

As mentioned previously, comparable instruction is a key aspect of this study. Several precautions were taken to ensure instruction was similar across groups. Because similar instruction across groups was determined, it allowed achievement and perceptions to be the main focus of this study.

When length of instruction was reviewed, the results showed the comparison group’s average lesson length was 22 minutes and 13 seconds, while the treatment group’s average lesson length was 22 minutes and 48 seconds. In addition, the number of strategies taught per lesson was equal, with the exception of one day when the comparison group asked a question causing them to be introduced to one additional strategy. The number of examples taught per lesson was also equal, with the exception of one class where a specific question was asked by the comparison group causing one additional example to be provided. Overall, the lessons were of similar length and quality, showing students received comparable instruction prior to completing homework.

As stated in Chapter 4, the teacher journal indicated few differences in instruction between the two groups. The notes did state that both groups struggled with percents above 100% and below 1%, which was not surprising based on my previous background knowledge of
teaching this topic. I stated that the comparison group was often more focused than the treatment group during math lessons. Overall, the treatment group was often more talkative than the comparison group. These differences between the concentration level and discussion may have played a part in any minor differences in achievement between the groups.

**Achievement When Using an iBook or Traditional Textbook**

Two data sources were designed to address how student learning compares between traditional textbook reading and static digital PDF homework versus the interactive iBook related homework in Iteration 3: (a) the pretest/posttest design, (b) mini quizzes.

Table 18 in Chapter 4 shows that prior to conducting the study, both groups had a similar mean score on the pretest. The table also shows that the means were similar for the posttest, and both groups made significant gains from the pretest to posttest. However, overall there was no significant difference between the two groups. Figure 12 in Chapter 4 provides the distribution of the scores showing a smaller range of scores and smaller interquartile range for the comparison group than for the treatment group on the posttest. In addition, when looking at gain scores from pretest to posttest between groups, means were similar and no significant differences were found between groups.

When looking at student achievement among the lower 20% of student scores on the pretest, all students improved their scores from pretest to posttest. However, as shown in Table 20 in Chapter 4, one student from the comparison group and one from the treatment groups still failed the posttest (scoring under 60%). In addition, the student who failed the posttest in the treatment group only increased his/her score by 26%, bringing overall achievement to 35% and indicating very little growth. Of the six students who were in the lower 20% in terms of scores on the pretest, two, one from each group, scored above an 80% on the posttest. These data
regarding the lower 20%, in conjunction with the teacher journal and student feedback, provides reason to believe the interactive features in the iBook may not be as useful for all students in terms of aiding them in gaining content knowledge from pretest to posttest. However, it is noteworthy that there were several limitations when designing the iBook that may caused fewer conceptual models to be included in the iBook. These will be discussed further in the limitations section.

Table 21 in Chapter 4 provided information regarding the top 20% of student scores from the pretest. Of the six students who scored the highest on the pretest, five scored above an 80% on the posttest. One student’s score, in the treatment group, only increased three points from pretest to posttest, causing this student be the only student in this group to have lower than a B on the posttest. Given that all of the other students in the top 20% scored much higher on the posttest than the pretest, the student who only slightly improved may be considered an outlier.

When reviewing the items from the posttest by topic, achievement on only one item showed a significant difference between groups. Item 18B asked students to convert 34% a decimal. Students in the comparison group scored significantly higher on this item, with all students receiving full credit. This finding was of interest as a similar question was asked on question 18D. However, on 18D, students were asked to convert 9% to a decimal, which is a more challenging skill. Average scores on this item did go down, compared to 18B, which was expected, but there was no significant difference between the students on this item.

Although achievement on no other items showed a significant difference between scores, there were several items in which students in both groups scored poorly. Specifically, students in both groups showed weakness in constructing number lines with fractions; comparing fractions, decimals, and percents; and working with percents above 100% and below 1%. There was no
significant difference between the groups in these areas, but both groups’ average scores on these items were lower than anticipated. Therefore, further consideration should be given to teaching these topics in future studies.

Of the five mini quizzes given over the course of the unit, the average time spent on the mini quiz for the treatment group was 10 minutes and 47 seconds whereas the comparison group spent 10 minutes and 52 seconds on average, showing similar amounts of time spent on the quizzes. Mean scores between the groups were also similar with the comparison group scoring an average of 73% and the treatment group scoring an average of 72%. T-test results showed no significant differences in achievement between the groups.

Achievement on the mini quiz focusing on percents above 100% and below 1%, in addition to the part of a number mini quiz, was lower than on the other quizzes. This finding is not surprising as both groups struggled with these topics. Also, the findings for percents above 100% and below 1% are consistent with the results from the item analysis of the posttest. Students typically scored lower on this topic across all iterations of this study. This finding is of interest as special consideration was given to this topic when developing the iBook prior to each study. For the first iteration, special videos were designed and recorded for this topic. Prior to the second iteration further development and rerecording of the videos was completed. Before the third iteration, several real-world examples were explained in detail within the iBook text in addition to the videos. Still, students struggled with this topic. Therefore, further consideration of teaching techniques that might enhance comprehension of this topic is necessary, including additional conceptual modeling and potential use of manipulatives as a model.

In conclusion, although there was one significant difference in achievement on a posttest item, no other significant differences were found. Students had comparable instruction, allowing
them equivalent opportunities to learn and providing them the tools to succeed with homework outside of iBook use. The activity level of the treatment group may have influenced achievement as they were less focused than the comparison group.

The one main difference between the groups is that the students who typically excel in mathematics tended to be successful with the iBook. This data aligns with the findings of Mosley and Okamoto (2008) discussed in Chapter 2. Within their study, students who were typically higher achieving in mathematics tended to perform better on rational number tasks than their peers. Therefore, higher achieving students may have the ability for independent study using the iBook as a tool for learning fractions, decimals, and percents.

**Student Perceptions About Homework**

Student perceptions about completing homework related to fractions, decimals, and percents were assessed using three sets of data: (a) homework perceptions, (b) questionnaires, and (c) the focus group.

When reviewing the data concerning homework perceptions, both groups had mixed feelings towards homework prior to the study. Additionally, both groups spent 10-20 minutes on homework prior to the study. Both groups also had similar feelings towards homework during the study, with both finding it a good experience. During the study, over 70% of students in both groups spent from 10-20 minutes on homework depending on the topic.

The comparison group generally had a positive attitude toward mathematics and found homework easy. These students stated they liked being given several methods to solve problems allowing them to choose the method with which they were most confident. In terms of the textbook, the students stated it was confusing and they did not use it much because of the language and examples, which caused them to struggle. The treatment group tended to agree that
they preferred an instructor to the iBook. Although they found the iBook useful, they preferred to use it as a resource and be taught material by an instructor in class so they could ask questions as necessary.

Overall, both groups had positive feelings toward homework during the study. Length of homework time was similar, showing that both groups had some students who took longer to complete homework while others took less time. This finding was unexpected because the treatment group had many resources available to them within the iBook, whereas the comparison group only had the textbook and the static digital PDF. It was hypothesized that students in the treatment group would spend more time on homework because they would use the interactive features within the iBook, such as the games and videos, which would cause homework to take more time.

The questionnaire data showed no significant differences between groups in terms of their confidence and understanding of fractions, decimals, and percents. Table 33 in Chapter 4 shows how students perceived their conversion skills. Averages across groups showed students agreed they understood how to convert fractions, decimals, and percents.

Table 34 in Chapter 4 shows student perceptions of learning fractions, decimals, and percents. Students in both groups overall agreed the textbook/static digital PDF homework or the interactive iBook, depending on the group, helped them increase their knowledge and understanding of fractions, decimals, and percents. Likewise, Table 35 in Chapter 4 shows students’ feelings toward mathematics. A significant difference in perceptions was found on only one of the three items. Students in the treatment group found the iBook convenient, whereas students in the comparison group did not find the textbook very convenient. When asked further in the focus group, several comparison group students admitted they did not read the textbook at
all because it caused increased confusion. These students further stated that they found the examples in the textbook difficult to understand in addition to the language used to explain concepts.

When reviewing the data from the open-ended questions, the results were similar between groups. Both groups stated they used parents and the Internet to help with homework, although two students from the treatment group stated they used the iBook to help with homework. When asked, some treatment group students stated they read the iBook and returned to the iBook for assistance if they became stuck on a problem. In contrast, comparison group students did not use the textbook for assistance, but rather friends or family.

Students all agreed they liked the mini lessons (which are defined as 15-20 minute increments of instruction providing students with hands-on experience with the content). These lessons were useful to help them complete their homework and understand the content. There were some differences between students within and across groups in terms of difficult topics in the chapter. In addition to percents above 100% and below 1%, students also stated they struggled with fractions with uncommon denominators. In Chapter 2, a study conducted by Clark and Roche (2009), was reviewed. One of the findings from this study was that students struggled with fractions with uncommon denominators. According to Clark and Roche (2009) this indicates that students are still relying on whole number reasoning. Therefore, more conceptual modeling may be necessary when learning about fractions.

Overall, students seemed to have similar feelings about their homework experiences. Both groups had positive responses and stated they found the activities and mini lessons useful in learning the content. Across groups, students stated they struggled with various topics, but it truly seemed to depend on the child as to which topics were difficult.
The results from the focus group showed 90% of students had access to a tremendous amount of technology outside of school. This may have allowed for less excitement about the iBook because these students were already experienced with technology. Students in the comparison group stated they preferred the workbook to completing their homework from the iPad with the static digital PDF version of homework on Edmodo. They found it difficult to transfer from the iPad to paper; although they could write answers on the iPad using Adobe Reader, they preferred to work out answers on paper. Treatment group students were more conscious about the environment, but still preferred to work on paper to the iPad.

In addition to feeling it was easier to complete homework on paper, several of the students stated that the workbook driven homework was easier than the homework provided during this study. Prior to conducting this study, students were given workbook driven homework. Most of the problems within the workbook were procedurally driven, whereas the questions posed during this study were more thought provoking and therefore, more challenging requiring more consideration. This finding aligns to the work of Weiman and Arbaugh (2014) who suggest students prefer homework with very little meaning that does not require them to engage in truly thinking.

