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Assessing the Impact of Picture Books in Primary Grades Mathematics Instruction

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I am submitting herewith a dissertation written by Jessica Stone entitled "Assessing the Impact of Picture Books in Primary Grades Mathematics Instruction." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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Assessing the Impact of Picture Books in Primary Grades Mathematics Instruction

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Dedication

This dissertation is dedicated to Tristan. This mountain seemed insurmountable, yet I was able to climb it because you were there as my belayer.

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Abstract

This study documents an educational field experiment evaluating the effects of picture books on primary students' mathematical achievement and their dispositions towards mathematics. The study involved 136 primary grade students from one elementary school in the southeastern region of the United States. The student population had an overrepresentation of students from minority backgrounds (91%), low socioeconomic status (93%) and English Language Learners (47%). During the 18-week treatment period, teacher participants from the treatment group received bi-weekly collaborative professional development regarding the use of picture books in mathematics instruction. The teachers in the control group followed their district's mathematics curriculum.

To determine the effect of picture books on students' mathematics achievement STAR gain scores and chapter tests were compared. This analysis revealed that students could learn mathematics when picture books were used. In fact, students in the treatment group demonstrated statistically significant mathematical achievement gains on the STAR assessment ($p < .05$). Compared to the increase from pretest to posttest in the control group, the increase in the treatment group was 40% larger. Similarly, kindergarten students in the treatment group demonstrated statistically significant higher mathematical achievement on all chapter tests ($p <.01$), yet a null treatment effect was found for first and second grade students as measured by chapter tests. Analysis of STAR gain scores (first and second grade) revealed no significant treatment between subgroups based on gender, ethnicity, or ELL status. However, the kindergarten chapter test data by subgroup revealed that the treatment had no effect by gender, higher effects for Black students as compared to Hispanic students, and that non-ELL students in both the treatment and control group had higher achievement than ELL students.

To determine if there was a relationship between students' mathematical dispositions and the use of picture books in mathematics instruction, students' self-reported disposition towards mathematics were recorded daily during six of the 18 weeks. The analysis comparing the treatment and control groups' dispositions revealed that all students had relatively high dispositions towards mathematics and that the use of picture books did not significantly impact students' positive dispositions towards mathematics.

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Chapter 1

Introduction

Mathematics was once thought to be necessary knowledge for a select few; this, however, is no longer the case. The National Council of Teachers of Mathematics (NCTM) *Principles and Standards* states this plainly proclaiming, "The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater" (2000, p. 4). A problem many students encounter is that the mathematics used in everyday life has only a small resemblance to the decontextualized problems learned in mathematics classrooms (Bransford, Brown, & Cocking, 2000). Moreover, Tucker, Boggan, and Harper (2010) assert that students struggle with mathematics "because they do not understand how it relates to their daily lives" (p. 155). To overcome this, Tucker, Boggan, and Harper (2010) have suggested the use of picture books in mathematics instruction, because these books can provide a context for students to explore mathematics in a way that relates to their personal lives.

Students' narrow understanding of mathematics is due, at least in part, to the traditional form of mathematics they experience in educational settings (National Research Council, 2001). In 1979, Fey reported a reliance on teacher-directed instruction followed by students completing worksheets requiring mindless repetitive practice. This type of instruction is problematic, because "it encourages learning that is inflexible, school-bound and of limited use" (Boaler, 1998, p. 60). Traditionally, mathematics education has focused on students' rote memorization of facts, algorithms, and procedures. This has been especially true in elementary classrooms where

computation skills have been the focal point of mathematics instruction (Battista, 1994). This "mindless mimicry mathematics", as the National Research Council (1989) calls it, has left students with the ability to compute mathematics without the ability to transfer this knowledge to problem solving in real world situations and thus hindering students from actually making use of their mathematical thinking and reasoning (Verschaffel et al., 1999).

Traditional forms of mathematics education have been changing (English & Bartolini Bussi, 2008). Yet, the need for continued improvement is evident given the most recent report from the National Assessment of Educational Progress (NAEP), which indicates that only 42 percent of fourth grade students in the United States achieved mathematical proficiency (NAEP, 2013). Stated inversely, more than half of fourth grade students in the U.S. are not reaching proficient levels of mathematical achievement. Although scores have steadily increased in fourth grade students' mathematics achievement from 1990 to 2013, the need for continued improvement persists.

Current mathematics education maintains the importance of facts and procedures while concurrently stressing the importance of conceptual understanding and problem solving (National Council of Teachers of Mathematics, 2000; National Research Council, 2001; Council of Chief State School Officers, 2010). The most current mathematics education standards, the Common Core State Standards (CCSS), specifically advocate a curriculum that is no longer a "mile wide and an inch deep"; instead, these standards are designed to facilitate students solving real-world problems using the procedural fluency

and conceptual understanding learned throughout their mathematics education (Council of Chief State School Officers, 2010).

To meet the demands of current mathematics education, teachers are asked to move from instructing students how to compute mathematics to instead guide students to construct mathematical knowledge that allows for the flexible use of mathematics (Wegner, 2008). For this reason, teachers are encouraged to use new and varied instruction that require students to be active participants in the learning process, thus moving from simply solving problems to applying mathematics in real world contexts that allow for an understanding that includes connections among mathematical concepts (Herrera & Owens, 2001). One such instructional strategy may be the use of picture books in mathematics instruction. As Whiten and Wilde (1992) explain, the use of picture books in mathematics instruction affords students with the opportunity to be mathematical problem solvers while also motivating students through the natural connection children have with the stories presented in books. In addition, the use of picture books in mathematics instruction may aid students in attaining mathematical proficiency (Tucker, Boggan, & Harper, 2010).

Research indicates that the use of picture books in kindergarten mathematics instruction leads to improved mathematics achievement (Hong, 1996; Jennings, Jennings, Richey, & Dixon-Krauss, 1992; van den Heuvel-Panhuizen Elia & Robitzsch, 2014), gains in student use of mathematical vocabulary and communication (Jennings et al, 1992), and improved student attitudes towards mathematics (Hong, 1996; Jennings et al., 1992). Despite these positive outcomes, research also indicates that the use of picture

books in mathematics instruction is scarce (van den Heuvel-Panhuizen Elia & Robitzsch, 2014; Flevares & Schiff, 2014). Due to the limited research regarding the use of picture books in mathematics instruction, the use of such books in mathematics instruction remains at its hypothesized state, rather than its realized potential (Flevares & Schiff, 2014).

Purpose of the Study

The purpose of this study was to build knowledge about the use of picture books in mathematics instruction by addressing the gaps in the current literature. This study investigated how using picture books in kindergarten, first, and second grade mathematics instruction impacted student learning outcomes and their dispositions towards mathematics. More specifically, this investigation focused on the following three research questions:

1. Is there a relationship between the mathematics achievement of students taught through regular mathematics instruction and those taught with the use of picture books as measured by the STAR Assessment and chapter tests accompanying the selected textbook?
2. Is there a relationship between the effect of the treatment and student demographics?
3. Is there a relationship between the mathematical dispositions of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

Based on previous findings (Hong 1996; Jennings et al.,1992; van den Heuvel-Panhuizen Elia & Robitzsch, 2014), it was hypothesized that the use of picture books in mathematics instruction would have a positive impact on student achievement. Likewise, it was hypothesized based on the findings of Hong (1996) and Jennings et al. (1992) that student dispositions towards mathematics would improve with the use of picture books.

Need for the Study

Twenty years ago, Hong (1996) called for more research investigating the use of picture books in mathematics instruction. Since that time, limited research has been conducted in this field, thus lending Flevares and Schiff (2014) to recently proclaim that a gap in the literature still exists regarding the use of picture books in mathematics instruction. As a result, the use of picture books in mathematics instruction remains at its hypothesized state, rather than its realized potential (Flevares & Schiff, 2014). The present study, therefore, heeded the call for more research and addresses the gap by investigating the impact of picture books used in primary grades mathematics instruction.

While addressing the call for more research, this study also expanded the previously investigated population. Past studies have focused solely on the impact such instruction has on kindergarten students, yet research is needed to understand how picture books impact students in other grade levels. Therefore, this study included kindergarten and expanded the population to include an investigation of first and second grade students.

Similarly, this study broadened previous studies by expanding the population to include large numbers of students from minority backgrounds, low socioeconomic status

(often measured by eligibility for the Free and Reduced Lunch Program), and English Language Learners (ELL). The need to discover instructional strategies to strengthen students' mathematical achievement for students from such backgrounds is undeniable given that the 4th grade mathematical achievement results of the NAEP 2013 Report Card. Tables 1, 2, and 3 present the percentage of students reaching mathematical proficiency categorized by ethnicity, socioeconomic status, and ELL status as reported on the NAEP 2013 Report Card.

Table 1. Mathematical Proficiency by Ethnicity, 2013 NAEP

Ethnicity	***Percent Reaching Proficiency***
White	54%
Hispanic	26%
Black	18%

Table 2. Mathematical Proficiency by Socioeconomic Status, 2013 NAEP

Free and Reduced Lunch Program Eligibility	***Percent Reaching Proficiency***
Ineligible	59%
Eligible	24%

Table 3. Mathematical Proficiency by English Language Learner Status, 2013 NAEP

English Language Learner Status	***Percent Reaching Proficiency***
Non-English Language Learner	44%
English Language Learner	14%

The information in these tables demonstrates that students from minority backgrounds, low socioeconomic status, and ELL students are outperformed by their counterparts, thus placing such students at a greater risk for academic failure in

mathematics. Despite the barriers students from such backgrounds must overcome, Borman and Overman (2004) point out that those possessing multiple factors from within these categories face an even greater risk of academic failure. Mindful of these dangers, this study investigated how the use of picture books in mathematics instruction impacted such students by conducting this study at a school site that had large minority representation (86%), low socioeconomic status (93%), and English Language Learners (33%). Although previous studies have included students from minority backgrounds and low socioeconomic status, they have utilized relatively small representations in these categories, thus limiting their findings. Additionally, no study has reported the effects of picture books in mathematic instruction on English Language Learners, thus highlighting the need for the current study.

Limitations

A limitation is a bias that the researcher did not or could not control which could affect the results (Ellis & Levy, 2009). Researchers, by outlining the limitations of a study, allow others to "judge to what extent the findings can or cannot be generalized to other people and situations" (Creswell, 2005, p. 198). The instruments used in this study imposed limitations. For instance, two instruments were used to measure student achievement, the STAR Assessment and chapter tests accompanying the enVisionMATH series. The measures of mathematics achievement are therefore limited to the type of knowledge valued and measured by these instruments. These measurements were selected due to their wide use in primary grades throughout the district in which this study was conducted. Likewise, one instrument, the Student Mathematics Disposition

Scale (SMDS), was used to measure students' mathematical dispositions. Students' ability to accurately and honestly record their disposition was dependent on their ability to first recognize their own attitude and then accurately record it on the scale. To minimize this limitation, students were read the same directions at each administration of the SMDS.

Lastly, the teachers in the treatment group were limited to the picture books provided by the researcher and those picture books which they had access to in their classroom or school library. It is possible that teachers and students could respond differently given a wider variety of picture books.

Delimitations

Delimitations are decisions made by the researcher that define the boundaries of the research (Ellis & Levy, 2009). This study was delimited to the population investigated. This population included students from one school in the southeastern region of the United States. This study was further delimited to teachers in the primary grades from this school that were willing to participate. This research is further delimited, because teacher participants were given the freedom to self-select their involvement in the control or the treatment group.

The student population investigated imposed further delimitations. For instance, only students taught by teacher participants were eligible for involvement in this study. The student population was further limited to student participants whose parent or guardian was willing to consent to their child(ren)'s involvement in this research project.

In addition, student assent was required. These delimitations were necessary in order to conduct ethical research in educational settings.

An additional delimitation imposed by the researcher is the 18-week treatment period. It is possible that a longer treatment could present more significant findings. However, a recent study on the use of picture books in mathematics instruction evaluating student achievement used a 12-week intervention period and revealed a 22 percent growth in the intervention group over the control group (van den Heuvel-Panhuizen & Robitzsch, 2014).

Assumptions

Assumptions are researchers' beliefs about variables (Ellis & Levy, 2009). This study was built upon the assumption that the teachers that self-selected their participation in the treatment group had an interest in the use of picture books in mathematics instruction. Conversely, it was not assumed that the teachers in the control group did not have an interest in picture books used in mathematics instruction.

Definition of Terms

To ensure readers perceive terms in the manner intended by the researcher, key terms have been defined. When seeking definitions, the researcher sought guidance from the literature surrounding these terms and ideas.

<u>Children's literature</u> – The Library of Congress (2008) defines children's literature as "material written and produced for the information or entertainment of children and young adults. It includes all non-fiction, literary, and artistic genres and physical formats".

Common Core State Standards (CCSS) – The Common Core State Standards are "a set of clear college- and career-ready standards for kindergarten through 12th grade in English language arts/literacy and mathematics" (NGA Center & CCSSO, 2010). These standards were "developed under the sponsorship of the National Governors Association Center for Best Practices and the Council of Chief State School Officers" (Conley, 2011, p. 16). Upon their release in June of 2010, they were quickly adopted by most states, including the state where this research takes place.

CCSStandards for Mathematical Practices – "The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students" (NGA & CCSSO, 2010). These practices are:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning.

Conceptual understanding – The National Research Council (2001) defines conceptual understanding as the "comprehension of mathematical concepts operations, and relations" (p.5).