In terms of the iBook, overall the treatment group had a positive reaction. They enjoyed the interactive features available. One student stated she found the galleries helpful because they walked her through solving problems with pictures and words in addition to including pictures to increase conceptual understanding. Another student claimed the embedded videos were extremely helpful when learning about percents above 100% and below 1%. She stated being able to watch the videos several times, pause, and rewind them was useful. Two students liked the review feature because it allowed them to see how well they understood the topic. Students
did suggest adding feedback to the iBook if an incorrect answer was chosen to help the learner determine what they might have done wrong.

Overall, student perceptions across groups were positive. Students in the comparison group found the homework, activities, and lessons useful. However, they did not find the textbook useful as it was confusing and the examples did not always align with what was taught in class. Students in the treatment group also found the homework, activities, and lessons useful. In addition, these students found the iBook useful as a resource.

Given that the treatment group had so many resources accessible to them, it causes one to wonder if they did not ask as many questions because they had so many resources available. It is possible these students felt they could go back to the iBook at any time for help and therefore were not as concerned during class whether they understood as well. Because the comparison group did not have the resources the treatment group did, maybe they were more engaged with the lesson to ensure they understood the content prior to going home and completing homework.

**Student Achievement on Homework**

Question 3 considers whether students achieve differently on homework when given an interactive iBook as opposed to static digital PDF for homework. This question was addressed through four types of data: (a) homework accuracy, (b) homework responses, (c) number of homework problems reviewed, and (d) amount of time spent checking homework.

In terms of homework accuracy, the treatment group scored an average of 75% whereas the comparison group scored an average of 74%. The differences in accuracy were not significant on any assignment. However, students in both groups did tend to struggle with percents above 100% and below 1%.
When reviewing comments about homework between groups, the comments were similar. Both groups stated that working with percents above 100% and below 1% was challenging. This again is consistent with findings from the posttest and mini quizzes, showing further considerations regarding teaching methods of this topic are necessary. Although students mentioned other topics they struggled with, percents above 100% and below 1% was mentioned by more than half of the students asked.

When considering the time spent checking homework, the comparison group spent an average of 11 minutes and 12 seconds daily, while the average for the treatment group was 7 minutes and 9 seconds. Over the course of the unit, this was an additional 20 minutes spent reviewing homework with the comparison group over the treatment group. Additionally, the results from Chapter 4 show the comparison group asked an average of 4 questions about homework each time homework was reviewed, while the treatment group asked an average of 3.2 questions.

One of the reasons for the difference in number of questions asked may have been because students with the iBook had access to the solutions from the review feature, whereas students in the comparison group were just asked to answer a multiple choice question. Often the numbers used in these problems were a more challenging. Therefore, I was regularly asked about the review questions from the comparison group but not the treatment group, which would account for the additional time spent reviewing homework with the comparison group. In addition, the treatment group students may have been able to spend more time determining why a multiple-choice answer was correct while completing homework because they were provided with the solutions whereas the comparison group did not know the answer until class.
Consequently, students in the treatment group may not have needed as much review time because they had the iBook to aid them while completing homework or to review later on.

Research Implications

In the previous section, I interpreted the results presented in Chapter 4 of Iteration 3 of my study in conjunction with the three research questions. During Chapter 2, I focused on four main areas of research: homework, technology integration, e-books, and motivation. In the next section, I use the interpretations of the results from Iteration 3 and discuss their implications related to the research provided in Chapter 2.

Homework Effectiveness in Mathematics in Relation to the iBook

According to Minotti (2005), homework effectiveness has been a topic of debate between educators, politicians, parents and students, but positive effects of homework have been shown for middle grades students. Although homework assignments began when rote memorizations dominated teaching (Weiman & Arbaugh, 2014), studies have shown a positive effect on academic achievement (Kackar et al., 2011). Therefore, homework was a key aspect of this study.

Typically homework is often used to review topics taught in class and does not require much thought from the student (Weiman & Arbaugh, 2014). However, according to Minotti (2005) homework can require more of students than rote review of content. Within this study, homework was a mix of typical computation questions and higher level thinking questions. The reasoning behind this was to ensure students understood how to complete various computations, but also to increase students’ engagement with the mathematics.

Most of the computation questions from the homework were written within a real-world context to increase student understanding of how fractions, decimals, and percents might be used
in the real-world. These questions often asked students to convert fractions to decimals, or decimals to percents. However, giving them a real-world context allowed students to consider the real-world implications of the mathematics.

In addition to the computation problems, students were presented with higher order thinking problems. Some problems asked students to explain how to solve a problem to a classmate. Others asked students to determine an error or give a visual representation of a problem. Students were also asked to report how well they understood a topic and whether they needed additional support. Therefore, the homework assignments were atypical in the sense that questions beyond computation were asked.

In terms of time spent on homework, Zhu and Leung (2011) found that 44% of students in middle and high school spend about fifteen to thirty minutes per night on mathematics homework. When asked, students spent a similar amount of time on their homework, with the range being closer to 10-20 minutes. Therefore, although more challenging questions may have been asked, students still spent a similar amount of time on homework as in other studies.

Using technology for homework is still a relatively new concept. However, according to Kitsantas et al. (2011), additional resources such as the Internet can increase student achievement. Within this study, all students had access to the Internet. However, only one group had access to the iBook. Although homework results were similar between groups, the students in the iBook group stated that the iBook was a useful resource. They also stated that having the iBook saved time because they did not have to search for the content, which allowed them to spend more time focusing on the assignment.

Some of the students stated they liked the immediate feedback from the review feature within the iBook. The positive response to immediate feedback aligns with results from Leong
(2013) who stated that immediate feedback improves self-efficacy. Although the students enjoyed the immediate feedback, they did state they would have liked guided feedback rather than just knowing whether the answer was correct or incorrect. Some students indicated that, while they knew the solution was incorrect, they did not know why and therefore would have liked more feedback from the iBook as to why the solution was incorrect or where they might have made an error.

Lastly, the results of this study align with the results of Hauk et al. (2014) who conducted a similar study looking at online algebra homework versus traditional algebra homework with undergraduate students. In their study, Hauk et al. (2014) found no significant differences between the groups, but like the current study, found students in both groups had similar achievement.

**Technology Integration in Regards to the iBook**

Currently, part of being a teacher includes preparing students for the digital world they will encounter as they enter the work force (Steinweg et al., 2010). However, there is still much debate about whether technology integration supports instruction. As mentioned in Chapter 2, the Clark and Kozma debate continues today with Clark’s belief that media is merely a vehicle to provide information and Kozma’s belief that media can make a difference in learning. Results from this study tend to indicate that Clark’s argument is correct. However, one must consider the limitations of the technology; if these limitations had been removed, there might have been differences in terms of technology use favoring Kozma’s beliefs. More consideration of this concept will be presented in the limitations section.

Although no significant difference was found in achievement between the groups in this study, an interesting correlation was noticed regarding students who typically do well in
mathematics and students who typically struggle in mathematics. In this study and in the previous iterations students who typically underperform in mathematics (typically scoring below 65% on math tests) tended to struggle more with the digital homework than the students who typically excel in mathematics (typically scoring above an 85% on tests). Students who are more adept in mathematics found the iBook useful as a resource and were able to follow the graphics and text to complete assignments as they had in previous iterations. Underperforming mathematics students stated they continued to struggle with the content even with the graphics and support from the iBook and overall preferred interaction with an instructor.

These differences in achievement may be linked to mathematics self-efficacy. Results from Kitsantas et al. (2011) showed a high correlation between mathematics self-efficacy and mathematics achievement. In addition, Bembenutty (2009) states that students who engage in self-regulation are often higher achieving, which allows these students to work through challenging problems and complete assignments. Therefore, students with higher mathematics self-efficacy might be more willing to work through difficult problems and review the text for support, whereas students with low mathematics self-efficacy may be more willing to say they do not understand and ask a teacher the following day.

One might also consider that students who are not adept with technology might struggle more with the technology. However, in this study, all students had regular access to technology. Therefore, comfort with technology was not considered as a limitation for students. During the focus group and on the questionnaires, it was clear all students involved in the study had regular access to technology even without the school provided iPad. Not only does this support comfort with technology, but it also shows students were less likely to excel with the iBook because of the novelty.
In terms of the development of the iBook, suggestions from Alessi and Trollip (2001) were considered. As noted in Chapter 2, Alessi and Trollip suggest graphics, videos, and clear text are needed features in an iBook. During the design of the iBook, many graphics were included; previously created videos, newly developed videos, and simple language were used. When asked, students found the language simple in the iBook and easy to read, allowing them greater understanding of the content. In comparison with the textbook, it seemed that the iBook was written in a manner that allowed students to grasp the content, while many students in the comparison group complained that the textbook was rather confusing to read.

Students in the comparison group also stated the graphics in the textbook were difficult to follow. Treatment group students stated they enjoyed the step-by-step graphics in the iBook and found them useful in solving problems. Comparison group students did not have access to videos, but students in the treatment group stated the videos included in the iBook were useful. Therefore, when digital books are designed using the recommendations of experts, the digital text can be at least as useful as a traditional textbook.

**E-books and iBooks for Learning**

Because iBooks are relatively new, little research is available on their use for educational purposes. Therefore, research was conducted on e-books, which are digital books, as they continue to replace written text (Taylor, 2012). The main difference between an e-book and an iBook is interactivity. Although both are digital texts, the iBook allows readers to interact with the text through galleries, reviews, videos and links to outside games and websites, whereas e-books often do not.

According to Woody et al. (2010), e-books are often not used for educational purposes, but rather for reading for enjoyment. Therefore, although students are comfortable using e-
books, they are not used to using e-books for educational purposes. This was clear in the current study as many students stated they preferred using paper to the iBook. Even students in the comparison group stated they preferred a paper version of homework to the online static PDF document provided to them on Edmodo. Therefore, although students are comfortable using technology in daily life, students may currently be less comfortable using technology for educational purposes.

Similar to Lee et al. (2013), there was difficulty downloading the iBook to the iPad. Due to the bandwidth and amount of people using the Internet during the day, I could only download four to five iBooks per day during lunchtime when Internet use was less than other times of the day. This caused difficulty in ensuring all students had the iBook on time for instruction. Although these difficulties ensued, all students were provided a copy of the iBook before the study began.

When learning to use the iBook, students struggled at first similar to the finding of Robledo (2013). An entire class period was devoted to showing students how to navigate the iBook, including the table of contents, glossary, websites, galleries, and embedded links. Even with this class time, some students still needed additional support for the next few days. However, after the initial few days, students became more comfortable with the iBook and were able to complete the assignments with less difficulty. Given this information, it might be useful to introduce the iBook earlier in the year to students to allow them time to adjust to the differences prior to being required to use it for homework. Also, if the iBook were to be used for a longer period of time, such as a semester or year, students may have become more comfortable with the features and used them more often.
In terms of attitude, student attitudes varied in regard to the iBook. Some students found the iBook useful and enjoyed reading it, while others stated they preferred a teacher and traditional homework assignments. These results are critical as there is little research available on middle grade student attitudes towards digital books. However, it is noteworthy that if some of the limitations in developing the iBook were removed students may have had a different experience with the iBook. This will be discussed more in the limitations section.

As noted in Chapter 2 young elementary students enjoy reading e-books (Ciampa, 2012), but undergraduate students prefer traditional textbooks to e-books (Huang et al., 2012). It is unclear whether this is a generational gap or an age difference as current undergraduates grew up with technology, but not to the extent of current elementary school students. Therefore, as digital natives progress through school there may be more acceptance of digital textbooks.

**Motivation in Relation to iBook Use**

As mentioned in Chapter 2, students often become less motivated to learn as they progress through the K-12 system (Bobis et al., 2011; Raufelder et al., 2013a). However, research does state that technology can improve attitude and achievement when used pedagogically and with appropriate curriculum design (Chapman et al., 2010). Therefore, this study looked at student attitudes toward technology.

When asked about perceptions of the iBook, student feelings were mixed. About half the students stated they enjoyed using the iBook while the other half preferred teacher instruction and traditional homework. Overall, students found the iBook useful, but 90% preferred traditional homework rather than the iBook homework. When asked, most students stated they preferred working on paper alone rather than working between a tablet and paper. In the focus
group, two students complained of glitches, but the glitches they reported typically had to do with the speed of pages loading, which is out of the control of the author.

According to Ross and Bergin (2011), students put more effort toward their homework when it is of the proper level of difficulty. When designing the iBook, the goal was to provide students with problems that were more challenging than typical homework, but still within the ability level of the student. Within this study, that goal was achieved. However, it is unclear whether students put forth more effort than they normally might with the assignments. Ninety percent of students, when asked, said they preferred the traditional workbook driven homework that was computation based (workbook homework was given prior to the study) because it was easier. Although they did not report this, they implied that they preferred computation based problems because they took less time and effort, minimizing homework time and intellectual effort.

One student in particular was motivated by the games included in the iBook. This result aligns with the research of Riconscente (2013) who studied whether Math in Motion would improve students’ comprehension and self-efficacy. The student who enjoyed the games struggles in mathematics and emphatically stated he found the games useful. He alluded to the fact that the games motivated him and increased his understanding of the content. This finding suggests that students who are inclined towards video games may find the games embedded into the iBook of use for additional practice. In addition, it is noteworthy that the comparison group students were more interested in video games than the treatment group. Therefore, it is possible that the comparison group may have preferred some of the features in the iBook more than the treatment group.
Implications for Practice

The previous section of this paper was meant to address researchers and research issues reported in this study. In this section, research implications from this study are the focus in terms of educational applications and how practicing teachers might use the results from this study in their own schools.

As mentioned previously, digital textbooks are relatively new in the classroom. Although research has shown success with elementary students improving their reading skills through the use of digital textbooks, little research has been conducted in the middle grades, especially in mathematics. Therefore, this study has addressed how digital textbooks might be used in middle grades mathematics courses. Results from this study have shown that there is no difference in student achievement between groups when one group completes a static PDF version of homework while the other group completes interactive iBook homework. At this time, further research is still necessary to determine if digital books can enhance learning through additional modifications to be discussed later in this chapter.

According to the research of Kitsantas et al. (2011), increased homework has been found to be more beneficial for lower-achieving students than higher-achieving students. However, if these lower-achieving students do not understand the content, homework may not benefit them. Due to a lack of self-efficacy, these students will be more likely to give up if they do not understand an assignment (Bembenutty, 2011). A solution to this problem might be to spend more time building conceptual knowledge with these students in the classroom. However, often teachers are unable to spend as much time with these students as they would like due to time constraints and the number of students in a classroom.
With this in mind, the iBook may be a viable option to provide teachers with time to support lower-achieving students. In this study and the previous iterations, students who typically excel in mathematics (typically scoring at least an 85% on tests) have been successful with the iBook. Therefore, this might be an opportunity to allow these advanced students more freedom in their learning, thus permitting teachers more time to work with struggling students. The iBook could be provided to higher-achieving students as an independent study tool with the teacher as a resource. Then, the teacher would have the ability to work with smaller groups of students to enhance their comprehension of rational numbers.

In addition, as a result of this study, practitioners may also consider modifications to homework. During this study, problems beyond computation were provided to the students. Although some were more difficult than others, they allowed students to think critically about the mathematics rather than completing computation based problems. When problems are set in a real-world context, students are more likely to make connections with the real-world application of the mathematics. In addition, providing students with opportunities to ponder mathematics or explain solutions may increase their comprehension without spending additional time on homework or working to a frustration level.

**Implications for Curriculum and Technology Developers**

In the previous section, I addressed how practicing teachers might use the iBook in their classroom. This section will address curriculum developers and technology developers to discuss some of the issues I discovered as I developed my iBook and how they might be modified.

Mendicino et al. (2013), discussed in Chapter 2, conducted a study with fifth grade students using a technology called ASSISTment. During the study, the comparison group was given worksheet homework, while the treatment group was given homework using ASSISTment.
The results of this study showed the students provided with digital homework performed significantly better on the posttest. Given that the design of this study was similar to the current study, one might think the results would be similar as well.

However, there were some key differences between the studies. ASSISTment, while a digital tool, provides leveled problems for students. Therefore, if a student correctly solves a problem the problems will become more difficult. If the student incorrectly solves a problem, the problems will become slightly easier. In addition, when students solve a problem incorrectly, they are prompted with information regarding why they might have gotten the problem incorrect and offered additional support through tutoring. Once students grasp what they did incorrectly, the problems become more challenging again. ASSISTment also provides feedback in detailed reports to the teacher regarding student progress.

These two features are both unavailable in the iBook. Although the review feature allows students to monitor their own progress, it does not allow additional feedback for students. This additional support would be useful as students work through assignments so they can determine their error immediately rather than continuing to work through problems using an incorrect method. In terms of teacher feedback, setting up the review feature to email results to the teacher would be a useful tool. In addition, number of tries to correctly identify the answer and time spent on each question would be useful information.

In a study conducted by Leong (2013), discussed in Chapter 2, students were provided with digital homework in a college math course. The results showed students had positive feedback regarding the digital homework, especially lower-achieving students. These students noted they liked the step-by-step solutions provided when they answered a question incorrectly.
In addition, they enjoyed the instant feedback to determine if they were solving problems correctly.

Although the galleries are useful to provide step-by-step solutions to problems in the iBook, the iBook does not include a feature to allow step-by-step solutions in the review. Therefore, once again, this would be a truly useful tool for students, especially lower-achieving students to aid them in learning as they progress through their homework. Again, this would be a useful place for emailed teacher feedback as well to show if these students are progressing or if they need more teacher assistance.

**Limitations**

Although this was the third iteration of this study, it still had its own unique characteristics. In the two pilot studies, no comparison group was included. In this third iteration, a comparison group was included in addition to the modifications made from the previous iterations such as an updated iBook, updated questionnaire, and updated lesson plans.

During this study, I was not only the teacher, but was also the researcher. Considerable thought was given to ensure students participating in the study did not receive special treatment to enhance results, but it is still possible some implicit differences occurred. Further, I was the only person interpreting the focus group data, so, I may have interpreted the data differently than another researcher, especially because I had a relationship with the students.

In addition, the study had a small sample of 30 students. Due to the small size of the sample, the power was very small, which influences its generalizability. Therefore, future studies are necessary with a larger sample size to determine if the results are conclusive. This study can be considered a baseline study showing no difference between students who receive static digital PDF homework and students who receive interactive iBooks homework.
The demographics of these students may also be considered a limitation for the study. Being enrolled in a small charter school, often parents are more involved with students’ academics. Therefore, students enrolled in this study may be more academically inclined than students of other demographics, causing the achievement gains potentially to be higher than the results might be at other schools.

Students enrolled in this charter school may also have had more access to technology than students at other schools. Each student in the school chosen for this study was supplied with an iPad. Smartboards are in each classroom and all teachers have an Apple TV in addition to an iPad. Therefore, technology is abundant in this setting, more than it might be in other schools. Because of the location of the school, most families were affluent and had a number of technology related devices at home for regular use allowing students to be technologically proficient.

It is also important to consider that the data are self-reported. Students may have had a tendency to claim they are more or less enthusiastic about the iBook than they truly are due to reporting data to their teacher. Familiarity with the iPad is something else to consider. Although all students were provided with an iPad, this may have been the first year some students had access to an iPad full-time. Though many children now have an iPad or tablet at home, some children do not and may have been at a disadvantage and the novelty for others may have quickly worn off.

Being unable to copy the homework for the comparison group was another limitation. Although I was able to find a way around copying homework through the use of a static PDF on Edmodo, it was not ideal as the original goal was to compare digital homework to paper based
homework. This last minute change caused unforeseen modifications to the study; although students were familiar with the static online homework, it was a drawback for the study.