Disposition – Katz (1991) and Katz and Chard (1989) are among the few who have attempted a definition describing “disposition” as habits of mind, including the pursuit of an activity or goal in the absence of expected rewards, that is, persistence at a task, or curiosity. In the study presented here, the term disposition is thus taken to mean such an attitude of active pursuit toward doing mathematics.

Ethnicity – The guardians of student participants self-selected, on district enrollment forms, students’ ethnic identity from the following options: Asian, Black or African American, Hispanic or Latino, Native American/Alaskan, or White.

English Language Learner – English Language Learner “refers to those students who are not yet proficient in English and who require instructional support in order to fully access academic content in their classes” (Ballantyne, Sanderman, & Levy, 2008, p. 2).

Mathematical proficiency – The National Research Council (2001) explains that mathematical proficiency is the mathematical knowledge needed to successfully learn mathematics. Mathematical proficiency is further explained using the following five strands:

- Conceptual understanding – comprehension of mathematical concepts, operations, and relations
- Procedural fluency – skill in carrying out procedures flexibly, accurately, efficiently and appropriately
- Strategic competence – ability to formulate, represent and solve mathematical problems

- Productive disposition – habitual inclination to see mathematics as sensible, useful and worthwhile, coupled with a belief in diligence and one's own efficacy.

<u>Mathematical understanding</u> – Mathematical understanding is defined as "being able to think and act flexibly with a topic or concept" (van de Walle, Lovin, Karp, & Bay-Williams, 2014, p.1). It has further been explained that a key component of mathematical understanding is the ability to justify a given mathematical response or why a mathematical rule uses sound logic (NGA & CCSSO, 2010).

<u>National Council of Teachers of Mathematics (NCTM) Principles and Standards</u> – NCTM explains that this document "outlines the essential components of high-quality school mathematics program" (Koestker, Felton-Koestler, Bieda, & Otten, 2013).

<u>Picture books</u> – A picture book is a "book in which the story depends on the interaction between written text and image and where both have been created with a conscious esthetic attention" (Arizpe & Styles, 2003, p. 22). In accordance with Flevares and Schiff (2014), this definition has been amended to include wordless picture books.

<u>Procedural fluency</u> – The National Research Council (2001) outlines procedural fluency as one of the five strands of mathematical proficiency and defines it as the "skill in carrying out procedures flexibly, accurately, efficiently, and appropriately" (p.5).

<u>Quasi-experimental design</u> – A quasi-experimental design contains two of the three key factors of an experimental design, pre and posttest, and an extended treatment phase, yet lacks the third component, random assignment. Instead, quasi-experimental design allows for self-selection or administrator judgment (Cook, 1979).

Theoretical Framework

The importance of situating one's research within a theoretical framework is a central piece of the research plan as it influences the design, assumptions, and interpretation of a study. As Guba and Lincoln (1994) explain, “facts are facts only within some theoretical framework” (p. 107). Theoretical frameworks provide a particular perspective, or lens, through which to examine a topic. The lens used in this research views the world as a place where absolute realities are unknowable, and thus the outcomes of one's research are individual perspectives or constructions of reality (Guba & Lincoln, 1994). Similarly, the present study also adheres to the perspective that “multiple realities exist that are inherently unique because they are constructed by individuals who experience the world from their own vantage points” (Hatch, 2002, p. 15). This research is grounded in three interrelated theoretical perspectives: constructivist learning, contextualized learning, and experiential learning.

Constructivist learning theory purports that knowledge is constructed by learners and is not merely transmitted from teacher to learner (Philipp, 1995). Constructivism encompasses the works of Vygotsky and Dewey, both of whom believed that education and experience were inseparable (Dimitriadis & Kamberelis, 2006). Dewey advocated students’ active participation in learning, which in turn created experiences through which students constructed their own learning, stating “there is an intimate and necessary relation between the process of actual experience and education” (Dewey, 1997, p. 20). It is through these experiences, embedded within a constructivist classroom, that students reading picture books may encounter cognitive disequilibrium as they relate to the

characters in the storyline solving problems that naturally arise. Through this process, students connect their prior knowledge to the new situation and reflect on new possibilities, thus creating their own knowledge (van den Heuvel-Panhuizen & van den Boogaard, 2008).

Contextualized learning—learning within a context that one can relate to—creates authentic involvement that enhances understanding. Brown, Collins, and Duguid (1989) explain the importance of this framework, which they call situated learning, by illustrating the usefulness of vocabulary learned through contextualized conversation as opposed to memorizing dictionary definitions, which is often a slow and generally unsuccessful process. They then relate this idea to mathematics stating that "it is common for students to acquire algorithms, routines, and decontextualized definitions that they cannot use and that, therefore, lie inert" (p. 33). Donaldson and Hughes (1979) highlight the importance of contextualized learning in mathematics education when they found that young children could understand mathematical concepts in context, they had not understood when presented formally. Lave and Wenger (1991) encourage the use of situated learning in school environments by explaining the misalignment between the typical confined school situations and real world contexts, further clarifying that learning acquired in decontextualized contexts is bound and often not useful in real life experiences. For instance, although mathematics word problems have often been seen as the bridge from procedural to conceptual understanding, the syntax and diction found in them is unique to word problems, thus creating decontextualized and unauthentic problems (Brown, Collins, & Duguid, 1989).

The authenticity issue is central to the theory of experiential learning, which places a high value on the relevance of learning through experiences (Dewey, 1997). The use of picture books in mathematics instruction could provide a platform for students learning mathematics to interact with a story and experience how the story's characters interact with and solve mathematical problems. This approach seeks to provide a contextualized format that would facilitate students' visualizing how mathematical knowledge is used in real life contexts.

The experiential, contextualized learning opportunities made possible by the use of picture books afford the potential for meaningful mathematics education. As Rhodes and Smith (2009) express, children enjoy picture books, because they can relate to the characters and the storyline, thus promoting conversation. This discussion is an important aspect of mathematics, as mathematical understanding extends beyond computational skills and includes the ability to validate and support one's process and answer (Ball, 1999). The ability to validate and justify one's responses is promoted by the Standards for Mathematical Practices outlined by the Common Core State Standards, which specifically advocate for students to be able to "construct viable arguments and critique the reasoning of others" (National Governors Association Center for Best Practices, 2010, para 4). Therefore, this study investigated the relationship between the use of picture books and students' mathematical achievement.

Reflexivity

As a constructivist, I believe that one's view of the world is impacted by one's background and experiences from which researchers cannot distance themselves during

engagement in scholarly work. Instead, a researcher's background can affect the choice of what to investigate, the manner of investigation, and the communication of the findings (Malterud, 2001). By acknowledging my motivation and rationale for conducting the present study, I hope to contextualize the investigation and its subsequent findings.

During my own schooling I can recall feeling alone in my enjoyment of the study of mathematics; my peers instead loved to read. This pattern continued as I began my coursework in preparation for teaching. For this reason, I sought to investigate an instructional strategy that had the potential to cultivate positive student dispositions towards mathematics. Reflecting on my peers' and colleagues' delight in reading and literacy instruction, I began to wonder if incorporating books might aid both teachers and students in enjoying and relating to mathematics in a new manner. Thus, I designed a study that, through professional development, aided teachers in the use of picture books, and then investigated the impact that these books had on students' mathematical achievement and dispositions.

I was especially interested in investigating how picture books impacted particular groups of students. As a person of Hispanic cultural heritage, I have often learned from family members through their storytelling traditions. Such storytelling traditions closely resemble teacher read alouds, which are common in literacy, yet scarce in mathematics. My delight in such stories is likely due, at least in part, to my background. Therefore, this study used student demographics to investigate the impact the use of picture books

had on students' mathematic achievement based on particular characteristics, such as ethnicity, ELL status, gender, and socioeconomic status.

As a researcher, it is important to acknowledge my biases while remaining open to new insights. Based on my reading of the current literature about the use of picture books in mathematics, I believed this instructional strategy held the potential to improve students' mathematical dispositions, ease teachers' hesitations about teaching mathematics, and improve students' mathematical achievement. Yet, it is important to note that I have not taught in a traditional elementary classroom and have not implemented this strategy as a teacher. Therefore, my investigation was not directly impacted by my own experience using picture books to teach mathematics.

My experiences as both a teacher and elementary school administrator have impacted the manner in which this study sought to use collaborative professional development. Throughout my ten years as an educator, I have spent many hours being told what and how to teach or "trained" on new instructional strategies with no guidance on how the new strategies would meet the particular needs in my classroom. It is my belief that this lack of contextualized professional development stunted the new instructional strategies from reaching their fullest potential. For this reason, the present study valued the knowledge teachers brought and sought to work with teachers through collaborative professional development that discussed their work environments and adjusted accordingly to meet the contextualized needs of each educator. I believe collaborative professional development between teachers and researchers can be mutually

beneficial, whereby educational theory and practice work in tandem to promote best teaching practices.

Dissertation Organization

This dissertation is presented in five chapters. This first chapter presented necessary background information about mathematics education, a statement of the research problem, the purpose, need for and significance of the study, as well as the limitations, delimitations, and assumptions imposed by this investigation. In addition, to aid the reader in understanding the researcher's perspective, this chapter provided definitions of key terms, the theoretical framework, and a reflexivity statement. The next chapter will provide, through a review of literature, background knowledge grounded in research on four topics: (a) teacher professional development, (b) student dispositions and achievement, (c) integrated instruction, and (d) the use of picture books in mathematics education. Chapter three provides a detailed account of the methodology utilized. Next, chapter four answers the research questions by reporting the findings of the investigation and a discussion of these findings. Lastly, chapter five briefly summarizes the study, relates the current study to prior studies from the review of literature, presents implications as a result of the findings, and then offers suggestions for future research.

Chapter 2

Review of Literature

A review of literature presents established ideas about a topic and identifies critical gaps, thus situating the current research within the current body of knowledge while also establishing the purpose and need for the current study (Randolph, 2009). The purpose of this study was to investigate how the use of picture books in primary grade mathematics instruction impacted students' mathematics achievement and students' dispositions towards mathematics. Due to this study's evaluation of both students' mathematics achievement and dispositions, literature explaining a connection between student mathematics achievement and dispositions is presented. Because students' mathematics achievement and dispositions are positively influenced when subjects are integrated, the literature about integrating subjects follows. However, teaching through the integration of subject matter and using strategies that promote mathematical learning is complex suggesting the need for professional development for teachers. Therefore, a review of various models of professional development is provided. The professional development section focuses on collaborative professional development models due to the study's use of collaboration over an extended period of time Lastly, in order to situate the current study within the body of knowledge already known about the use of picture books in mathematics instruction, the findings of previous research investigations on this topic are detailed and compared to the current study.

Student Dispositions and Achievement

Recognizing student dispositions, or attitudes, towards mathematics is important, because they can influence student participation and academic achievement. The National Research Council (2001) emphasizes the importance of students' mathematical dispositions stating, "Students who have developed a productive disposition are confident in their knowledge and ability. Those with positive dispositions believe that with appropriate effort they can achieve mathematical success" (p. 133). Moreover, dispositions have been found to have a major influence on student's mathematical performance and attainment of mathematical proficiency (Akey, 2006; Haladyna, Shaughnessy, & Shaughnessy, 1983; National Research Council, 2001). One explanation for this is that dispositions affect students' motivation level (Brophy, 2010; Haladyna, Shaughnessy, & Shaughnessy, 1983; Tuan, Chi-Chin, & Shyang-Horng, 2005). For instance, students are more likely to persist through challenging concepts when they enjoy the content.

Alternatively, students with negative mathematical dispositions are less motivated to learn mathematics, demonstrate significantly higher levels of mathematical anxiety, and have lower confidence in their mathematical abilities (Ashcraft, 2002; National Research Council, 2001). Hannula (2002) cautions that negative dispositions can also be an indicator of the cognitive struggles students are experiencing. Knowing the origins of negative mathematical dispositions is necessary to overcome such dispositions and their implications. It has been pointed out that students' negative mathematical dispositions stem from traditional mathematics instruction that focuses on rote memorization (Geist,

2010). Tobias (1998) and Tsui and Mazzocco (2006) further elaborate by identifying elements of traditional instruction that are associated with the formation of negative dispositions. Their collective work indicates that the following elements of traditional mathematics instruction lead to negative student dispositions:

- Instruction focused solely on lecturing from textbook
- Instruction without real world application
- Standardized instruction for all students
- Instruction accepting only one strategy to solve problems
- Instruction using large amounts of repetition

Although, students as young as kindergarten have been identified as displaying negative dispositions towards mathematics (Rameau & Louime, 2007), most students enter school with positive dispositions towards mathematics (National Research Council, 2001). Given the adverse effects of negative dispositions and the beneficial effects of positive dispositions, it is important students maintain positive mathematical dispositions throughout their academic careers.

It has been explained that positive dispositions stem from students' use of mathematics in their daily lives (National Research Council, 2001). In order to ensure that students entering school with positive mathematical dispositions continue this outlook, teachers should emphasize the continued formation of positive dispositions. However, most teachers neglect the development of such dispositions, instead focusing solely on skills (National Research Council, 2001). As a means of overcoming this shortfall and to improve students' mathematical dispositions, teachers should utilize a

variety of teaching strategies that relate to students' real life experiences (Bursal & Paznokas, 2006). In fact, the integration of subjects has been identified as a useful strategy for developing students' positive dispositions towards mathematics for the following reasons: (a) increased motivation to reflect on the learning, (b) learning within real-life scenarios, and (c) it encourages students to build connections between new knowledge and their existing knowledge (Ellis & Fouts, 2001; Hargreaves & Moore, 2000).