In terms of the iBook, the platform constraints caused several limitations in design, some that have already been mentioned in previous sections. As the design developed over the previous two iterations, I realized including more conceptual learning was key. One feature that would have been useful in the iBook would have been a drag and drop feature. For example, having a hundreds chart that allowed students to fill it in to create a visual model of fractions, decimals, and percents would have been useful. This would have allowed students to develop deeper understanding of the connections between rational numbers. In addition, if this feature had been available, it would have been an active adaption and constructive adaptation according to the Technology Integration Matrix (Florida Center for Instructional Technology, 2013).

Another constraint of the iBook was animated graphics. The inclusion of some animation or cartoons to ask questions of the students would have made the iBook more interactive and engaging. In addition, this would have incorporated additional active adaptation according to the Technology Integration Matrix (Florida Center for Instructional Technology, 2013).

Many of the features I have discussed that would be of use in the iBook would increase the technology integration into the curriculum allowing the technology application to move closer to the transformation end of the matrix. In addition, if these tools had been available, it is possible the results might have been different, enhancing Kozma’s (1994) belief that media can make a difference on learning.

**Directions for Future Research**

Just as this research has answered several questions, it has also generated several more to be addressed in future research. Here, I discuss the questions this study has generated and how
they might be addressed in future studies. The first area to be considered is the sample size of the group in this study. Because the sample size for this study was so small, its goal was to ensure using an iBook would cause no harm. This study has shown there is no difference in achievement between students who use an interactive iBook for homework and students who use a static digital PDF of homework. Therefore, I recommend conducting a larger scale study to determine whether the iBook would increase learning with a larger sample of the population, including participants who do not have regular access to technology. Some key research questions for this study might be:

1. When learning fractions, decimals, and percents, in what ways do students achieve differently on a unit test when using an interactive iBook for homework as compared to traditional textbook and worksheet homework?

2. What are students’ perceptions of learning fractions, decimals, and percents with an interactive iBook compared to traditional instruction?

3. In what ways does students’ achievement on homework differ when completing homework related to fractions, decimals, and percents from an interactive iBook compared to traditional textbook and worksheet homework?

4. What aspects of the iBook do students enjoy, what aspects do they dislike, and what recommendations for improvement?

5. In what ways, if any, do student perceptions change in regard to the iBook when they do not have regular access to technology?

These questions are a continuation of Iteration 3 with the addition of student opinions regarding improvement for the iBook and looking at whether access to technology affects student perceptions of the iBook and achievement. Within the context of this study, it may be of
value to consider the length of the study and conducting the study for a longer period of time to determine whether length of use has an effect on student achievement, use of interactive elements, and/or student perceptions.

A second area in need of further research is the development of the iBook. The results of this study clearly show students had interest in the iBook, but there were several aspects in need of modification. For example, students requested additional feedback for review questions to explain why answers were incorrect and the option to include more conceptual modeling through features such as a drag and drop option. Also, as the iBook was developed, the reviewers requested modifications that the author was unable to make due to confines of the iBooks Author software. Therefore, further research should be conducted on software to include more interactive features and additional feedback on review questions to increase conceptual understanding.

A third avenue of research to be conducted is to look deeper into the differences between students who typically perform well in mathematics (scoring above 85% on tests) and students who typically struggle in mathematics (scoring below 65% on tests). During the three iterations of this study, students who typically excel in mathematics tended to perform better with the iBook than students who typically struggle with mathematics. Therefore, research is necessary to determine if this finding is consistent in a larger scale study with other teachers involved or whether the findings are valid only for this study. If students who typically excel in mathematics are more successful with the iBook, this could open avenues for teachers to support these students through technology while working in smaller groups with students who need additional support to increase mathematical achievement.
One other area of research this study has prompted relates to motivation. Further research is necessary to determine how different students are affected by the iBook. It is unclear whether motivation increases for students who typically perform well in mathematics. In addition, because the students in this study had regular access to technology, they may not have been as motivated as students who do not have regular access to technology. Research in this area could increase understanding of motivation in light of technology to determine the best method of incorporating technology into the classroom for increased achievement.

**Conclusion**

The purpose of this study was to determine if, when instruction is held constant as much as possible, Grade 6 students’ understanding of rational numbers would be increased through using interactive iBooks for homework rather than static digital PDF oriented homework. A secondary purpose of this study was to determine student perceptions of learning fractions, decimals, and percents with an interactive iBook and whether students feel learning from technology through the use of iBooks enhanced their learning.

My conceptual framework was modified from the work of Shapley et al. (2011), which sought to determine whether enhancing the curriculum with technology would improve achievement in middle grades students, and the Technology Integration Matrix (2013) which focuses on assisting teachers with technology integration in the classroom. Throughout the three iterations, modifications were made to improve the iBook, pre and posttest, lessons, and instruction. The results of this study show no difference between the treatment and comparison groups.

As mentioned in Chapter 1, technology has drastically influenced our lives over the past decade (Barak & Ziv, 2013). We have gone from a society of dial up Internet and encyclopedias
to researching online and mobile devices in the hand of each man, woman, and child. It is clear continued research is necessary in the technology arena, but the current study is a starting inquiry into interactive digital books in the classroom. Therefore, further research should be conducted to determine how digital texts could begin to improve academic achievement. Within this study, the iBooks Author software created many confines, which deterred the researcher from making modifications necessary. However, with further research and understanding of how to develop digital books, increased academic achievement may be possible.
REFERENCES


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[http://www.nctm.org](http://www.nctm.org)


APPENDICIES
## Appendix A

### Technology Integration Matrix

<table>
<thead>
<tr>
<th>Entry: The teacher begins to use technology tools to deliver instruction to students.</th>
<th>Adoption: The teacher directs students in the conventional use of technology tools.</th>
<th>Adaptation: The teacher facilitates students in exploring and independently using technology tools.</th>
<th>Infusion: The teacher provides the learning context and the students choose the technology tools to achieve the outcome.</th>
<th>Transformation: The teacher encourages the innovative use of technology tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active:</strong> Students are actively engaged in using technology as a tool rather than passively receiving information from technology.</td>
<td>Information is passively received</td>
<td>Conventional, procedural use of tools</td>
<td>Conventional independent use of tools; some student choice and exploration</td>
<td>Choice of tools and regular, self-directed use</td>
</tr>
<tr>
<td><strong>Collaborative:</strong> Students use technology tools to collaborate with rather than working individually</td>
<td>Individual student use of tools</td>
<td>Collaborative use of tools in conventional ways</td>
<td>Collaborative use of tools; some student choice and exploration</td>
<td>Choice of tools and regular use for collaboration</td>
</tr>
<tr>
<td><strong>Constructive:</strong> Students use technology to connect new information to their prior knowledge rather than to passively receive information</td>
<td>Information delivered to students</td>
<td>Guided, conventional use for building knowledge</td>
<td>Independent use for building knowledge; some student choice and exploration</td>
<td>Choice and regular use for building knowledge</td>
</tr>
<tr>
<td><strong>Authentic:</strong> Students use technology tools to link learning activities to the world beyond the instructional setting rather than working on decontextualized assignments.</td>
<td>Use unrelated to the world outside of instructional setting</td>
<td>Guided use in activities with some meaningful context</td>
<td>Independent use in activities connected to students’ lives; some student choice and exploration</td>
<td>Choice of tools and regular use in meaningful activities</td>
</tr>
</tbody>
</table>

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Appendix B
iBook Graphics

Interactive 2.1 Khan Academy


For more help, please visit this website.

Review 1.1 Equivalent Fractions

Question 1 of 4
Which of the following is not equivalent to \( \frac{10}{12} \)

- A. \( \frac{20}{24} \)
- B. \( \frac{5}{8} \)
- C. \( \frac{30}{36} \)
- D. \( \frac{5}{6} \)

Check Answer
Equivalent Fractions and Decimals

**Objectives:**
You will:
1. Review how to find equivalent fractions
2. Learn how fractions and decimals are similar

**Standards:**
1. Work flexibly with fractions, decimals, and percents to solve problems
2. Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers
3. Develop and analyze algorithms for computing with fractions, decimals, and integers and develop fluency in their use

**Key Terms**
1. Fraction: Part of a whole. A number written with the bottom part (the denominator) telling you how many parts the whole is divided into, and the top part (the numerator) telling how many you have.
2. Decimal: A part of a whole. Another form of writing a fraction.
3. Equivalent Fractions: Fractions which have the same value, even though their numerators and denominators are different.

Fractions:
Fractions are part of a whole. If you were to cut 1/2 of a pie, the fraction would visually be represented as:

If you ate 2/4 of the pie, the fraction would be represented as:

Though the fractions are different, they look the same. Therefore, 1/2 = 2/4, but why?

What do we do with percents greater than 100%?

**Objectives:**
You will:
1. Understand what a percent larger than 100% looks like
2. Learn how to work with percents larger than 100%

**Standards:**
1. Work flexibly with fractions, decimals, and percents to solve problems
2. Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers
3. Develop and analyze algorithms for computing with fractions, decimals, and integers and develop fluency in their use
4. Develop meaning for percents greater than 100 and less than one

**Key Terms**
1. Percent: A ratio that compares a number to 100.
2. Ratio: A ratio shows the relative size of two or more values.
   Ratios can be shown in different ways. Examples 2:3, 1/3, 1 to 3.

Percents larger than 100% can look overwhelming, but let's think about them in context. Let's say you are the buyer for Target. You're in charge of purchasing light bulbs and you've purchased each light bulb for $4. However, Target needs to make a 50% profit on each light bulb they sell. How much will they sell the light bulb for?

Let's consider this:
Purchase Price: $4, which is equivalent to 100% of the cost. If you want to make a 50% profit then you would need to add 1/2 of the sale price onto the purchase price.

Half of the purchase price is $2. Therefore, you would have a purchase price of $4 and an additional $2 to make a 50% profit. This would make the cost of the light bulb at Target $5. When considering this as a percent, Target is selling the light bulb for 150% of its purchase price because the 100% is what purchase for was $4. Then, we added $2 because $2 is 50% of the purchase price. When we added the $4 and $2 we get $6. Therefore, when we add 100% and 50%, we get 150%.
Appendix C
iBook Evaluation Tool

iBook Evaluation Tool
Adapted from Sealy Evaluation Tool

Part I-
Directions: Please answer all items regarding the 6th grade iBook as a supplemental unit for homework to teach Fractions, Decimals, and Percents using the following scale:
SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree, C= No Comment

Section 1- iBook Design and Content
Please rate the iBook based on the Design Standards using the following scale:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The iBook is well organized, flows logically and is easy to navigate.</td>
</tr>
<tr>
<td>1.2</td>
<td>The iBook graphics are appropriate and contribute to the learning experience.</td>
</tr>
<tr>
<td>1.3</td>
<td>The websites included in the iBook are appropriate and contribute to the learning experience.</td>
</tr>
<tr>
<td>1.4</td>
<td>The iBook reviews at the end of each lesson are appropriate and contribute to the learning experience.</td>
</tr>
<tr>
<td>1.5</td>
<td>The iBook videos are appropriate and contribute to the learning experience.</td>
</tr>
<tr>
<td>1.6</td>
<td>The language used is appropriate for typical 6th grade students.</td>
</tr>
<tr>
<td>1.7</td>
<td>The iBook is professionally presented to a standard expected of a learning resource for middle grades students.</td>
</tr>
<tr>
<td>1.8</td>
<td>The iBook content reflects a contemporary (current) command of the field.</td>
</tr>
<tr>
<td>Code</td>
<td>Statement</td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>1.9</td>
<td>The iBook content provides clear evidence of structural alignment with the standards.</td>
</tr>
<tr>
<td>1.10</td>
<td>The iBook assessment items in the reviews provide clear evidence of structural alignment with the iBook content.</td>
</tr>
<tr>
<td>1.11</td>
<td>The iBook self-directed learning tasks provide clear evidence of structural alignment.</td>
</tr>
<tr>
<td>1.12</td>
<td>The iBook intended learning outcomes provide clear evidence of structural alignment.</td>
</tr>
<tr>
<td>1.13</td>
<td>Overall, the iBook is a suitable learning resource.</td>
</tr>
</tbody>
</table>

**Section 2- Alignment with Mathematical Standards**

Please rate the extent to which you agree that the content and activities included in the iBook provide students with the opportunity (and resources) to meet the following industry standards using the same scale as above:

SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree, C= No Comment

<table>
<thead>
<tr>
<th>Code</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The iBook promotes understanding of fractions.</td>
</tr>
<tr>
<td>2.2</td>
<td>The iBook promotes understanding of decimals.</td>
</tr>
<tr>
<td>2.3</td>
<td>The iBook promotes understanding of percent.</td>
</tr>
<tr>
<td>2.4</td>
<td>The iBook contributes to knowledge of converting fractions, decimals, and percents from one mode to another.</td>
</tr>
<tr>
<td>2.5</td>
<td>The iBook aids students in accessing and using fractions, decimals, and percents in real-world scenarios.</td>
</tr>
</tbody>
</table>
Section 3- Student Learning Experience

Please rate the extent to which you agree that the iBook provides students with the opportunity to achieve the following learning experiences using the same scale:

SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree, C= No Comment

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>The iBook provides students with a stand-alone learning resource for learning about fractions, decimals, and percents.</td>
</tr>
<tr>
<td>3.2</td>
<td>The iBook provides students with a sufficient number and variety of opportunities to undertake self-directed learning about the relationships among fractions, decimals, and percents.</td>
</tr>
<tr>
<td>3.3</td>
<td>The iBook provides students with information and examples that are relevant to the real-world.</td>
</tr>
<tr>
<td>3.4</td>
<td>The iBook provides students with the opportunity to use technology to learn mathematics.</td>
</tr>
<tr>
<td>3.5</td>
<td>The iBook has made effective use of technology and provides opportunities for students to engage with technology in learning about fractions, decimals, and percents.</td>
</tr>
<tr>
<td>3.6</td>
<td>The iBook has made effective use of and provides opportunities for students to engage in resource-based learning about fractions, decimals, and percents.</td>
</tr>
</tbody>
</table>
Overall, this iBook is likely to provide an authentic, real-life based and meaningful learning experience for learning about fractions, decimals, and percents.

Section 4- Overall Rating
Please give an overall rating to the iBook considering design, content, and student learning experience.

SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree, C= No Comment

In consideration of all of the above criteria and of your personal and professional experience, please rate to what extent you agree that the iBook will provide students with a worthwhile and rewarding learning experience. Please answer in respect to the expected breadth, depth and type of learning experience provided.

Part II-
Directions: Please answer all open-ended response items regarding the 6th grade iBook replacement unit to teach Fractions, Decimals, and Percent.

Section 1- iBook Design and content

1.1 In what ways are the iBook design and content likely to stimulate and promote student learning?

1.2 Additional comments (strengths, weaknesses, etc.) regarding the iBook content and design.

Section 2- Alignment with Mathematical Standards

2.1- In what ways is the content of this iBook likely to promote and enhance student competence and confidence with mathematical knowledge?

2.2- Additional comments (innovations, strengths, weaknesses, etc.) regarding the iBook content with respect to mathematics requirements.
Section 3 - Student Learning Experience

3.1 - In what specific ways (that is, by which teaching & learning methods) do you think that this resource will promote student learning? Please explain your answer. (Examples of methods may include – problem-based learning, scenario-based learning, work-integrated learning, resource-based learning, reflective practice, etc).

3.2 - Please comment on the extent to which you think that the teaching and learning methods used in the iBook are appropriate for the content and the students.

3.3 - Additional comments regarding the potential/expected student learning experience.

Section 4 - Overall Rating

4.1 - Please provide additional comments that you wish to make about the iBook that have not yet been addressed in this peer review document.

(Eg: comments on unique/innovative practices used; expected student experiences; content depth and breadth; resources; presentation)
## Appendix D
Wisconsin Center for Education Research called *SEC K-12 Mathematics Taxonomy*

Cognitive Demand Categories for Mathematics

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Memorize Facts, Definitions, Formulas</td>
<td>Perform Procedures</td>
<td>Demonstrate Understanding of Mathematical Ideas</td>
<td>Conjecture, Analyze, Generalize, Prove</td>
<td>Solve Non-Routine Problems / Make Connections</td>
</tr>
<tr>
<td>Recite basic mathematical facts</td>
<td>Use numbers to count, order, denote</td>
<td>Communicate mathematical ideas</td>
<td>Determine the truth of a mathematical pattern or proposition</td>
<td>Apply and adapt a variety of appropriate strategies to solve non-routine problems</td>
<td></td>
</tr>
<tr>
<td>Recall mathematics terms and definitions</td>
<td>Do computational procedures or algorithms</td>
<td>Use representations to model mathematical ideas</td>
<td>Write formal or informal proofs</td>
<td>Apply mathematics in contexts outside of mathematics</td>
<td></td>
</tr>
<tr>
<td>Recall formulas and computational procedures</td>
<td>Follow procedures / instructions</td>
<td>Explain findings and results from data analysis strategies</td>
<td>Recognize, generate or create patterns</td>
<td>Apply to real world situations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solve equations/formulas/routine word problems</td>
<td>Develop/explain relationships between concepts</td>
<td>Find a mathematical rule to generate a pattern or number sequence</td>
<td>Synthesize content and ideas from several sources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organize or display data</td>
<td>Show or explain relationships between models, diagrams, and/or other representations</td>
<td>Make and investigate mathematical conjectures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Read or produce graphs and tables</td>
<td>Identify faulty arguments or misrepresentations of data</td>
<td>Reason inductively or deductively</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Execute geometric constructions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix E
Textbook and iBook Examples

Real-World Example from the Textbook

![Real-World Example]

Conceptual Example from the Textbook

![Conceptual Example]
Percents larger than 100% can look overwhelming, but let’s think about them in context. Let’s say you are the buyer for Target. You’re in charge of purchasing light bulbs and you’ve purchased each light bulb for $4. However, Target needs to make a 50% profit on each light bulb they sell. How much will they sell the light bulb for?

Let’s consider this:

Purchase Price: $4, which is equivalent to 100% of the cost. If you want to make a 50% profit then you would need to add 1/2 of the purchase price onto the sale price.

Half of the purchase price is $2. Therefore, you would have a purchase price of $4 and an additional $2 to make a 50% profit. This would make the cost of the light bulb at Target $6. When considering this as a percent, Target is selling the light bulb for 150% of its purchase price because the 100% is was purchase for was $4. Then, we added $2 because $2 is 50% of the purchase price. When we added the $4 and $2 we got $6. Therefore, when we add 100% and 50%, we get 150%.
Conceptual Example from the iBook

Percents are looked at as a number out of one hundred. So, for example if you had 60% of something, it could be modeled in several different ways. For example, below is a fraction bar with ten pieces. If each piece is equivalent to 10% then we would color in 6 pieces.

We could also look at a ten by ten grid where each box is equivalent to 1%. In this scenario, we would color in 60 boxes to represent 60% as shown below.