The instructional avenue a teacher takes, be it the use of a variety of strategies that includes the integration of other subjects or a traditional rote memorization approach, has a large impact on the development of students' disposition towards mathematics. In order to help foster students' positive dispositions towards mathematics, teachers must first evaluate and be cognizant of student dispositions. For this reason, the present study used students' self-reported daily disposition towards mathematics evaluated through the use of an emotion scale (Appendix A). A comparison of the control and treatment groups' disposition towards mathematics provides insight regarding the impact the use of picture books has on students' mathematical dispositions.

Integrated Instruction

Improved students' mathematical dispositions are one of the many proposed benefits of integrated instruction. Despite schools long-standing tradition to teach subjects in isolation from one another, integrating subjects across the curriculum can demonstrate to students how knowledge from multiple disciplines are used to solve real world problems. Integrating mathematics across the curriculum demonstrates how

mathematics goes beyond memorized algorithms to provide students with opportunities to see how mathematics is useful in their daily lives. Van De Walle (1994) articulates this point asserting, “Children should see that mathematics plays a significant role in art, science, and social studies. This suggests that mathematics should frequently be integrated with other discipline areas and that applications of mathematics in the real world should be explored” (p. 5). Vacca, Vacca, and Mraz (2014) specifically encourage the integration of mathematics and literacy proclaiming that picture books can be used to enhance instruction in every content area, because such books captivate students’ attention in ways that textbooks simply cannot. Yet, the knowledge acquired through textbooks and picture books alike are not enough. As stated by the National Council of Teachers of English and the International Reading Association, “knowledge alone is of little value if one has no need to, or cannot, apply it” (*Standards for the English Language Arts*, 1996, p. 12). Accordingly, integrated instruction affords students with the necessary application of knowledge by allowing students to utilize the information from one subject when it is needed to solve problems presented in other subject areas.

A means of integrating instruction is through the use of picture books. The use of picture books in mathematics provides students with opportunities to apply their knowledge while solving problems, thus fostering critical thinking skills, a necessary skill for the use of mathematical knowledge in real world situations. Uy and Frank (2004) state that “outside of school, students must make connections between disciplines for real-life and real-time experiences and use higher order thinking skills to solve problems” (p. 180). By using picture books to integrate mathematics and literacy,

students can see problems in contexts that resemble real life experiences, thus encouraging them to see how mathematics is useful beyond the confines of the classroom.

Picture books use stories to integrate the curriculum, which provides unique and useful benefits. Because stories have been an influential part of society since the inception of time, they are a familiar context. In ancient times oral stories were passed from generation to generation, and advancements in technology now allow such stories to be passed in written form that hold “wondrous tales” (Malinsky & McJunkin, 2008, p. 410) that “speaks to the heart of children” (Spann, 1992). Cognitive scientists have affirmed the significance of this long standing storytelling tradition, indicating that they are the most instinctive way to organize information for retention (Bruner, 1987; Schank & Abelson, 1995; Casey et al., 2008). Accordingly, research has found that information learned within a story context produces greater retention and information recall (Bower & Clark, 1969; Graesser, Hauft-Smith, Cohen, & Pyles, 1980; Mishra, 2003), a necessary skill to reach mathematical proficiency. Furthermore, the retention and recall of information is especially true for stories that combine text and pictures (Levie & Lentz, 1982; Mayer, 2011).

Using picture books in the classroom can tap into the rich storytelling traditions, because these books synergistically use “both text and illustration to create meaning; one is not as powerful alone as it is with the other” (Giorgis, 2010, p. 51). Thus, picture books have the “potential to act as a magnifying glass that enlarges and enhances the reader’s personal interactions with a subject” (Vacca &Vacca, 2005, p. 161). Draper

(2002) specifically states that such books not only make mathematics and reading compatible but also inseparable. However, picture books should not replace the curriculum or textbook. They instead can enhance the mathematics curriculum when used to introduce mathematical content, assess student's prior knowledge, address mathematical misconceptions, or demonstrate visual representations of mathematical ideas (Whitin & Whitin, 2004).

Picture books may also enhance the learning of mathematics vocabulary learned in a contextualized format. Literacy experts have long proclaimed increased vocabulary as a major benefit of picture book readings. For instance, shared picture book readings between adults and students have been found to spark conversations (Wasik & Bond, 2001) that extend beyond everyday communication, thus expanding students' vocabulary (Fletcher & Reese, 2005). It has been proposed that similar effects would be found for mathematics content (Casey, Kersh, & Mercer Young, 2004; Shiro, 1997; Welchman-Tischler, 1992). For example, it is proposed that students learning mathematics vocabulary in context, as opposed to memorized definitions, supports students' flexible understanding and application of mathematics vocabulary in new situations (Brown, Collins, & Duguid, 1989). In addition, research indicates that large amounts of mathematics vocabulary can best be learned within a story context, void of teachers' direct instruction of definitions (Nagy, Herman, & Anderson, 1985).

Many researchers and educators alike have written about the distinct benefits of integrating mathematics and literacy through picture books. In particular, Lakes (2009) explains three benefits: (a) an increase in a student's natural mathematics interest, (b) an

increase in mathematical communication where students explain their thinking, and (c) strengthened problem-solving and reasoning abilities. Others have outlined similar benefits, which include mathematics presented:

- Visually to aid in the understanding of abstract concepts (Shatzer, 2008; Tucker, Boggan, & Harper, 2010; Whitin & Whitin, 2004)
- Multiculturally (Leonard, 2008; Whitin & Whitin, 2004)
- Contextually (Clark 2007; Columba, 2013; Golden, 2012; Thatcher, 2001; Whitin & Whitin, 2011).

Other benefits written about include:

- Fostering a student's ability to build mathematical connections (Clark, 2007; Golden 2012; Shatzer, 2008; Shiro, 1997; Ward, 2005)
- Creating positive attitudes towards mathematics (Burns, 2010; Clark, 2007; Tucker, Boggan, & Harper, 2010)
- Increasing students' use and understanding of mathematics vocabulary (Golden, 2012; Kurz & Bartholomew, 2012; Moyer, 2000; Ward, 2005).

Furthermore, such stories and books provide a meaningful avenue to invigorate and enlighten students' knowledge across the curriculum (Rhodes & Smith, 2009); therefore, it seems such books hold great potential as a teaching resource.

It has been proposed that the stories captured in picture books play a powerful role for the teaching and learning of mathematics (Whitin & Wilde, 1995). For instance, a study conducted with kindergarten students found that students learning geometry concepts within an oral storytelling context outperformed those who learned the same

concepts in a decontextualized format (Casey, Erkut, Cedar, & Mercer Young, 2008). It has further been suggested that these benefits of learning through stories are particularly advantageous for children from diverse cultures, many of whom come from cultures with strong oral storytelling traditions (Pellowski, 1990; Schiro, 2004).

There have been many written about advantages regarding the use of children's literature to integrate instruction. This study sought to investigate how integrated instruction through picture books used in mathematics instruction impacted student achievement and student dispositions towards mathematics. The population sample of the present study (86% minority) afforded the opportunity to investigate the aforementioned hypothesized advantage of learning within a story context for children from diverse cultures with long standing traditions of oral storytelling.

Collaborative Professional Development

It has been cautioned that despite the many benefits of integrated instruction, it is difficult and demanding for teachers to implement (Hargraves & Moore, 2000). A well-documented strategy for improving classroom instruction to overcome such difficult and demanding tasks is professional development (Ball & Cohen, 1999; Carney, Brendefur, Thiede, Hughes, & Sutton, 2014; Cohen & Hill, 2000; Corcoran, Shields, & Zucker, 1998; Darling-Hammond & McLaughlin, 1995; Elmore, 1997; Little, 1993; National Commission on Teaching and America's Future, 1996; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). In order for students to reap the full benefits of integrated instruction, Douville, Pugalee, and Wallace (2003) encourage professional development focused on integrated instruction.

Professional development is a key component for improving classroom instruction to in turn impact student achievement (Ball & Cohen, 1999; Carney, Brendefur, Thiede, Hughes, & Sutton, 2014; Cohen & Hill, 2000; Corcoran, Shields, & Zucker, 1998; Darling-Hammond & McLaughlin, 1995; Elmore, 1997; Little, 1993; National Commission on Teaching and America's Future, 1996; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). As Lieberman (1995) and Sarason (1990) explain, schools should aim to cultivate not only student learning but also teachers' continued learning throughout their careers. In doing so, schools are not neglecting student learning, but rather affecting student learning through continuous teacher learning. Darling-Hammond (2008) accentuates this point stating that "the professional teacher is one who learns from teaching, rather than one who has finished learning how to teach" (p. 95). Involving teachers in professional development aids in their continued learning. For this reason, the particular needs of both teachers and students should be considered when designing professional development to garner the most impact from professional development (Guskey & Huberman, 1995).

Traditionally, professional development has taken the form of large-scale district workshops or in-service training that focus solely on specific skills and the knowledge necessary to implement specific instructional practices (Beswick, 2006). Such professional development often takes the form of a more knowledgeable "expert" informing the "less knowledgeable teacher" of practices needed in their classroom (Cochran-Smith & Lytle, 1999). Yet, this "expert" often has little, if any, knowledge of the context in which the teacher executes the complex task of teaching. Simply

providing teachers with resources, curriculum materials, and instructional ideas without properly attending to their contextualized needs is insufficient. Doing so is analogous to students reciting math facts or executing memorized procedural steps without properly understanding mathematics. Not surprisingly, this traditional form of professional development has had “a terrible reputation among scholars, policy-makers, and educators alike as being pedagogically unsound, economically inefficient, and of little value to teachers” (Smylie, 1997, p. 45). Moreover, Flint, Zisook, and Fisher (2011) add that traditional forms of professional development designed to leave teachers feeling more empowered in fact leave them feeling less empowered; thus, the investment of time and money spent on traditional forms of professional development to impart knowledge fail to provide dividends in teacher learning or increased student achievement.

In light of the ineffectiveness of traditional professional development (Ball & Cohen, 1999; Darling-Hammond & McLaughlin, 1995; Smylie, 1997), the value of large-scale facilitator-directed professional development has recently been questioned (Flint, Zisook, & Fisher, 2011). As a result, new forms of professional development have emerged that move away from solely presenting teachers with knowledge and instead work with smaller groups of teachers within a collaborative setting that allows the presentation of new knowledge over longer periods of time. It is explained that such new forms of professional development are largely dependent upon collaborative discussion between professional developers and teachers which focuses on teacher reflections on the implementation of the new practice and their contextualized questions (Dajani, 2014). Research demonstrates that teachers largely prefer and value this type of professional

development that provides connections between the theory presented and teachers' contextualized work environments (Garet, Porter, Desimone, Birman, & Yoon, 2001).

To aid the creators of professional development in designing collaborative learning opportunities for teachers, Darling-Hammond (2008) outlines the following essential elements: (a) the engagement of teachers in concrete teaching and assessment tasks and observations of other teachers, (b) an integration of teachers' questions within educational research, (c) the collaboration of teachers and the creators of professional development in the sharing of knowledge, (d) a direct connection between new teaching methods and teachers' work with their particular students, (e) problem-solving around specific problems of practice which take place over longer periods of time, and (f) a connection with other aspects of school, district, and state-wide change. Echoing the sentiments of the aforementioned essential elements of effective professional development, Flint, Zisook, and Fisher (2011) add that effective professional development is a collaborative process that is teacher and student learning centered and is personally related to the teaching practices of educators.

Meeting these essential elements of effective professional development is difficult in large district wide professional development meetings. Effective professional development can more readily be met within smaller groups of teachers collaborating with professional developers within a relationship of trust, respect, acceptance, and support (Shroyer, Yahnke, Bennett, & Dunn, 2007; Stien, Hubbard, & Mehan, 2002; Swars, Meyers, Mays, & Lack, 2009). An integral component of professional development conducted in these small groups is the shift from one expert dispensing their

knowledge to all group members collaborating together to strengthen teaching practices. When this occurs, the traditional relationships of professional development are altered from vertical relationships, where one person imparts their knowledge to those needing the information, to horizontal relationships, where collaboration among the entire group is valued (Wesley & Buysse, 2001). Professional development in this manner modifies the traditional form of professional development intended to dispense knowledge to large groups of teachers to smaller job-embedded professional development, which include less teachers but are more effective in influencing teachers' practices (Avalos, 2011; West & Staub, 2003).

Professional development for elementary teachers focused on mathematics instruction is also needed, because the teaching of mathematics requires knowledge that extends beyond proficiency in procedural skills. Hill, Schilling, and Ball (2004) describe this as the difference between knowledge of mathematics and mathematical knowledge for teaching. They describe the knowledge of mathematics as the ability to proficiently employ mathematical algorithms, to think and reason mathematically, and "do mathematics". It is further explained that this type of knowledge is sufficient for the general population. Alternatively, teachers' mathematical knowledge must extend beyond this ability to include the knowledge one needs to effectively teach mathematics. Such knowledge includes why and how mathematical algorithms work, how to best present mathematical content to students from particular grade levels and backgrounds, and the types of errors students are likely to make in order to identify and explain the mathematical flaws presented by such errors (Hill, Schilling, & Ball, 2004).

Unfortunately, it is reported that most elementary teachers not only dislike the teaching of mathematics but also lack the appropriate mathematical knowledge for teaching, thus necessitating content area professional development (Ma, 1999).