Appendix F
Mini Lessons: Iteration 2

Turning Decimals into Fractions-
- Discuss what a fraction is
- Discuss what a decimal is
- Write 0.35 on the board and ask students how they might represent it on the hundreds chart and why
- Discuss what each box represents of a hundred boxes
- Allow students to discuss how this might translate into showing decimals on a hundreds chart
- Ask students how they might translate a visual image of a decimal into a fraction
- Ask students if there are other methods to turn a decimal into a fraction including: reading the decimal aloud and using the tenths, hundredths, thousandths, etc. to determine the denominator
- Ask if anyone has any questions
- Allow students to work on homework

Comparing and Ordering Fractions-
- Present the students with the following fractions and ask them to compare them- $\frac{1}{4}$ and $\frac{3}{4}$
- Discuss how students know $\frac{3}{4}$ is larger than $\frac{1}{4}$
- Present the students with the following fractions and ask them to compare them- $\frac{5}{7}$ and $\frac{4}{9}$
- Give students time to discuss how they can compare the fractions
- Discuss possibilities, which might include: drawing a picture, finding a common denominator, or reducing
- Present the students with the following fractions and ask them to find the answer by drawing a picture- $\frac{3}{8}$ and $\frac{2}{7}$
- Present the students with the following fractions and ask them to find the answer by finding a common denominator- $\frac{6}{7}$ and $\frac{7}{9}$
- Present the students with the following fractions and ask them to find the answer by reducing- $\frac{9}{12}$ and $\frac{5}{15}$
- Ask students to discuss which method they found most useful and why.
- Answer any questions
- Allow students to begin homework
Appendix G
IRB Approval

The first two iterations of this study are covered under USF IRB #9335 in which I am the Principal Investigator (PI) and Dr. Denisse Thompson is the Co-PI. Additionally, IRB approval was granted through Pinellas County with myself as the PI and Dr. Thompson as the Co-PI. For this third iteration, IRB approval was granted through Pinellas County and USF IRB #17355 with myself as the PI and Dr. Eugenia Vomvoridi-Ivanovic as the Co-PI.
September 4, 2014

Jennifer Zakrzewski, M.A.
Teaching and Learning
4202 E. Fowler Avenue, EDU105

Tampa, FL 33620

RE: Expedited Approval for Initial Review
IRB#: Pro00017355
Title: Effect of Teaching Fractions, Decimals, and Percents with an iBook on Sixth Grade Students’ Mathematics Achievement and Attitudes


Dear Ms. Zakrzewski:

On 9/4/2014, the Institutional Review Board (IRB) reviewed and APPROVED the above application and all documents outlined below.

Approved Item(s):
Protocol Document(s):
Protocol
Study involves children and falls under 45 CFR 46.404: Research not involving more than minimal risk.

Consent/Assent Document(s)*:
Child Written Assent.pdf
Parental Permission Consent.pdf

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve
only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

[Signature]

Kristen Salomon, Ph.D., Vice Chairperson
USF Institutional Review Board
May 21, 2014

Ms. Jennifer Zakrzewski
1601 Carlew Road
Palm Harbor, FL 34683

Re: Proposal number 0719-1314

Dear Ms. Zakrzewski:

Preliminary approval is granted for your research proposal, "How do iPads affect teaching and learning of mathematics?" Approval is based on the application submitted to this office for review.

You may contact school principals, and ask for their willingness to participate in this study. When making contact with school principals, please provide the principals with a copy of this letter and a copy of the Principal Agreement (Form A). This permission letter does not obligate schools, teachers, students or parents to participate in your study; participation is voluntary. Please take into consideration local and state assessments or other school activities when contacting schools for their participation in this study.

I also would like to reinforce our practice on monetary rewards to school board staff and students; the school board staff cannot be paid for work performed related to this study during working hours and students may not be rewarded money for participating in a study. Monetary rewards can be given to school(s) participating in the study.

Compliance with the following item(s) is required to obtain final approval and conduct the research:

- Principal's Agreement (Form A) for the participating schools
- Obtaining IRB approval, please submit a copy to the Assessment, Accountability and Research Office.

Please notify this office of any modifications made to this study prior to initiating your study. If there are any questions or if additional information is needed, please contact the AAR office at 727-588-6253.

Best wishes for continued success.

Merlande Petit-Bois
Executive Manager, Evaluation
Assessment, Accountability and Research
Pinellas County Schools
Appendix H
Mini Lessons and Activities: Iteration 3

Percents to Fractions-
- Discuss what a percent is
- Display page 293 from the Burns book and ask students to discuss each scenario and whether the percent makes sense or not
- Ask students how to represent 58% on a hundreds chart
- Ask students if there is a way to use their drawing to turn 58% into a fraction
- Discuss with students how they might use the hundreds chart to turn a percent into a fraction
- Ask students if they can come up with an alternative method to turning a percent into a fraction (putting 58% over 100 and simplifying)
- Give students the percent 36% and ask them to turn it into a fraction
- Allow students to discuss their preferred method with a neighbor
- Answer any questions
- Allow students to begin homework

Fraction War-
- Ask students if they have ever played the card game war
- If so, have one of the students explain the directions, if not explain the directions
- Allow students to ask questions for clarification
- Explain that students will be playing the game in pairs today using fractions instead of a traditional deck of cards
- Tell students they need to determine which fraction is larger and whoever has that fraction gets the two cards
- The game will end when one student has all of the cards
- Allow students to ask further questions
- Let students begin playing the game
Appendix I
In-Class Activities

In Class Activity!

We are going to play a little game of war. However, there is a twist. You will use a deck of fraction cards. Each person will flip a fraction and the person with the larger fraction will win the cards. If you find you have equivalent fractions you will each lay three cards face down and a fourth face up. Whoever has the larger fraction will win all of the cards. This will continue until one person has all of the cards.

Reflection: Please respond in your math journal.

1. Was it easy to determine which fraction was larger? Why or why not?

2. Did you and your partner become stuck at any time? If so, what did you struggle with and why?

3. Do you feel confident in comparing fractions? If not, what is confusing?
In Class Activity!

Today we are going to play equivalent fraction and decimal memory. You and your partner will be given a deck of playing cards. Cards will be placed face down on the table. Your partner and you will take turns choosing two cards (one must be a decimal and the other a fraction). If the cards are equivalent then you get to keep them. If the cards are not equivalent then you will put them back. The winner will be the person with the most cards at the end.

Reflection:

In your math journal please answer the following questions:

1. Did you find converting fractions and decimals easy in this game? Why or why not?

2. What did you find most challenging about this game in terms of mathematics? Why?

3. Do you feel comfortable converting fractions to decimals and decimals to fractions? If not, what is difficult about it?
In Class Activity!

Now that we have learned how to compare decimals, fractions and percents we are going to work on an activity. Today we are going to create a fractional clothesline. You will be divided into groups of three or four. Each group will be assigned a clothesline and given various fractions, decimals and percents. Your job will be to put all of the fractions, decimals and percents onto the clothesline in the proper order. Work with your team to complete the task.

As you finish, answer the following questions in your math journal under the heading “Fractional Clothesline page 47.”

1. Was this task easy or difficult? Explain why.
2. Was it easy to work in a group or would you have rather worked by yourself? Explain.
3. What did you learn from this activity?
4. Did this activity help you understand fractions, decimals and percents more? Why or why not?
## Levels of Cognitive Demand

**APPENDIX J**

**Levels of Cognitive Demand**

![Image](image.png)

**THE TASK ANALYSIS GUIDE**

**Memorization Task**
- Involve reproducing previously learned facts, rules, formulae, or definitions to memory.
- Cannot be solved using procedures because a procedure does not exist or because the time frame in which the task is being completed is too short to use a procedure.
- Are not ambiguous. Such tasks involve exact reproduction of previously seen material and what to be reproduced is clearly and directly stated.
- Have no connection to the concepts or meaning that underlie the facts, rules, formulae, or definitions being learned or reproduced.

**Procedures with Connections Tasks**
- Focus students’ attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas.
- Suggest pathways to follow (explicitly or implicitly) that are broad general procedures that have close connections to underlying conceptual ideas as opposed to narrow algorithms that are opaque with respect to underlying concepts.
- Usually are represented in multiple ways (e.g., visual diagrams, manipulatives, symbols, problem situations). Require some degree of cognitive effort. Although general procedures may be followed, they cannot be followed mindlessly. Students need to engage with the conceptual ideas that underlie the procedures in order to successfully complete the task and develop understanding.

**Procedures without Connections Tasks**
- Are algorithmic. Use of the procedure is either specifically called for or its use is evident based on prior instruction, experience, or placement of the task.
- Require limited cognitive demand for successful completion. There is little ambiguity about what needs to be done and how to do it.
- Have no connection to the concepts or meaning that underlie the procedure being used.
- Are focused on producing correct answers rather than developing mathematical understanding.
- Require no explanations, or explanations that focus solely on describing the procedure that was used.

**Doing Mathematics Tasks**
- Require complex and no algorithmic thinking (i.e., there is not a predictable, well-rehearsed approach or pathway explicitly suggested by the task, task instructions, or worked-out example).
- Require students to explore and understand the nature of mathematical concepts, processes, or relationships.
- Demand self-monitoring or self-regulation of one’s own cognitive processes.
- Require students to access relevant knowledge and experiences and make appropriate use of them in working through the task.
- Require students to analyze the task and actively examine task constraints that may limit possible solution strategies and solutions.
- Require considerable cognitive effort and may involve some level of anxiety for the student due to unpredictable nature of the solution process required.


Appendix K
Pretest/Posttest

6th Chapter 4 Study Test

Subjective Short Answer
Be sure to show all of your work.