Elementary teachers' relatively weak mathematical content knowledge and mathematical knowledge for teaching has led many to dislike the teaching of mathematics and therefore replicate the manner in which they were taught (Ball, Thames, & Phelps, 2008; Wilkins, 2008). This is problematic, because teachers' past experiences in mathematics often differ greatly from current educational goals (Ball, 1996; Ball, Thames, & Phelps, 2008; Wilkins, 2008). For example, elementary teachers' mathematical knowledge may be based on memorized procedural rules (Ball, 1996), yet current mathematics education asks teachers to move from instructing students how to compute mathematics to instead guide students to construct mathematical knowledge that allows for the flexible use of mathematics (Wegner, 2008).

In addition, elementary teachers replicating the manner in which they were taught often dislike the teaching of mathematics. Wood (1988) further explains that elementary teachers' displeasure with mathematics is a perpetual problem whereby students' aversion to mathematics often stems from years of instruction from teachers who themselves disliked mathematics. To break this cycle, professional development should include the development of positive attitudes towards mathematics (Wilkins, 2008). To accomplish this, Lakes (2009) suggests the integration of literacy into mathematics instruction, because many elementary teachers have a strong language arts background and, therefore, enjoy the teaching of literacy. Yet, as Hargraves and Moore (2000) warn,

integrating the curriculum, although beneficial for students, is difficult and demanding for teachers. A means to integrate literacy and mathematics is through the use of picture books in mathematics instruction. To assist teachers in the demanding task of integrating picture books in mathematics instruction and to ensure teachers have the resources and knowledge to integrate literacy and mathematics through picture books, Flevares and Schiff (2014) call for professional development focused on this instructional strategy.

Mindful of the demanding task of integrating picture books into mathematics instruction and the benefits of collaborative professional development, this study provided elementary teachers with weekly collaborative professional development that focused on the use of picture books in mathematics instruction. The teachers in the treatment group met bi-weekly in grade level groups for 18 weeks to select picture books that aligned with their mathematics curriculum and their students' interests. During each meeting, teachers reflected on previous lessons with specific attention to the picture book portion of the lesson, and then used their previous experiences to select a picture book for upcoming lessons (one per week).

The Use of Picture Books in Mathematics Education

The call for professional development to aid teachers in the use of picture books in mathematics instruction seems prudent given the relatively short history the use of picture books has in mathematics instruction. The first published articles encouraging the use of picture books in mathematics education were both published in 1962, one by Beard and the other by Whitaker. Both publications recommend children's books that can invite the learning of mathematics, but provide no instructional strategies or evidence

for the effectiveness of such instruction. Seventeen years after the aforementioned publications, Far (1979) published an article supporting the use of picture books for mathematical learning, yet she pointed out that the books available at that time were antiquated and often out-of-print. Therefore, she appealed for more accurate and inviting books to present conceptual mathematics to children. Shortly thereafter, Radebaugh (1981) published an article not only supporting and recommending picture books in mathematics instruction, but also providing a rationale for the use of such books. Yet, evidence supporting its effectiveness was still absent.

Currently, articles providing teachers with practical advice for the use of picture books in mathematics instruction are common; in fact, Flevares and Schiff (2014) indicate that such articles have been on the rise since the 1990's. Interestingly, this coincides with the National Council for Teachers of Mathematics (NCTM, 1989) *Curriculum and Evaluation Standards* that emphasized the need for the teaching of mathematics for conceptual understanding. The *Curriculum and Evaluation Standards* specifically advocate "…the use of children's books as a vehicle for communicating mathematical ideas" (National Council of Teachers of Mathematics, 1989, p. 5). Additionally, this publication states that "Many children's books present interesting problems and illustrate how other children solve them. Through these books students see mathematics in a different context while they use reading as a form of communication" (1989, p. 28). With a steady increase in practitioner publication and support from the NCTM, it is not surprising that studies evaluating the effectiveness of this practice soon followed. Jennings, Jennings, Richey, and Dixon-Krauss (1992) carried out the first

investigation evaluating the impact of picture books used in mathematics instruction, the next such study was conducted by Hong (1996), and, most recently, van den Heuvel-Panhuizen, Elia, and Robitzsch (2014) examined this topic. Table 4 situates the present research within previous investigations by outlining the details of each.

The previous investigations evaluating the impact of picture books used in mathematics education have been conducted in settings that differed from one another. In fact, none of the previous studies have been conducted in the same country, thus limiting the comparability of these studies. Jennings et al. (1992) examined 61 kindergarten students in Arkansas, most of whom were white (92%) and half (50%) of whom were classified as low socioeconomic status. Hong (1996) investigated 57 kindergarten students from one private school in Korea. The ethnicity and socioeconomic status of these students is not reported. Yet, because the students were educated at a private school, one might be able to infer that only a small percentage of students came from low socioeconomic backgrounds. Van den Heuvel-Panhuizen et al. (2014) conducted the largest study, which was comprised of 384 students from 18 schools in the Netherlands. It is reported that 12% of these participants came from a low socioeconomic status, 87% were Dutch, 13% were non-Dutch, and approximately 15% of participants spoke a non-Dutch language at home. It is not, however, reported if the students speaking a non-Dutch language at home received language support at school.

In order to expand the literature, the current study investigated within a context that differed from the previous research. Unlike the previous studies, which were limited to kindergarten, this study expanded the population by including first and second grade

Table 4. Comparison of Studies

	Jennings et al. (1992)	***Hong (1996)***	***Van den Heuvel-Panhuizen et al. (2014)***	***Present Study***
Location	United States	Korea	Netherlands	United States
Student Sample Size	61	57	384	136
Teacher Sample Size	4	2	18	12
Minority Group Representation	8%	Not Reported	13%	91%
Low Socioeconomic Status	50%	Not Reported*	12%	93%
English Language Learner Representation	Not Reported	Not Reported	Home Language Reported	47%
Student Population by Grade Level	Kindergarten	Kindergarten	Kindergarten	Kindergarten, First Grade, Second Grade
Duration of Treatment Phase	20 Weeks	9 Weeks	12 Weeks	18 Weeks
Book and Lesson Selection	Prescribed	Teacher Collaboration	Prescribed	Teacher Collaboration
Increased Mathematics Achievement	Yes	Yes**	Yes	Evaluated
Mathematical Achievement Instrument	Standardized Test	Standardized Test & Qualitative Measure	Researcher Developed Measure	Standardized Test
Increased Mathematical Dispositions	Yes	Yes	Not Evaluated	Evaluated

Notes. *See narrative, **Qualitative measure only

students, thus providing new insight on how the use of picture books used in mathematics impacts other primary grades. The continued inclusion of kindergarten students allowed the present study to be compared with previous studies.

The population of the present study also enhanced the literature by expanding the diversity of studied populations through examining a larger pool of students from low socioeconomic (93%) and minority groups (91%). Although one study (Van den Heuvel-Panhuizen et al., 2014) reports the home language of the students, no study provides findings to indicate how the use of picture books impact students receiving language support in school. Therefore, the present study investigated how this practice impacts the 47% of participants classified as ELL students who receive English language support at school. The inclusion of a high percentage of students from a low socioeconomic status, minority backgrounds, and those receiving English language support in school provides important information given the mathematical achievement gap that exists in the U.S. today (NAEP, 2013).

Just as the populations in previous studies differed, so too does the method of investigation. Jennings et al. (1992) investigated the impact of picture books on students' mathematical achievement during a 20-week treatment period in four classrooms from two elementary schools that utilized two different mathematics curricula. The teachers in this study were randomly assigned to either the control or treatment group. The students in the control group were taught using the regular mathematics curriculum used at that research site; conversely, the students in the treatment group were taught with the use of 20 picture books incorporated into the regular mathematics curricula used at that school

site. In addition, the teachers in the treatment group met weekly for training through demonstrations on how to use picture books to teach the required curriculum. Teachers were also provided with lesson plans and suggested questions to stimulate mathematical thinking, thus teachers taught using a prescribed picture book lesson. Two different standardized tests were used as the pre-post measurements. The pretest measurement used was the Test of Early Mathematics Ability and the posttest measurement was Metropolitan Readiness Test. A t-test analysis of the pretests showed no statistically significant difference between the two groups, thus establishing the comparability of the two groups' mathematical achievement. The t-test analysis of the posttest revealed a statistically significant increase in the mathematical achievement of students in the treatment group as compared to those in the control group, thus indicating a positive effect associated with the use of picture books and mathematical achievement.

Hong (1996) used a mixed methods approach to assess the impact of picture books in mathematics instruction on students' mathematical achievement. This study took place in two classrooms that were randomly assigned to either the control or the treatment group. Students were given The Learning Readiness Test as a pretest measure. No significant difference was found between the two groups, thus indicating the comparability between the two groups' mathematical achievement. Then, collaborative planning for teachers in both the control and treatment group was utilized throughout the nine-week treatment period. Teachers from both groups collaboratively selected the books to be used each week. The predetermined book selection criterion was that the book should relate to the educational themes (all curriculum, not just mathematics) of the

week. Both the control group and the treatment group used 28 books in total; however, the books between the two groups differed. The control group teacher selected books that related to the general educational themes without consideration of the mathematics curriculum. Conversely, the teacher in the treatment group selected books that related to the educational themes and could be used to teach the mathematics curriculum. After the treatment period, the Early Mathematics Achievement Test was administered as a posttest, which revealed no statistically significant difference between the two groups. This indicated that both groups had progressed at approximately the same rate, thus indicating a neutral effect associated with the use of picture books in mathematics instruction. A voluntary qualitative measure, which involved students performing four mathematical tasks, was also administered to some but not all students. The results of these tasks indicated higher mathematical achievement attained by the treatment group as compared to the control group, thus indicating a positive effect associated with the use of picture books and mathematical achievement.

To assess the impact the use of picture books has on students' mathematical achievement, Van den Heuvel-Panhuizen et al. (2014) utilized a 12- week treatment period with 18 teachers randomly assigned to either the control or treatment group. In preparation for the treatment period, the researchers conducted two three-hour professional development sessions for the teachers in the treatment group. These sessions outlined the predetermined books for each lesson and provided prescribed lessons and training for the effective use of picture books as determined by the researchers. The teachers in the treatment group were expected to use two pre-assigned

picture books per week, and it is important to note on those two days per week the picture books would replace the regular instruction from the textbook (the textbook without picture books would be used the other three days per week). Because the picture books would replace the textbook two days per week, it was essential the teachers understood and implemented the prescribed mathematics tasks as outlined by the researchers. In contrast, the control group continued with regular instruction and submitted their lesson plans to researchers. Interestingly, the submitted lesson plans revealed that during this period, no teacher in the control group chose to use a picture book in mathematics instruction. The PICO test, a test designed by the researchers, was used as both a pre and post assessment of students' mathematical achievement. The results of the two separate one-way ANOCOVAs indicated that the students in the treatment group had a mathematical achievement increase that was 27% larger than that of the control group. This indicated a positive effect associated with the use of picture books and mathematical achievement. Further analysis revealed no significant difference based on home language, age, socioeconomic status, mathematical ability, or language ability. However, picture books were found to significantly increase girls' but not boys' mathematical achievement.

The present study also sought to evaluate the impact the use of picture books had on students' mathematical achievement. Two measures of mathematical achievement were used: the STAR Math assessment and chapter tests associated with the curriculum used at the research site (enVisionMATH). Like van den Heuvel-Panhuizen et al. (2014), the mathematical achievement of students was evaluated to seek relationships between

the effect of the treatment and student demographics. A unique aspect of this study is the manner in which it allowed for more collaboration with and input from the teachers in the treatment group than have previous studies. First, a quasi-experimental design was used that allowed teachers to self-select their involvement in either the control or treatment group. Second, teachers in the treatment group worked collaboratively with the researcher on a bi-weekly basis throughout the 18-week treatment period to plan instruction that met the contextualized needs of each teacher. More specifically, the teachers in the treatment group had bi-weekly collaborative professional development meetings with the researcher and the other teachers in their grade level that self-selected their participation in the treatment group. During these meetings teachers shared their triumphs and challenges from previous weeks and used these experiences to help guide each teacher to select new picture books for future weeks. At each meeting, the researcher provided book recommendations for the upcoming lessons, and then each teacher selected one book to be used during each of the two upcoming weeks (teachers could select the same book, though they were not required to do so). Once a book had been selected by each teacher, the researcher and the teachers brainstormed instructional strategies to be used in conjunction with the picture book. Then, teachers selected the day to use the picture book (once per week) and the instructional strategy that they felt best met the needs of their students.

This collaborative approach stands in stark contrast to the prescribed lessons used by Jennings et al. (1992) and Van den Heuvel-Panhuizen (2014). Hong (1996) states that different books were used in the control and treatment groups, yet he does not specify

who selected the books or how they were selected. Therefore, it is unclear if teachers were given choices or if any meetings took place between the teachers and the researcher. He does, however, provide the lesson plan template to be used by both groups, thus implying that this study allowed for less teacher collaboration than the present study.

Two of the previous studies evaluated the impact the use of picture books in mathematics had on students' mathematical dispositions. Jennings (1992) investigated students' dispositions towards mathematics through an evaluation of students' voluntary mathematical vocabulary used during activity centers in the classroom. To do this, four research assistants recorded student's mathematics vocabulary during activity centers that followed the mathematics lesson. An informal analysis of student comments during activity centers coupled with comments made by parents, teachers, and other significant adults provided informal evidence to support an increased interest and motivation in students' attitude towards mathematics, thus indicating an informal positive effect on students' mathematical dispositions when picture books are used.

Hong (1996) used a different approach to interpret students' mathematical dispositions; his evaluation included a student created bar graph indicating their favorite activity center. When choosing among book, reading, writing, mathematics, manipulative, science, dramatic play, and art activity centers, students in the treatment group much preferred the mathematics activity center over the other centers. In fact, 11 of the 29 students in the treatment group selected mathematics as their favorite corner, as opposed to 5 of the 28 students in the control group. In addition, it was observed that students in the treatment group voluntarily spent "somewhat" more time in the

mathematics activity center than did those in the control group, therefore indicating their voluntary participation in mathematical tasks, which suggests a positive impact on students' mathematical dispositions when picture books are used in mathematics.

The present study also sought to evaluate how the use of picture books impacted student dispositions towards mathematics. Like Hong (1996), student responses were used, however, unlike Hong, this study used student responses given at multiple times throughout the study. A five-point emotion scale with images was given to students to self-report their feelings toward mathematics during six of the 18 weeks of the treatment period (administered daily during these six weeks), thus allowing for a more comprehensive evaluation of student dispositions.

Chapter Summary

In summary, the material presented in this review of literature addressed four areas: the link between student dispositions and achievement, integrated instruction, collaborative professional development, and the findings of previous research investigating the use of picture books in mathematics instruction.

Regarding students' mathematical dispositions, the importance of positive student dispositions was on account of such dispositions fostering perseverance and academic achievement. It was further presented that traditional mathematics education focusing on rote memorization of algorithms negatively impacts student dispositions. Therefore, teachers should instead utilize a variety of teaching strategies that focus on conceptual understanding within a contextualized learning format, which readily allows students to relate to the new information. Mindful of this, the present study sought to evaluate how

the contextualized learning format of picture books impacted students' mathematical dispositions, which in turn could affect student achievement.

Next, advantages of an integrated curriculum were explored with particular attention to the use of picture books and stories as a medium for the integration of literacy and mathematics to improve mathematical understanding. The advantages presented included: (a) the opportunity to apply knowledge and foster critical thinking, (b) greater retention of knowledge, such as mathematical vocabulary, and (c) a meaningful avenue that is culturally relevant thus allowing students to personally relate to the content. Along with the many proposed benefits of integrated instruction, a caution regarding its difficulty was also presented.

In light of the difficulty teachers face when integrating instruction, the need for professional development focused on this instructional strategy were presented. Various models of professional development were presented, then, due to this project's focus on collaborative professional development, the benefits of this style were presented. As outlined by Darling-Hammond (2008), collaborative professional development allows teachers and the creators of professional development to work collaboratively over an extended period of time so that, through reflective discussions, teachers can resolve questions stemming from their contextualized needs, thus creating a bridge between theory and practice. This section also presented elementary teachers' need for mathematics education professional development.

Lastly, previous studies and publications regarding the use of picture books in mathematics instruction were presented to establish the current knowledgebase and

demonstrate how the present study broadened this field. Previous studies have found that the use of picture books increases mathematical achievement and positively impacts students' mathematical dispositions. However, the findings of these studies are limited by the populations previously investigated; therefore, the present study expanded their findings by including a broader range of grade levels and by assessing the impact such instruction had on large populations of minority students, students from low socioeconomic groups, and ELL students.

Chapter 3

Methodology

This study investigated the use of picture books as a means to support students' mathematical understanding. More specifically, this study utilized quasi-experimental research to evaluate the causal impact picture books had on students' mathematical achievement and their dispositions towards mathematics. Results were delineated across gender, grade level, ethnicity, and ELL status. This section outlines the collection of data, the method of data analysis, and the rationale for each decision.

Research Design

An experimental research design randomly assigns participants from a common pool into two groups. One group receives a treatment while the other group does not. In this study, the treatment consisted of collaborative professional development in which the treatment group of elementary teachers reviewed and selected picture books to enhance the mathematics curriculum, then planned mathematics lessons that used at least one picture book per week. Meanwhile, the teachers in the control group followed their district's mathematics curriculum. However, in this study, teachers were allowed to self-select whether to participate in the treatment or control group. Cook (1979) would describe this as a quasi-experimental research design as it lacks the random assignment of participants to the control or treatment group. Campbell and Stanley (2015) explain that such research is common in educational research in order to account for the real world context in which the research takes place.

Research Questions

Through a quantitative analysis of students' mathematical achievement on tests and self-reported dispositions towards mathematics, this study addressed the following three research questions:

1. Is there a relationship between the mathematical achievement of students taught through regular mathematics instruction and those taught with the use of picture books as measured by the STAR Assessment and chapter tests accompanying the selected textbook?
2. Is there a relationship between the effect of the treatment and student demographics?
3. Is there a relationship the mathematical dispositions' of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

Context of the Study

The population in this study was comprised of teacher and student participants from one school, Riverside Elementary (pseudonym). This school was selected for two reasons: (a) the relationship developed between the researcher and the school and (b) the student demographics of the school. Two years prior to the start of this study, the researcher began serving as a volunteer translator at various school events and established relationships with the teachers and administrative staff. Because of this relationship, the principal asked the researcher to conduct the present study at her school. Thus, the researcher was able to draw on these relationships to enhance the collaborative work

already begun with the teachers who, then, became study participants. Secondly, this site was selected because of the diverse pool of learners represented in the student population. This aligned with the researcher's question regarding how the use of picture books in mathematics instruction impacted students from diverse backgrounds.

Riverside Elementary is situated in an urban setting in the southeastern region of the United States. This school educates approximately 400 pre-kindergarten through fifth grade students from economically disadvantaged (93%) and minority groups (42% Black or African American, 44% Hispanic or Latino, and 14% White). Student achievement scores from the third through fifth graders at Riverside Elementary reveal that approximately 23% of students attained proficient levels in mathematics and 13% attained proficient levels in reading.

Riverside Elementary has approximately 24 classroom teachers and four English as a Second Language teachers, as well as additional support faculty and staff. All kindergarten, first, and second grade teachers were invited to voluntarily participate in the study. Four teachers from each grade level (12 total teachers) chose to take part in the study, and one teacher preferred not to participate. In order to be respectful of teachers' interests, time, and commitment levels, these 12 teachers were allowed to self-select their involvement in either the control or treatment group. A total of seven teachers self-selected their participation in the control group (two kindergarten, two first grade, and three second grade teachers) and five teachers self-selected their participation in the treatment group (two kindergarten, two first grade, and one second grade teacher). All 12-teacher participants were certified teachers with an average of four and a half years of

teaching experience, three and a half of which took place at Riverside Elementary. The 136 student participants came from these 12 classrooms.

All students from the 12 classrooms were invited to take part in the study through an information sheet and parent consent form that were sent home in students' homework folders at the start of the school year. These forms were available in both English and Spanish due to the large Hispanic population at Riverside Elementary. Student assent was also obtained from participating students. The study began with 174 students, but five students withdrew from Riverside Elementary and an additional student started receiving special education services. Consequently, they were removed from the study.

At the end of the first academic quarter (nine weeks), the teachers felt the needs of the first grade students would be better met through homogeneous ability grouping. Consequently, after ability grouping, 32 of the 63 first grade students switched between treatment and control group. Thus, these 32 first grade students were excluded from the study. It is important to note that the 31 students that remained in the study may have been reassigned to a different teacher; however, they either continually received instruction with the use of picture books once a week or continually received the regular mathematics curriculum without the use of picture books.

In summary, the study began with 174 students, five students were eliminated, because they transferred to a new school, an additional student was excluded, because he began receiving special education during mathematics instruction, and 32 first grade students were eliminated due to the ability grouping reassignments. Ultimately, the study analyzed the data of 136 students from 12 classrooms (seven control and five treatment).

Due to the uneven split of teachers in the control and treatment groups, 59% of the student participant population was taught with the regular mathematics curriculum, and thus represented the control group. The remaining 41% of the student participant population was taught through the use of, at least, one picture book per week and represented the treatment group. The student population had almost an even split of males and females (48% male and 52% female) from the three grade levels. The kindergarten students comprised the largest grade level group in the study representing 43% of the total student participant population. First and second grade students represented approximately 23% and 35% respectively.

Not unexpectedly, the student participant sample had large representations of students from minority backgrounds (32% Black, 59% Hispanic and 9% White). Additionally, 47% of the students involved in the study were classified by the school as ELL students and, therefore, received language support throughout the duration of the study. This diversity allowed for the specific analysis of how picture books used in mathematics instruction impacted students from diverse backgrounds.

Description of the Treatment

Teachers in the treatment group had bi-weekly collaborative professional development meetings in grade level teams with the researcher. It was important to this researcher to establish a relationship built on trust, respect, and acceptance so that participants would honestly share their accounts that reflected both their triumphs and challenges. To establish this trust, the researcher listened to teachers, encouraged brainstorming among the group, and only offered suggestions when the conversation had

stalled. During each collaborative professional development session, teachers used their weekly math journal entries (journal prompts are included in Appendix B) as a starting point to share their experiences from the previous two week's lesson. The focus of the conversation was the effectiveness of the picture book lesson in cultivating mathematical understanding and the students' positive disposition towards mathematics. These shared experiences were then used as a springboard for selecting picture books for upcoming lessons that aligned with the mathematics curriculum and appealed to students' interests and planning for the effective use of the selected book to enhance students' mathematical understanding.

Each collaborative professional development meeting was audio recorded and transcribed by the researcher. The researcher then read and reread the transcripts to gain a deeper understanding of the needs of each teacher. The researcher used these insights to plan for the next meeting by seeking picture books that both met these needs and aligned with the mathematics curriculum to be taught in the next two weeks. Rather than choosing one book, the researcher supplied teachers with several picture book options that could be used in future lessons. Teachers were not obligated to use these books; in fact, they were encouraged to seek picture books from their own classroom libraries. As picture books were considered for use in mathematics instruction, a mathematics picture book library list (Appendix C) was created. Appendix D details the books used by each teacher.

Data Collection and Instruments

Data were collected to evaluate how the use of picture books in mathematics instruction impacted students' disposition toward mathematics and mathematical achievement. Students' data about their dispositions towards mathematics were collected through student self-reported scores on a five-point emotion scale during predetermined weeks of the treatment phase (collected daily during weeks 1, 4, 8, 11, 14, and 18). Two measures were used to assess student's mathematical achievement: the STAR Assessment and chapter tests. The chapter tests used came from the enVisionMATH curriculum published by Pearson Education. The enVisionMATH curriculum and its accompanying chapter tests were selected for this study because of its use at the school site.

The STAR Math Enterprise Assessment is a computer based skills assessment of mathematics achievement created by Renaissance Learning, who has been designing student-learning assessments since 1984 and mathematics skills assessment since 1998. Presently, the company reports 18,000 schools worldwide utilize their testing software. The average test time for this 34-item examination is 20 minutes. The testing software operates on Computer Adaptive Testing (CAT), meaning that the difficulty of each test item is determined by the response to the previous question. Due to the adaptive nature of the STAR exam, it begins with an easy question, which if answered incorrectly prompts another easy question. When a student continues to miss the easier questions, she/he may be exited from the exam without receiving a score. The CAT has a test bank of 5,000 items, thus allowing for multiple tests per year without overlapping test

questions. However, it is important to note that the software ensures the presence of test items from all domains during each test administration.

Renaissance Learning, as well as independent organizations, reports the internal consistency of the STAR Assessment for all grade levels combined to be 0.97 and its use for re-test to be 0.93. They also report that the STAR Assessment is aligned with state and national curricula, such as the Common Core State Standards. The company has conducted statistical analyses using predictive measures and lists many state exams, including the state where this study took place, for which the STAR assessment can be used as a predictive measure. The National Center for Student Progress Monitoring (U.S. Department of Education, 2006) and The National Center on Intensive Intervention (U.S. Department of Education, 2015), both funded by the U.S. Department of Education, have concluded that the STAR assessment meets their requirements for validity and reliability.

The STAR assessment was chosen as a measure of students' mathematical achievement for this study, because it has proven to be a valid and reliable assessment and because of its existing use at Riverside Elementary. The STAR Assessment at Riverside begins in first grade; consequently, no STAR Assessment data were available for kindergarten student participants. The STAR Assessment achievement scores were collected from first and second grade students at the start and conclusion of the treatment period allowing for a pre/posttest standardized assessment. Chapter test scores for all grades (kindergarten, first, and second) were collected, as the tests were administered throughout the treatment period. The aforementioned student data collected were analyzed using quantitative measures.

The Student Mathematics Disposition Scale (SMDS) was developed by the researcher to assess students' attitude toward mathematics at the conclusion of mathematics lessons. This single question survey allows students to self-report their disposition towards mathematics using a five-point emotion scale (Appendix A). This scale utilizes facial images to assist students in accurately describing their emotion and/or attitude towards mathematics on a given day. The images provided in Qualtrics, an online survey software, were used to provide uniformity in the facial images across the scale. Teachers were provided with definitions for each picture in the scale and were instructed to read these definitions to students at each administration of the SMDS survey. The following definitions were provided: the saddest face means "I hated math today", the sad face means "Math was not fun today", the neutral face means "I thought math was OK today", the happy face means "I liked math today", and the happiest face means "I loved math today". To assist students in recognizing the correct facial expression, teachers pointed to the picture as they read each definition.

The SMDS was administered frequently during the treatment phase in order to assess if students' mathematical dispositions changed over time. The SMDS was administered daily during six of the eighteen weeks of the treatment phase of the study (weeks 1, 4, 8, 11, 14, and 18). The rationale for the selection of these weeks was to administer the survey approximately once every three weeks of the treatment phase. With this in mind, the research site's academic calendar was evaluated in order to avoid weeks when school was not in session. By attending to such detail, each data collection week provided a full five days of instruction.