1. Mitch’s little brother is 2.75 years old. Write his age as a fraction in simplest form. (2 points)

2. Jennifer spends \( \frac{5}{2} \) of her allowance on clothes and \( \frac{3}{4} \) of her allowance on CDs. Does she spend more money on clothes or CDs? (2 points)

3. The table shows the amount of incoming phone calls for the three teenagers in the Landen family. Find the percent of phone calls for each teenager.
   A. Who has the smallest percent of incoming phone calls? (2 points)
   B. What is their percent? (2 points)

<table>
<thead>
<tr>
<th>Teenager</th>
<th>Treyton</th>
<th>Derisse</th>
<th>Jakobe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of Calls</td>
<td>( \frac{1}{10} )</td>
<td>( \frac{2}{5} )</td>
<td>( \frac{1}{2} )</td>
</tr>
</tbody>
</table>

4. There are 200 students in the sixth grade at Brighton Middle school. If 72% of the sixth-grade class participated in a recent school fundraiser, how many students participated? (2 points)

5. Kirsten lost an earring in the hayloft of her father’s barn. Her father told her she has \( \frac{1}{2,000} \) chance of finding the earring. Express \( \frac{1}{2,000} \) as a percent. (2 points)

6. Ana uses \( 2 \frac{1}{2} \) cups of flour for her recipe. Barney uses 2.6 cups for his recipe, and Chloe uses \( 2 \frac{5}{12} \) cups for her recipe. Express each flour amount as a decimal and state whose recipe uses the least amount of flour? (3 points)

7. Two students ranked the following numbers from smallest to largest. Decide which student has the correct order. Justify your reasoning. (3 points)

   8.75%, 8.65, 0.0865, \( \frac{8}{4} \)

   Student 1: 0.0865, 8.65, 8.75%, \( \frac{8}{4} \)
   Student 2: 0.0865, 8.75%, 8.65, \( \frac{8}{4} \)

8. Josh walks 4.3 blocks to school, 6.1 blocks to basketball practice, and then 3.1 blocks to his grandmother’s house. Express the total amount of blocks he walked today as a mixed number in simplest form. (2 points)
6th Chapter 4 Study Test

9. The table shows the breakdown of the types of questions on Mr. Rheinhardt’s history test.
   A. What percent of the test will be true or false questions? (2 points)
   B. What fraction of the questions will be essay? (2 points)

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Multiple Choice</th>
<th>Short Answer</th>
<th>True or False</th>
<th>Essay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of Test</td>
<td>1/3</td>
<td>1/4</td>
<td>1/20</td>
<td>20%</td>
</tr>
</tbody>
</table>

10. The original price of a jacket is $80. The sale price is 35% off the original price. What is the sale price, in dollars, of the jacket? (2 points)

11. The circle graph shows the percents of the types of DVDs Lacey owns. In simplest form, what fraction of Lacey’s DVDs are comedies? (2 points)

![Circle graph showing percents of DVDs]

12. A scientist estimates that an oak tree is currently at 365% of its original size when it was transplanted. What decimal is equivalent to 365%? (2 points)

13. At a cookware party, 7 of the 25 items are made of glass. What percent of the cookware items are glass? (2 points)

14. People spend about 30% of their lives sleeping. By the age of 60, how many years of a person’s life has been spent sleeping? (2 points)
6th Chapter 4 Study Test

15. Dillon wants to leave a 20% tip for a $14.36 restaurant bill. How much money should he leave to cover the bill and tip? (2 points)

16. A jacket that originally costs $58 is on sale for 50% off. If you have $34, how much change will you receive? (3 points)

Essay

17. a. Plot the fractions $\frac{1}{6}$, $\frac{2}{9}$, $\frac{2}{14}$, and $\frac{12}{10}$ on the number line. (2 points)

---

18. Mr. Langford owns several apple orchards. During the first weekend of the fruit season, he gathered information about the number of trees ready to be picked from each orchard. The managers of the orchards provided the information shown in the table below.

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Decimal Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevor Farms</td>
<td>0.21</td>
<td>-</td>
</tr>
<tr>
<td>Hartford</td>
<td>-</td>
<td>34%</td>
</tr>
<tr>
<td>East Apple Valley</td>
<td>0.1</td>
<td>-</td>
</tr>
<tr>
<td>West Apple Valley</td>
<td>-</td>
<td>9%</td>
</tr>
</tbody>
</table>

a. Write the amount of trees at Trevor Farms as a percent. Show your work. (2 points)
b. Write the amount of trees at Hartford as a decimal. Show your work. (2 points)
c. Write the amount of trees at East Apple Valley as a percent. Show your work. (2 points)
d. Write the amount of trees at West Apple Valley as a decimal. Show your work. (2 points)

19. One Saturday afternoon, at 2 p.m., Mary recorded the number of different sizes of dogs at the community dog park. Her results are shown below.

<table>
<thead>
<tr>
<th>Size of Dog</th>
<th>Number of Dogs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>20</td>
</tr>
<tr>
<td>Large</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

Write the percent of dogs of each size that were at the dog park at 2 p.m. Show your work. (2 points)

20. A jar contains 40 pieces of candy. Ahmad is told he can either have $\frac{3}{8}$ or 0.15 of the total candy.
   a. Write $\frac{3}{8}$ as a decimal. (2 points)
   b. Which option would give Ahmad more candy? Explain. (2 points)
## Appendix L

### Pretest/Posttest Scoring Rubric

<table>
<thead>
<tr>
<th>Question</th>
<th>0- Incorrect work and answer</th>
<th>1- Work shows the correct fraction unsimplified or the correct simplified fraction without the whole number</th>
<th>2- Correct answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Work shows a common denominator for the fractions, correct decimal equivalents for 5/7 and 3/4, or correct percentages</td>
<td>Correct answer</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Incorrect fraction chosen, but properly converted to a percent</td>
<td>Correct percent</td>
</tr>
<tr>
<td>3a</td>
<td></td>
<td>Work shows a correctly set up proportion or correct multiplication such as $200 \times 0.72$</td>
<td>Correct answer</td>
</tr>
<tr>
<td>3b</td>
<td></td>
<td>Work shows dividing to create a denominator of 100 or dividing 1 by 2000</td>
<td>Correct answer</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Work shows the correct decimal equivalents, but does not show the whole number or gives the correct person for using the least amount of flour</td>
<td>Correct decimal equivalents or answer</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Work shows dividing to create a denominator of 100 or dividing 1 by 2000</td>
<td>Correct decimal equivalents and answer</td>
</tr>
</tbody>
</table>
Question 7
0- Incorrect work and answer
1- Work shows correct equivalents of each number as decimals, fractions or percents or justification includes a description of why 8.65 is larger than 8.75%
2- Combination of two of the following: correct answer; work shows correct equivalents of each number as decimals, fractions or percents; or justification includes a description of why 8.65 is larger than 8.75%
3- Correct answer and justification includes a description of why 8.65 is larger than 8.75%

Question 8
0- Incorrect work and answer
1- Work shows correct total distance in decimal form as a total or for each individually or shows the correct total distance without a whole number
2- Correct answer

Question 9a
0- Incorrect work and answer
1- Work shows the correct decimal equivalent of true/false questions
2- Correct answer

Question 9b
0- Incorrect work and answer
1- Correct work for converting a percent to decimal with arithmetic error or non-simplified equivalent of essay questions
2- Correct answer

Question 10
0- Incorrect work and answer
1- Work shows the correct discount or the correct proportion setting up the work or multiplying 80 by .35 or gives correct discount of $28
2- Correct answer

Question 11
0- Incorrect work and answer
1- Work shows a correct decimal equivalent or an unsimplified equivalent fraction
2- Correct answer

Question 12
0- Incorrect work and answer
1- Work shows 365% being divided by 100 or 365 over 100
2- Correct answer
Question 13
0- Incorrect work and answer
1- Work shows 7/25 as a fraction being multiplied to get a denominator of 100 or 7 being divided by 25 then multiplied by 100
2- Correct answer

Question 14
0- Incorrect work and answer
1- Work shows a correctly set up proportion or 58 being multiplied by 0.3
2- Correct answer

Question 15
0- Incorrect work and answer
1- Work shows a correctly set up proportion or 14.36 being multiplied by 0.2, or gives the tip amount of $2.87
2- Correct answer

Question 16
0- Incorrect work and answer
1- Work shows the correct discount price of $29 or $57.99 being multiplied by 0.5 or a correctly set up proportion
2- Correct discount is being subtracted from $57.99
3- Correct answer

Question 17
0- Incorrect work and answer
1- Work shows common denominators between fractions or equivalent decimals or percents
2- Correct answer

Question 18a
0- Incorrect work and answer
1- Work shows the 0.21 being multiplied by 100 or being turned into an equivalent unsimplified fraction
2- Correct answer

Question 18b
0- Incorrect work and answer
1- Work shows 34% being made into an equivalent fraction or being divided by 100
2- Correct answer

Question 18c
0- Incorrect work and answer
1- Work shows the 0.1 being multiplied by 100 or being turned into an equivalent fraction with 100 as the denominator
2- Correct answer
Question 18d
0- Incorrect work and answer
1- Work shows 9% being made into an equivalent fraction or being divided by 100
2- Correct answer

Question 19
0- Incorrect work and answer
1- Work shows the correct fractional or decimal equivalents or the number of dogs for each category being divided by 50 then multiplied by 100 or showing each fraction being multiplied to make the denominator 100
2- Correct answer

Question 20a
0- Incorrect work and answer
1- Work shows 1/6 being divided 1 by 6
2- Correct answer

Question 20b
0- Incorrect work and answer
1- Answer states 1/6
2- Answer states 1/6 because 1/6 as a decimal is approximately .16 which is larger than 0.15
Appendix M
Questionnaires

Comparison Questionnaire

Directions- Read each statement. Decide whether you agree with the statement or not. Circle one of the five options below the statement that best expresses how you feel about the statement.

1. Reading the textbook and completing my homework helped me understand how to convert fractions to decimals and percents.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

2. Reading the textbook and completing my homework helped me understand how to convert decimals to fractions and percents.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

3. Reading the textbook and completing my homework helped me understand how to convert percents to fractions and decimals.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

4. The homework helped me learn fractions, decimals, and percents.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

5. The homework helped me connect ideas about fractions, decimals, and percents in new ways.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

6. The homework helped me understand fractions, decimals, and percents.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

7. The homework helped me develop confidence in mathematics.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

8. The homework motivated me to learn fractions, decimals, and percents more than regular mathematics activities.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
9. Using the textbook is more convenient than using resources on my iPad.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

10. Did you use any resources other than your textbook to complete your homework? If so, please list them.

   ____________________________________________
   ____________________________________________

11. About how long did you spend on math homework each night?

   ____________________________________________

12. Did you spend more time, less time, or about the same amount of time on homework for this chapter as for previous chapters?

   ____________________________________________

13. Which of the topics you learned in this chapter were difficult? Why?

   ____________________________________________
   ____________________________________________

14. Which of the topics you learned in this chapter were easy? Why?

   ____________________________________________
   ____________________________________________
   ____________________________________________

15. Did you find the mini lessons useful? Why or why not?

   ____________________________________________
   ____________________________________________
Treatment Questionnaire
iBook Questionnaire

Modified from Rossing, Miller, Cecil, and Stamper (2012)

Directions- Read each statement. Decide whether you agree with the statement or not. Circle one of the five options below the statement that best expresses how you feel about the statement.