Data Analysis

To determine the relationship between mathematical achievement and the use of the treatment in first and second grade, a one-way ANOVA was conducted. Because this study was investigating achievement and students gain scores were used, the combining of first and second grade scores was not a concern (Zimmerman & Williams, 1982). Wang and Wu define gain scores as the difference between two successive test scores (2004). It should also be noted that gain scores, unlike other comparisons, do not necessitate the comparability of two groups at the start of treatment, because gain scores do not compare overall achievement but instead achievement gains during the treatment phase (Wang and Wu, 2004). This study's utilization of gain scores allowed for larger group comparison, which provided the quantitative analysis with higher statistical power (Kraemer & Thiemann, 1987). Mindful of the appropriateness and benefits of gain scores, the mathematical achievement growth of each student was calculated by subtracting their pretest score from their posttest score. Huck, McLean, and Hernstein (1975) state that a one-way ANOVA is a sound statistical analysis for gain scores.

Unlike the STAR assessment, which allowed for grouping across grade levels, the chapter test data was grade-level specific due to the specific content and tests associated with each grade. A one-way ANOVA was used to determine if there was a difference between the average mathematical achievement on chapter tests from students in the control and treatment group at each grade. The first step in this analysis was to record the percentage of correct answers, not the number of correct answers for each student test score. Doing so allowed for the equal comparison between all chapter tests within each

grade level. For each student, a chapter test average was calculated. This was an appropriate analysis, because, as Gravetter & Wallnau (2011) explain, a one-way ANOVA can be used to determine if two sets of data are significantly different from each other.

This one-way ANOVA, by utilizing the mean scores from the chapter tests, examined the difference between the treatment and control group throughout the duration of the study. Yet, it did not establish the comparability between the treatment and control group at the start of the treatment phase. Since picture books were used by the treatment group leading up to the first chapter test, it would have been difficult to know if the data demonstrated comparability because of or in spite of the treatment effect. Therefore, it was deemed that establishing comparability at the start of the study, then reassessing this comparability at the conclusion of the study, was not appropriate within the context of this study. Instead, trend line graphs were created to visually depict the differences of the groups' mean scores for each chapter test, thus visually representing data trends or patterns. As Kivikunnas (1998) explains, this type of representation strengthens statistical analysis.

Student achievement scores from either chapter tests (kindergarten) or STAR Assessment gains scores (first and second grade) were then compared by subgroups to evaluate if there was a difference between the mathematical achievement by gender, ethnicity, and ELL status subgroups. Socioeconomic status comparisons were not completed, because such a high percentage (93%) of student participants came from low socioeconomic backgrounds. However, given the high concentration of students from

low socioeconomic status, the findings of this study can be generalizable to students from similar backgrounds. Similarly, only 9% of the student participant identified as White; therefore, this group was too small to be statistically compared to the minority students (32% Black, 59% Hispanic). However, the Black and Hispanic student participant populations were large enough to be compared, thus allowing the study to examine how the use of picture books differently impacted the mathematical achievement of these two minority groups.

Due to the uneven split of treatment and control group teachers in second grade, one teacher and three teachers respectively, the treatment sample was too small to be compared by subgroups. Similarly, first grade had small treatment and control groups due to the ability grouping that caused approximately half of the student sample to be withdrawn from the study. Therefore, the mathematical achievement of the first and second grade students by subgroup was compared through the sole use of STAR gain scores as a dependent variable in a one-way ANOVA. Because kindergarten students did not take the STAR Assessment, their subgroups were only compared through the use of chapter test data in a one-way ANOVA. Kindergarten students represented the largest sample size in the data set and had an adequate sample size for delineation by student demographics.

To evaluate if there was a relationship between the mathematical dispositions of students and the use of picture books in mathematics instruction, a two-way mixed ANOVA was conducted. As previously described, students self-reported their disposition towards mathematics on a daily basis using a five-point emotion scale during

weeks 1, 4, 8, 11, 14 and 18. Students in both groups rated their mathematical disposition daily on the assigned weeks and had five entries per week. These daily scores were then used to calculate a weekly average for each assigned week that represented the students overall disposition for the week. The rationale for producing a weekly average was to investigate if the use of picture books in mathematics instruction affected students' overall disposition, not just the disposition for the day in which the picture book was used. The students' self-reported overall dispositions of the treatment and control group from these six time points was analyzed with a two-way mixed ANOVA. As Willett (1989) declares, the analysis of multiple time points, such as that of the present study, allows for the analysis of the pattern of change overtime. Moreover, the two-way mixed ANOVA permitted an analysis of the interaction between time and treatment (Gravetter & Wallnau, 2011).

Missing data is ubiquitous in clinical research (Little & Rubin, 2014); therefore this study, like most studies, had missing data. For instance, in most instances, students had five data entries for each administration of the SMDS (one for each of the five week days). However, in some instances, students had missing data entries, because (a) they did not complete the survey when the rest of the class did, (b) they selected two scores for the same day in which case no score was entered for that day, (c) they were absent, or (d) the class did not have a mathematics lesson on that day due to events, such as field trips. The average score for students missing one or two disposition scores was calculated based on the number of data entries. For instance, if a student had data entries for Monday, Wednesday, and Friday, but lacked entries for Tuesday and Thursday, the

average was calculated by dividing the sum of the entries for Monday, Wednesday, and Friday by three instead of five. On nine occasions students had less than three data entries per week. When this occurred, their average score for that week was determined by inserting a mean score based on the other weeks' data. For example, when a student had less than three entries on the SMDS on week 14 of the study, a score for week 14 was determined by calculating that student's average score from weeks 1, 4, 8, 11, and 18. Graham (2009) asserts the use of mean data as a predictor for missing data for statistical analysis.

To avoid missing data from chapter test scores, teachers administered chapter tests to students who were absent on test days upon students return to school. Although a more equal comparison would have compared chapter tests that were taken by all students on the same day, this was not possible given the real world context in which this study took place. However, allowing chapter tests to be taken when students returned omitted the need to use estimates to effectively handle individual students missing chapter test data. Yet, a significant amount of chapter test data was eliminated due to the first grade ability grouping that took place at the nine-week marking period of this study. When this took place, the various first grade groups began using different chapter tests to assess student progress, thus limiting the comparability of those chapter test results for the second nine-week marking period. For this reason, the first grade chapter test data compared by the one-way ANOVA only utilizes the tests from the first nine-week marking period. Similarly, the trend data depicted in the line graph only displays the tests from the first nine-week marking period.

Missing data from the STAR assessment occurred for three first grade students who did not meet the minimum standard of the assessment during the pretest and were consequently exited from the exam and received no score. However, all three students received a STAR post treatment achievement score. To determine an imagined pretest score for these three students, the researcher rank ordered all student participant posttest scores. The three students having test scores below the student not receiving a pretest score were identified, as were the three students whose test scores were above this student. Then, the pretest scores of these six students were averaged to determine a pretest score for the student who was missing a pretest score. This was repeated for each of the three students missing a pretest score.

Chapter Summary

The purpose of the study was to investigate how using picture books in kindergarten, first, and second grade mathematics instruction impacted students' mathematical achievement and students' dispositions towards mathematics. A quasi-experimental research design was used to compare student scores on chapter tests, the STAR Assessment, and student self-reported mathematical dispositions recorded on a five-point emotion scale between a treatment and control group. The treatment group teachers engaged in bi-weekly collaborative professional development meetings over an 18-week period to select and discuss how to use one picture book per week in their mathematics lessons. These books were selected to align with the mathematics curriculum and with students' interest. Students in the control group were taught using the district's mathematics curriculum. Additional analysis of student data from both

groups was also used to determine: (a) if there was a relationship between student achievement of the two groups, (b) if there was a relationship between the effect of the treatment and student demographics, and (c) if there was a relationship between students' dispositions towards mathematics between those taught with the use of picture books and those taught without the use of picture books.

Chapter 4

Results and Discussion

The purpose of the study was to investigate how using picture books in kindergarten, first, and second grade mathematics instruction impacted students' mathematical achievement and their dispositions towards mathematics. More specifically, this study addressed the following three research questions:

1. Is there a relationship between the mathematics achievement of students taught through regular mathematics instruction and those taught with the use of picture books as measured by the STAR Assessment and chapter tests accompanying the selected textbook?
2. Is there a relationship between the effect of the treatment and student demographics?
3. Is there a relationship between students' disposition towards mathematics of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

As explained in chapter three, student data was collected through enVisionMATH curriculum chapter tests, the STAR Assessment, and student self-reported mathematical dispositions recorded through the SMD Scale. This chapter presents the findings for each research question.

Analysis Plan

To evaluate the students' mathematical achievement and disposition towards mathematics, scatter plots were assessed in order to visually identify missing data. Then, missing data was addressed as outlined in chapter three. Next, general descriptive statistics were calculated to determine the mean and standard deviations of the variables analyzed. Lastly, the appropriate analyses were run to answer each research question. These analyses included one-way ANOVAs and a two-way mixed ANOVA. The most commonly used level of statistical significance, the .05 level, was used in this study for hypothesis testing (Salkind, 2006).

Sample Description

The student sample for this data was comprised of 136 students representing three grade levels from one urban school located in the southeastern region of the United States. The frequency and percentage of the group distributions by group and grade level are provided in Table 5. Gender among the students was evenly represented as presented in Table 6. Additionally, in Table 6, the large representations of minority students and ELL students are presented. Although the socioeconomic status of this sample is not provided, it should be noted that this sample drew from a student population where 93% of the students were eligible for the Free or Reduced Lunch Program.

Table 5. Group Assignments by Grade Level

Grade Level	***Treatment or Control***	***Classroom Frequency***	***Classroom Student Frequency***	***Classroom Student Percentage***	***Total Student Frequency***	***Total Student Percentage***
Kindergarten	Treatment	2	29	21.32	57	42.6
	Control	2	29	21.32		
First	Treatment	2	14	10.29	31	22.8
	Control	2	17	12.5		
Second	Treatment	1	13	9.56	47	34.6
	Control	3	34	25		
Total		12	136	100	136	100

Table 6. Demographic Representation by Treatment or Control

Treatment or Control	***Gender***		***Ethnicity***			***ELL Status***	
	Male	Female	Black/ African American	Hispanic/ Latino	White	ELL	non-ELL
Treatment	27	29	19	32	5	26	30
Control	38	42	25	48	7	38	42
Total Frequency	65	71	44	80	12	64	72
Total Percentage	47.8	52.2	32.4	58.8	8.8	47.1	52.9

Results

Research Question #1

Is there a relationship between the mathematics achievement of students taught through regular mathematics instruction and those taught with the use of picture books as measured by the STAR Assessment and chapter tests accompanying the selected textbook?

A one-way between-subjects ANOVA (Table 7) was conducted to evaluate the relationship between the use of picture books in mathematics instruction and the first and second graders' mathematical achievement as measured by STAR gain scores. The mean gain score for the control group (N = 51) was 52.98 (SD = 36.90), and the mean gain score for the treatment group (N = 27) was 74.59 (SD = 50.94). There was a statistically significant difference between the gain scores of the treatment and control group, $F(1,76) = 4.62$, $p = .04$, indicating that the use of picture books had an effect on the STAR gain scores of the treatment group. In other words, the treatment group had larger gain scores than the control group. Due to the fact that there were only two groups, treatment and control, no post hoc tests were necessary. R-squared indicates that the treatment explains 5.7% of the variance in the gain scores ($R^2 = .057$).

A one-way between-subjects ANOVA (Table 8) was conducted to evaluate the relationship between the use of picture books in mathematics instruction and kindergarteners' mathematical achievement on chapter tests. The treatment group (N = 29) had a combined mean for all chapter tests of 83.15 (SD = 14.75), and the control group (N = 29) mean was 69.27 (SD = 18.29). There was a statistically significant

Table 7. One-Way Analysis of Variance of Gains Scores by Treatment and Control Groups

	df	***F***	***η***	***p***
Between Subjects	1	4.62	.05	.03
Error	76			
Total	78			

Notes. $R^2 = .057$ ($p < .05$)

difference between the chapter test scores of the treatment and control group, F (1, 56) = 10.12, $p = .002$, indicating that the use of picture books had an effect on the chapter test scores of the treatment group. In other words, the treatment group had higher chapter tests scores than the control group. Due to the fact that there were only two groups, treatment and control, no post hoc tests were necessary. R-squared indicates that the treatment explains 15.3% of the variance in the chapter test scores ($R^2 = .153$). In addition, Figure 1 depicts the treatment and control group mean score for each chapter test. This figure demonstrates that the treatment group outperformed the control group on all chapter tests.

Table 8. One-Way Analysis of Variance of Kindergarten Chapter Tests Scores by Treatment and Control Groups

	df	***F***	***η***	***p***
Between Subjects	1	10.12	.15	.002
Error	56			
Total	58			

Notes. $R^2 = .153$ ($p < .01$)

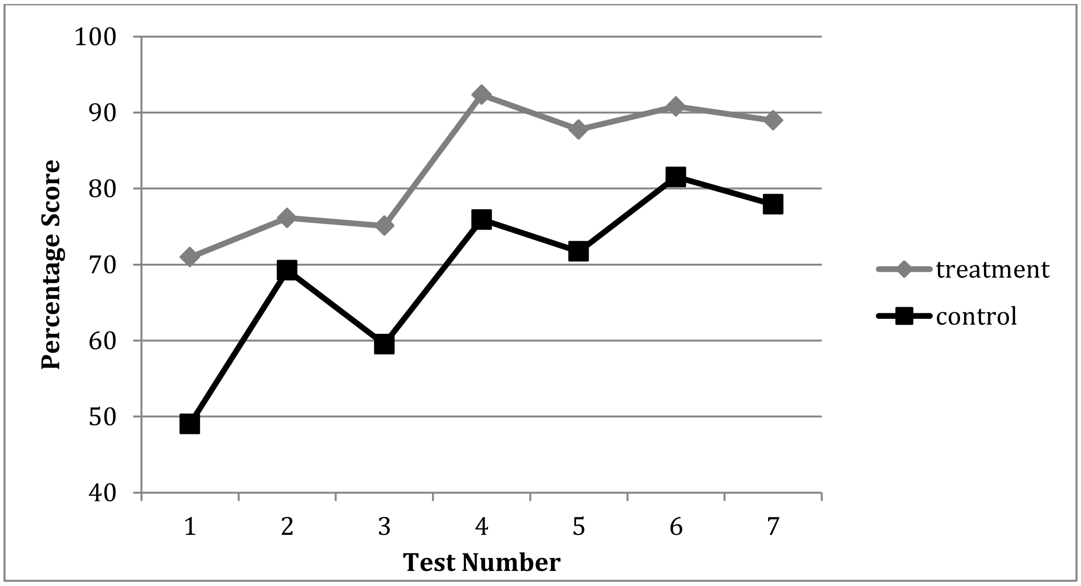

Figure 1. Kindergarten Chapter Test Scores Trend Data

A one-way between-subjects ANOVA (Table 9) was conducted to evaluate the relationship between the use of picture books in mathematics instruction and first graders mathematical achievement on chapter tests. The treatment group (N = 14) had a combined mean for all chapter tests of 71.93 (SD = 3.98), and the control group (N = 17) mean was 68.38 (SD = 12.83). There was no statistically significant difference between the chapter test scores of the treatment and control group, F (1, 57) = .11, p = .740, indicating a null treatment effect associated with the use of picture books in mathematics instruction for first grade students. In addition, Figure 2 depicts the treatment and control group mean score for each chapter test. This figure demonstrates that the treatment group outperformed the control group on three chapter tests, the control group outperformed the treatment group on one chapter test, and, on two occasions, the difference between the two groups was less than two percentage points.

Table 9. One-Way Analysis of Variance First Grade Chapter Tests Scores by Treatment and Control Groups

	df	***F***	***η***	***p***
Between Subjects	1	.11	.004	.74
Error	29			
Total	31			

Notes. $R^2 = .004$ ($p > .05$)

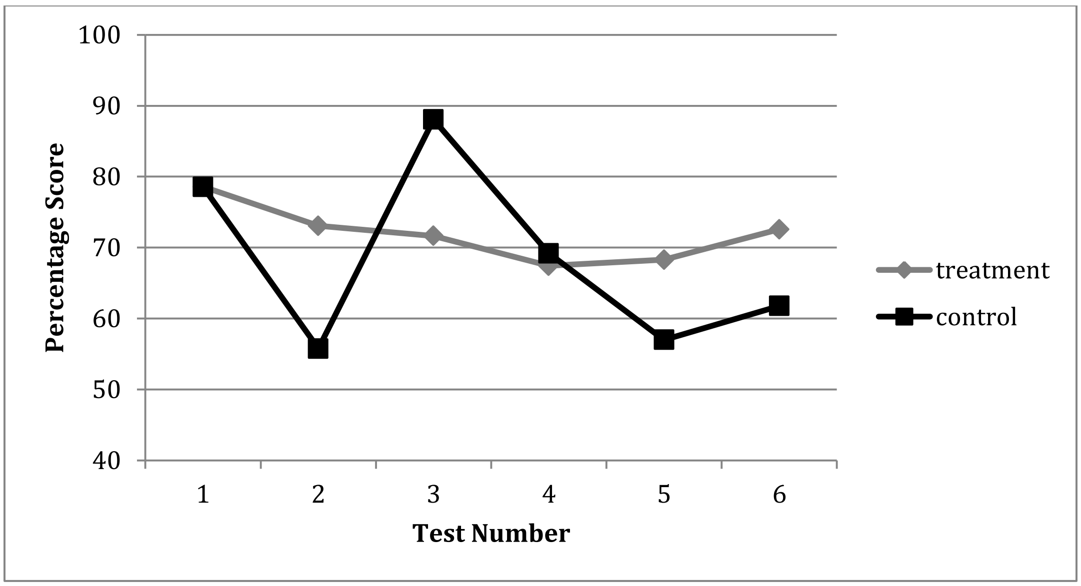

Figure 2. First Grade Chapter Test Scores Trend Data

Table 10. One-Way Analysis of Variance of Second Grade Chapter Test Scores by Treatment and Control Groups

	df	***F***	***η***	***p***
Between Subjects	1	1.04	.02	.31
Error	45			
Total	47			

Notes. $R^2 = .023$ ($p > .05$)

A one-way between-subjects ANOVA (Table 10) was conducted to evaluate the relationship between the use of picture books in mathematics instruction and second graders mathematical achievement on chapter tests. The treatment group (N = 13) had a combined mean for all chapter tests of 74.85 (SD = 6.27), and the control group (N = 34) mean was 79.06 (SD = 6.44). There was no statistically significant difference between the chapter test scores of the treatment and control group, F (1, 46) = 1.04, p = .314, indicating a null treatment effect associated with the use of picture books in mathematics instruction for second grade students. In addition, Figure 3 depicts the treatment and control group mean score for each chapter test. This figure demonstrates that the treatment group outperformed the control group on two chapter tests, the control group outperformed the treatment group on seven tests, and, on two occasions, the difference between the two groups was less than two percentage points.

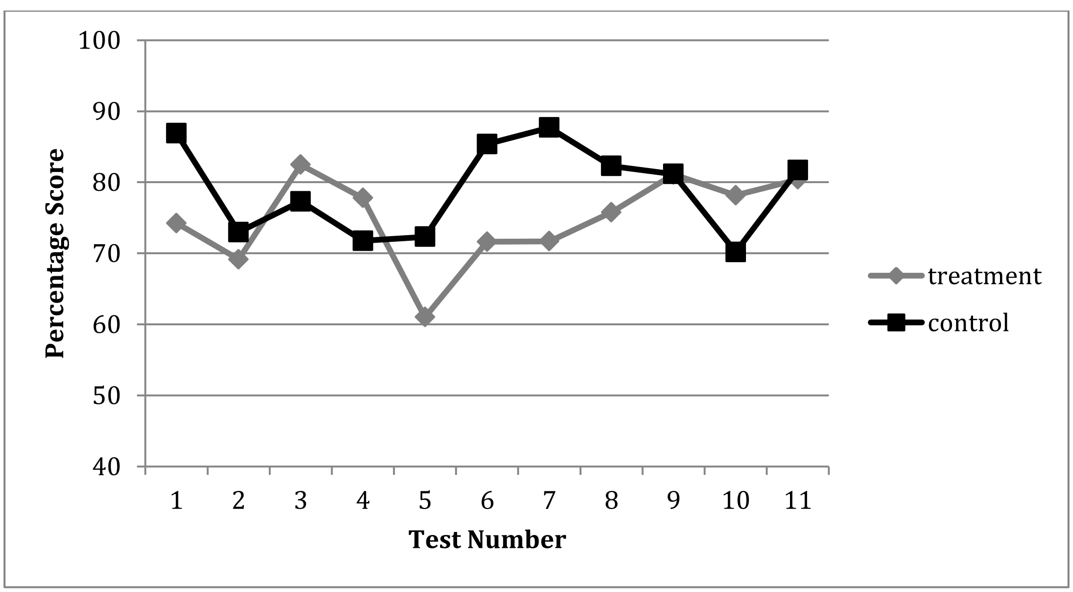

Figure 3. Second Grade Chapter Test Scores Trend Data

Research Question #2

Is there a relationship between the effect of the treatment and student demographics?

Gender. A one-way between-subjects ANOVA (Table 11) was conducted to evaluate the relationship between the use of picture books in mathematics instruction of the first and second grade treatment group on STAR gain scores by gender. The mean gain score for females (N = 16) was 76.87 (SD = 53.69), and the mean gain score for males (N = 11) was 71.27 (SD = 49.01). There was no statistically significant difference between the gain scores of the treatment group delineated by gender, F (1,25) = .08, p = .785, indicating a null treatment effect by gender associated with the use of picture books in mathematics instruction.

Table 11. One-Way Analysis of Variance of Gains Scores by Treatment and Control Groups by Gender

	df	***F***	***η***	***p***
Between Subjects	1	.08	.003	.79
Error	25			
Total	27			

Notes. R^2 = .003 (p > .05)

A one-way between-subjects ANOVA (Table 12) was conducted to evaluate the relationship between the use of picture books in mathematics instruction of the kindergarten treatment group on chapter tests by gender. The mean chapter test score for females (N = 16) was 83.77 (SD = 15.09), and the mean chapter test score for males (N = 13) was 82.45 (SD = 14.90). There was no statistically significant difference between the chapter test scores of the treatment group delineated by gender, F (1,27) = .05, p = .822,

indicating a null treatment effect by gender associated with the use of picture books in mathematics instruction.

Table 12. One-Way Analysis of Variance of Kindergarten Chapter Test Scores by Treatment and Control Groups by Gender

	df	***F***	***η***	***p***
Between Subjects	1	.05	.002	.82
Error	27			
Total	29			

Notes. R^2 = .003 (p > .05)

Ethnicity. A one-way between-subjects ANOVA (Table 13) was conducted to evaluate the relationship between the use of picture books in mathematics instruction of the first and second graders from the treatment group STAR gain scores by ethnicity. The mean gain score for Black students (N = 9) was 83.88 (SD = 52.88), and the mean gain score for Hispanic students (N = 15) was 68.67 (SD = 52.41). There was no statistically significant difference between the gain scores of the treatment group delineated by ethnicity, F (1,22) = .44, p = .515, indicating a null treatment effect by ethnicity associated with the use of picture books in mathematics instruction.

Table 13. One-Way Analysis of Variance of Gains Scores by Treatment and Control Groups by Ethnicity

	df	***F***	***η***	***p***
Between Subjects	1	.44	.02	.52
Error	22			
Total	24			

Notes. R^2 = .020 (p > .05)

A one-way between-subjects ANOVA (Table 14) was conducted to evaluate the relationship between the use of picture books in mathematics instruction of the kindergarten treatment group on chapter tests by ethnicity. The mean chapter test score for Black students (N = 10) was 92.37 (SD = 4.91), and the mean chapter test score for Hispanic students (N = 17) was 79.09 (SD = 14.73). A statistically significant difference between the chapter test scores of the treatment group delineated by ethnicity was found, F (1,25) = 7.53, p = .01, indicating a positive treatment effect associated with the use of picture books in mathematics instruction for Black students' mathematical achievement on chapter tests as compared to Hispanic students. Due to the significance of ethnicity in the treatment group, an exploratory analysis was conducted to compare the difference between the mean chapter tests scores of the Black and Hispanic students from the control group. The mean chapter test score for Black students (N = 8) was 73.46 (SD = 18.42), and the mean chapter test score for Hispanic students (N = 18) was 65.13 (SD = 18.53). A one-way between-subjects ANOVA (Table 15) using the control group by ethnicity was found to not be statistically significant at any confidence level, F (1,24) = 1.13, p = .299.

Table 14. One-Way Analysis of Variance of Kindergarten Chapter Test Scores for Treatment Group by Ethnicity

	df	***F***	η	***p***
Between Subjects	1	7.53	.23	.01
Error	25			
Total	27			

Notes. R^2 = .231 (p < .05)

Table 15. One-Way Analysis of Variance of Kindergarten Chapter Test Scores for Control Group by Ethnicity

	df	***F***	***η***	***p***
Between Subjects	1	1.13	.05	.3
Error	24			
Total	26			

Notes. R^2 = .045 (p > .05)

Table 16. One-Way Analysis of Variance of STAR Gain Scores for the Treatment Groups by ELL Status

	df	***F***	***η***	***p***
Between Subjects	1	.15	.006	.71
Error	25			
Total	27			

Notes. R^2 = .006 (p > .05)

statistically significant difference between the gain scores of the treatment group delineated by ELL status, F (1,25) = .15, p = .706, indicating a null treatment effect by ELL status associated with the use of picture books in mathematics instruction.

A one-way between-subjects ANOVA (Table 17) was conducted to evaluate the relationship between the use of picture books in mathematics instruction of the kindergarten treatment group on chapter tests by ELL status. The mean chapter test score for ELL students (N = 15) was 78.32 (SD = 11.00), and the mean chapter test score for non-ELL students (N = 14) was 88.33 (SD = 16.46). There was a statistically significant difference at a lower confidence level (p < .10) between the chapter test scores of the treatment group delineated by ELL status, F (1,27) = 3.64, p = .067, indicating that the use of picture books had an effect on the chapter test scores of ELL students within the

treatment group. In other words, non-ELL students within the treatment group had higher average chapter test scores than ELL students within the treatment group. Due to the fact that there were only two groups, ELL and non-ELL, no post hoc tests were necessary. R-squared indicates that the treatment explains 11.9% of the variance in the chapter tests averages (R^2 = .119). Due to the significance of ELL status in the treatment group, an exploratory analysis was conducted on the control group for comparison. The mean chapter test score for ELL students (N = 17) was 63.12 (SD = 17.58), and the mean chapter test score for non-ELL students (N = 12) was 77.99 (SD = 16.14). A one-way between-subjects ANOVA (Table 18) using the control group was found to be statistically significant, *F* (1,27) = 5.38, p = .02. Given that ELL students in both the treatment and control group experienced lower average chapter test scores than non-ELL students, this could indicate a possible confounding variable not accounted for in this model, including language barriers throughout the course of this study. Yet, it is worth noting that the ELL students in the treatment group had higher chapter test averages than the ELL students in the control group.