1. Reading the iBook and completing my homework helped me understand how to convert fractions to decimals and percents.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

2. Reading the iBook and completing my homework helped me understand how to convert decimals to fractions and percents.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

3. Reading the iBook and completing my homework helped me understand how to convert percents to fractions and decimals.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

4. The iBook helped me learn fractions, decimals, and percents.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

5. The iBook helped me connect ideas about fractions, decimals, and percents in new ways.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

6. The iBook helped me understand fractions, decimals, and percents.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

7. The iBook helped me develop confidence in mathematics.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

8. The iBook motivated me to learn fractions, decimals, and percents more than regular mathematics activities.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
9. The iBook was more convenient compared to a regular textbook.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

10. Did you use any resources other than your iBook to complete your homework? If so, please list them.

________________________________________________________________________
________________________________________________________________________

11. About how long did you spend on math homework each night?

________________________________________________________________________

12. Did you spend more time, less time, or about the same amount of time on homework for this chapter as for previous chapters?

________________________________________________________________________

13. Which of the topics you learned in this chapter were difficult? Why?

________________________________________________________________________
________________________________________________________________________

14. Which of the topics you learned in this chapter were easy? Why?

________________________________________________________________________
________________________________________________________________________

15. Did you find the mini lessons useful? Why or why not?

________________________________________________________________________
________________________________________________________________________
Appendix N
Semi-Structured Focus Group Interview Questions

Focus Group Protocol

When meeting with the group, use these questions as a guide. Be sure to get answers to all questions listed, but you may add others. Please be sure to take notes as you have your conversation. Additionally, please record the conversation for later transcription. Let all participants know that their information is confidential and that honesty is important. What they say will not affect their grades and the interview is simply to understand their feelings regarding their instruction and homework for the chapter being studied. The focus group should last no longer than an hour.

Treatment Focus Group Questions
Modified from Bloemsma (2013)

1. Do you enjoy using technology? Why or Why not?
2. What technology(ies) do you have access to outside of school?
3. How often do you use this/these technologies? For what purposes?
4. Have you used iPads outside of school? If so, how? How often?
5. How did you feel when you first learned you would be using iPads in your mathematics class?
6. How do you like using the iBook?
7. What aspect of the iBook was most/least engaging? Explain.
8. What features did you like about the iBook? Were the features useful? Why or why not?
9. How did you use the iBook when doing your homework?
10. Did you use any resources for your homework other than the iBook? Which ones? Where did you find them?
11. Do you normally like mathematics? Why or why not?
12. Did using the iBook change your feelings about mathematics in any way? If so, how?
13. Do you feel using the iBook helps you learn mathematics better? Why or why not?
14. If you were put in-charge of iPad use at your school next year, what recommendations do you have? Who? What? When? Where? How?
15. What parts of chapter four were easy? Why?
16. What parts of chapter four were difficult? Why?
17. Do you feel you spent more time, less time or an equal amount of time on homework this chapter as compared to previous chapters’? Why?
Comparison Focus Group Questions
Modified from Bloemsma (2013)

1. Do you enjoy using technology? Why or Why not?
2. What technology(ies) do you have access to outside of school?
3. How often do you use this/these technologies? For what purposes?
4. Have you used iPads outside of school? If so, how? How often?
5. How do you like using the textbook?
7. What features in the textbook were useful? Why?
8. How did you use the textbook when doing your homework?
9. Did you use any resources other than your textbook for your homework? Which ones? Where did you find them?
10. Do you normally like mathematics? Why or why not?
11. Do you feel using the textbook helps you learn mathematics better? Why or why not?
12. What parts of chapter four were easy? Why?
13. What parts of chapter four were difficult? Why?
14. Do you feel you spent more time, less time or an equal amount of time on homework this chapter as compared to previous chapters’? Why?
Appendix O
Mini Quizzes

Mini Quiz-11/04/14
Equivalent Fractions Mini Quiz
List three equivalent fractions for each fraction.
1. \( \frac{10}{12} \)
2. \( \frac{3}{4} \)
3. \( \frac{5}{6} \)

Mini Quiz 11/06/14
Fractions to decimals and vice versa
1. \( \frac{3}{12} \)
2. \( \frac{450}{800} \)
3. 0.62
4. .456

Mini Quiz-11/10/14
Fractions, Decimals and Percents
Convert \( \frac{6}{8} \) to a percent.
Convert 48% to a fraction.
Convert .32 to a percent.
Convert 86% to a decimal.

Mini Quiz 11/11/14
Convert to Fractions and Decimals:
1. 450%
2. 0.55%

Convert to Percent and Decimal:
3. \( \frac{5}{10} \)
4. \( \frac{6}{1000} \)

Convert to a Fraction and Percent
5. 5.65
6. 0.005

Mini Quiz-11/17/14
1. What is 60% of 20?
2. What is 35% of 80?
3. Turn into a decimal and fraction- 345%
4. Turn into a decimal and fraction- 0.006%
Appendix P  
Class Recording Analysis

Class Recording Analysis

Date of Recording: ________________________________

Date Listening: _________________________________

Listeners:

________________________________________________

<table>
<thead>
<tr>
<th></th>
<th>Comparison</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Instruction began</td>
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</tr>
<tr>
<td>Time Instruction ended</td>
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<td></td>
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<tr>
<td>Length of Instruction</td>
<td></td>
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<tr>
<td>Number of questions asked by students during lesson</td>
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<tr>
<td>Number of questions reviewed from homework</td>
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<td>Level of Questions</td>
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<td>M</td>
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<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Questions on Skill vs Application or Representation (Method)</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>R</td>
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<tr>
<td>Number of problems reviewed during the lesson</td>
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</tr>
<tr>
<td>Type or Problem (Word Problem or Computation)</td>
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<tr>
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</tr>
<tr>
<td>Number of strategies taught in lesson</td>
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<td></td>
</tr>
<tr>
<td>Strategies taught in lesson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of different students who asked questions</td>
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<td></td>
</tr>
</tbody>
</table>
Appendix Q
Examples of Written Response Questions

**Review**

Take a few minutes to complete the review to your right. Write the answers to each question in your math notebook under the title “Review 1.2. page 7.” Also, answer the following questions in your math journal:

1. What is a decimal?

2. How is a decimal similar to a fraction?

3. Has using the iBook helped you learn how fractions and decimals relate?

4. Do you feel you understand how to turn a fraction into a decimal? If not, what is confusing?

After you’ve written, visit the link to the right to play Death to Decimals.

**Review!**

I know it seems quick, but it is time for a review. Write the answers to each question in your math notebook under the title “Review 5.1 page 51.” Also, answer the following question in your math journal:

1. Which method do you prefer for finding part of a number? Explain.

After you have written, you may watch “Percents” on the Brainpop app.

[Interactive 1.3 Equivalent Fractions and Decimals](http://mmussbaum.com/death-to-decimals-ipad.html)
Appendix R  
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Title: Math Connects Course 1, 2012  
ISBN: 0078951291  
Description of material: Mathematics example 1 on pg. 200 and 4 on pg. 201

Fee: Waived

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Title: 'Effect of Teaching Fractions, Decimals & Percents with an iBook on Sixth Grade Students...'
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Publication Date: 2015
Format: ProQuest’s Website
Distribution/territory: USA
Languages: English

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Title Author
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Please let me know if you have any questions.

Sincerely,

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Publications Assistant
Good Evening,

I am currently a doctoral student at USF and in the process of writing my dissertation. One of the features of my dissertation is mathematics in technology. Your SEC K-12 Mathematics Taxonomy has been very helpful and I would like permission to include it in my dissertation. Please let me know either way and if you have any questions I would be happy to answer them.

Thank you,
Jennifer Zakrzewski

---

Paul Baker
PBaker@wcer.wisc.edu
Tel 608-263-6814
W www.wcer.wisc.edu
T & @paulbaker55

February 23, 2015 at 10:14 AM

Hi

Have you heard from the SEC staff?

just checking

On 2/23/2015 10:17 AM, Jennifer wrote:
   Good Morning,
       Thank you for checking. I have not heard from anyone yet.

   Thanks,
   Jenn Zakrzewski
   Sent from my iPhone

Jon
I would say go ahead and use it for your dissertation, with proper attribution.

Paul Baker
WCER Communications
Technology Integration Matrix Permission from the Florida Center of Instructional Technology

Good Evening,

I am currently a doctoral student at USF and in the process of writing my dissertation. One of the features of my dissertation is technology integration into the classroom. Your Technology Integration Matrix has been very helpful and I would like permission to include it in my dissertation. Please let me know either way and if you have any questions I would be happy to answer them.

Thank you,
Jennifer Zakrzewski

Hi Jennifer,

Thanks for contacting me. The main TIM page includes the 5 x 5 grid with the summary indicators. The site also includes detailed indicators and other descriptions. In what ways would you anticipate incorporating it into your work?

James L. Welsh, Ph.D.
jwelsh@usf.edu
813-974-9979
Director, PC/T
University of South Florida, College of Education
http://foi.usf.edu/

Hi James,

Thank you for getting back to me so quickly. What I would like to do is include the matrix in an appendix. Currently, I am using the matrix as a guide to incorporating more technology into the classroom. That being said, I am situating my current study within the matrix to show where the technology is enhanced and where it is still lacking.

Thank you,
Jennifer Zakrzewski

Welsh, James
To: Jennifer Zakrzewski
Re: Technology Integration Matrix

Sounds good. I'll give you some language to use for crediting the figure. What program are you using?

See More from Jennifer Zakrzewski

Welsh, James
To: Welsh, James
Re: Technology Integration Matrix

Great! I am in the math education program. Thank you!

Thanks,
Jennifer Zakrzewski
Sent from my iPhone

See More from Welsh, James
Theoretical model of Technology Immersion Figure Permission from Taylor and Francis

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T & F Reference Number: P040715-02

4/7/2015

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jz7@ms.com

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