Table 17. One-Way Analysis of Variance of Kindergarten Chapter Test Scores for Treatment Group by ELL Status

	df	***F***	***η***	***p***
Between Subjects	1	3.64	.12	.07
Error	27			
Total	29			

Notes. R^2 = .119 (p < .10)

Table 18. One-Way Analysis of Variance of Kindergarten Chapter Test Scores for Control Group by ELL Status

	df	***F***	***η***	***p***
Between Subjects	1	5.38	.17	.03
Error	27			
Total	29			

Notes. R^2 = .166 (*p*> .05)

Research Question #3

Is there a relationship the mathematical dispositions' of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

A two-way mixed ANOVA (Table 19) was conducted to evaluate the relationship between the mathematical dispositions of students and the use of picture books in mathematics instruction over time. The mean self-reported disposition for the treatment and control group (N=136) at each of the six time points (weeks 1, 4, 8, 11, 14, and 18) are reported in Table 30. A Mauchly's Test of Sphericity produced a value of .74 (*p* = .00) indicating that the variances of difference between levels was not significantly different. Because of this, Greenhouse-Geisser was used to determine the within-subject effects (Tabachnick & Fidell, 2012). There was not a statistically significant interaction between the effects of the treatment and time on students' mathematical dispositions, *F* (4.43, 593.85) = .592, p = .685. Due to non-significance, a simple main effects analysis was not conducted. This result could mean that the students entered the treatment with initial positive mathematical dispositions that were not affected by time or the treatment.

Table 19. Two-Way Mixed Analysis of Variance of the Interaction of Time and Treatment

	df	***F***	***p***
Time	4.43	.84	.51
Treatment	1	2.12	.15
Time*Treatment	4.43	.59	.69
Within-Subjects Error	593.85		
Between-Subjects Error	134		

Notes. $p > .05$

Table 20. Mean Mathematical Dispositions by Treatment and Control Groups

	Week 1	**Week 4**	**Week 8**	**Week 11**	**Week 14**	**Week 18**
Control Mean (SD)	4.17 (.95)	4.23 (.93)	4.2 (1.1)	4.19 (1.12)	4.18 (1.23)	4.19 (1.13)
Treatment Mean (SD)	4.3 (.74)	4.43 (.93)	4.49 (.82)	4.22 (.89)	4.37 (.93)	4.47 (.75)

*Note*s. Treatment N=80, Control N=56

Discussion

A discussion section interprets, describes, and presents an explanation of the findings reported in the results section (Brett, 1994). Because this research is viewed through a constructivist lens, where absolute realities are unknowable, and thus the outcomes of one's research are individual perspectives or constructions of reality, multiple interpretations for each research question are presented (Guba & Lincoln, 1994). This section is organized by restating each research question, followed by a brief summary of the findings, and then interpretations that describe and explain the findings within the context of the study are presented.

Research Question #1

Is there a relationship between the mathematics achievement of students taught through regular mathematics instruction and those taught with the use of picture books as

measured by the STAR Assessment and chapter tests accompanying the selected textbook?

The analysis, which combined the first and second graders STAR gain scores, demonstrated statistically significant achievement growth from the treatment group as compared to the control group .It is important to note that this finding does not measure overall achievement, but instead the achievement growth during the 18-week treatment period. Respectful of this understanding, a comparison of the mean increase between the treatment (M=74.59) and control (M=52.98) group indicates that the increase of the treatment group was 40.79% larger. This coupled with the statistically significant difference between the treatment and control group can be taken to mean that the use of picture books in mathematics instruction had a positive effect on students' mathematical achievement.

Yet, a closer inspection of these findings reveals that the standard deviation of the treatment group (SD = 50.94) was higher than that of the control group (SD = 36.90). Although this may mean that the use of picture books had greater effects for some students than others, thus creating an achievement gap, an alternative explanation is also possible. The higher standard deviation reported for the treatment group might be explained by the ability grouping that took place in the first grade classrooms at the nine-week marking period. When this took place, the first grade treatment teacher participants became the instructors of high and low ability groups. Consequently, the students that remained in the treatment group belonged to one of these two ability groups. Likewise, the students that remained in the control group derived from the two mid-level groups

that were taught by the control group teacher participants. For this reason, the gain scores of the first grade control group may have been clustered closer together; yet, the gain scores from the treatment group may have shown more irregularity, due to the differing abilities represented by the high and low ability groups from which the treatment group was comprised. Therefore, the influence of the first grade ability grouping could help explain the higher standard deviation reported by the treatment group. Moreover, the impact of the first grade homogeneous grouping by ability taken together with the heterogeneous mix of abilities from the second grade treatment group, given the first and second grade significant increase in STAR gain scores, might also indicate that students from all ability groups can learn mathematics when picture books are used.

Like the STAR Assessment, the chapter test data provides insights regarding the effects of picture books on students' mathematical achievement. Although one might expect identical findings on both measures, this was not the case for the present study. The analysis comparing the mathematical achievement of first and second grade students (evaluated independently), unlike the STAR gain scores, demonstrated no statistically significant difference between the achievement of the treatment and control group. Understanding the differences between these assessment measures may provide an explanation for the discrepancy between the significant and non-significant findings. Due to the nature of CAT, the STAR Assessments can measure students' mathematical achievement gains without regard for students assigned grade level or the content presented in that grade level. Chapter tests, on the other hand, are constrained to measure

student achievement of grade level specific content. With these differences in mind, it is possible that the STAR Assessment is able to measure connections made between mathematical operations while learning about a given content. In other words, if, while learning about subtraction, students build connections about addition being the inverse operation of subtraction, the STAR Assessment could measure student achievement on both addition and subtraction. Yet, the chapter test scores might focus solely on students' understanding of subtraction. Mindful of this, it is possible that the discrepancy in findings between the two assessments indicates that the use of picture books in mathematics instruction aided students in building connections between mathematical concepts, which were not measured by chapter tests.

An alternative explanation for the discrepancy of the treatment effect of picture books in mathematics instruction for first and second grade students as measured by the STAR gain scores and the chapter tests lie in the content assessed by each chapter test. The trend line graphs (Figures 1-3) displaying the mean chapter test scores for the treatment and control groups from these grade levels demonstrate the amount by which the treatment or control group outperformed the other varied. This variance in achievement levels between chapter tests may suggest that the use of picture books may help students understand some mathematical concepts better than others. A content analysis investigation, which was outside the scope of the present study, could explore these differences.

Similarly, a content analysis could help explain the variance in achievement levels between the chapter tests of the kindergarten students (Figure 1). An important

distinction regarding the kindergarten chapter test graph is that the treatment group displayed higher mathematical achievement on every test. In addition, this difference was found to be statistically significant. This finding should, however, be exercised with caution, because no baseline data were available to establish the kindergarten treatment and control groups' comparability. For this reason, it is possible that the higher mathematical achievement can be explained by the treatment groups' higher mathematical understanding at the onset of this study. Yet, based on previous research (Jennings et al., 1992; Hong 1996; van den Heuvel-Panhuizen et al., 2014), which also indicates positive treatment effects associated with the use of picture books in kindergarten mathematics instruction, it is possible that the use of picture books explains the higher mathematical achievement displayed by the treatment group in this study.

Another explanation for the variance in achievement levels between the chapter tests scores depicted in each graph may lie in the academic freedom afforded by the collaborative nature of the professional development used in this study. This academic freedom honored teacher voice by providing teacher participants not with the book to use for each week, but instead several books from which to choose. Consequently, the variance may suggest that some books had greater effects than others. Similarly, the collaborative professional development did not provide scripted lessons that dictated the manner in which the picture books should be used. Therefore, this variance in achievement might also be explained by the unique ways in which the teachers chose to utilize the picture books to enhance the mathematics curriculum.

Despite several possible explanations for the variance in achievement between chapter tests, the findings from this data can be taken to mean that the use of picture books in mathematics instruction does not have a negative effect on students' mathematical achievement and, in some instances, has a statistically significant positive treatment effect.

Research Question #2

Is there a relationship between the effect of the treatment and student demographics?

The investigation of students' mathematical achievement by subgroups revealed conflicting results by grade level. No significant treatment effect on students' mathematical achievement was found by gender, ethnicity, or ELL status for the combined analysis of first and second grade students from the treatment group, as measured by STAR gain scores. Similarly, no significant treatment effect was found on the mathematical achievement of kindergarten students from the treatment group delineated by gender. However, a significant treatment effect was found in kindergarten for Black students as compared to Hispanic students from within the treatment group; yet, this difference did not hold true when the same analysis was run on the control group. In addition, the investigation of kindergarten students from the treatment group by ELL status revealed a significant difference between the mathematical achievements of non-ELL students as compared to ELL students, whereby the non-ELL students demonstrated higher mathematical achievement. Likewise, the non-ELL students from the kindergarten control group attained significantly higher mathematical achievement than did the non-ELL students.

The discrepancy between significant findings by some subgroups (ELL and ethnicity) in kindergarten, but not first and second grade might be explained by the different measures of assessments used to analyze the subgroups from these grade levels. As noted in chapter three, an analysis by subgroups of first and second grade independent of one another (chapter tests) was not possible due to the small student samples in these grade levels. Therefore, the subgroup analysis for first and second grade utilized the STAR gain scores. Yet, this measure could not be used for kindergarten, because it was not the practice of the research site to administer this test to kindergarten students. For this reason, the kindergarten subgroup analysis, instead, used chapter test scores. As Padilla (2001) explains, assessments can have cultural biases that give unfair advantages to one group over another. Therefore, the discrepancy in findings might be attributed to these measures sensitivity to evaluating the differences between these subgroups. Alternatively, it could also mean that the use of picture books in mathematics instruction has different effects on kindergarten students by subgroups than in first or second grade.

Nonetheless, the first and second grade data were evaluated using the same measure (STAR gain scores), and no significant difference was found from within the treatment group by gender, ethnicity, or ELL status. This can be taken to mean that the use of picture books in mathematics instruction has little, if any effect, on the subgroups evaluated. Or, it can be explained to mean that the use of picture books holds equal potential for the learning of mathematics for students from these subgroups. Regardless of one's interpretation, it seems the use of picture books in first and second grade

mathematics instruction does not have negative effects on the mathematical achievement of students from varied groups, such as gender, ethnicity, or ELL status.

The kindergarten data, on the other hand, revealed differences between the ELL status and ethnicity. A point, which should not be overlooked regarding the kindergarten chapter test data, is that the treatment group showed significant achievement gains over the control group. Yet, a within group comparison of the treatment or control group both demonstrated that non-ELL students exhibited higher mathematical achievement than ELL students. Although this data might be taken to mean that the treatment had greater effects on non-ELL students than ELL students, it can also be understood that the difference might be accounted for by a confounding variable outside the scope of the present study. Yet, within the context of this study, it should be noted that, although the kindergarten non-ELL students showed significantly higher mathematical achievement than ELL students, the ELL students from the treatment group had higher mean chapter tests (M = 78.32, SD = 11.00) than the ELL students from the control group (M = 63.12, SD = 17.58). Accordingly, this data might be interpreted to suggest that using picture books with ELL students in kindergarten cultivates mathematical achievement.

In the same manner that the kindergarten ELL subgroup analysis revealed differences, so too did the analysis by ethnicity. More specifically, when delineated by the two ethnic groups with large enough student samples for comparison, the kindergarten data from the treatment group revealed a significant treatment effect for Black students when compared to Hispanic students. Yet, an exploratory analysis of the control group found no significant difference between the achievement of Black and

Hispanic students. Although the variation in findings between the control and treatment group, due to the lack of baseline mathematical achievement data, could be accounted for by a difference in mathematical achievement prior to the onset of the study, it could also indicate the use of picture books in mathematics instruction holds greater potential for Black kindergarten students than Hispanic kindergarten students. In fact, a factor which may have contributed to the higher treatment effect of Black kindergarten students is that some picture books selected by the treatment teacher participants from this grade level depicted Black characters, with whom the students could have self-identified. Therefore, the use of picture books could have aided the treatment teachers in mathematics instruction that utilized culturally relevant pedagogy (Ladson-Billings, 1995), which manifested in higher achievement by Black students. A qualitative analysis of the transcripts from the collaborative professional development meetings, which was outside the scope of the present study, could be analyzed to further understand if this phenomenon was present.

In light of the possibility that the Black students in kindergarten may have self-identified with the characters depicted in the picture books used, it should be noted that results of the present study were influenced by the picture books available to the treatment teachers. Despite the researchers best effort to afford teachers with picture books choices that both aligned with the mathematics curriculum and appealed to students' interest, additional book options could have been made available to teachers. A valuable resource not utilized in this study, which could have provided additional book recommendations that may have resonated with more students from each subgroup, is the

school or public librarian. Librarians, due to their extensive interaction with books, could have added valuable book recommendations, which may have influenced the picture books teacher participants utilized, which in turn could have impacted the student data.

Research Question #3

Is there a relationship between the mathematical dispositions of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

The analysis comparing the weekly mean mathematical dispositions of the treatment and control group revealed no significant difference between the treatment and control groups' dispositions and that this effect did not change over time. A keen understanding of this data analysis can provide insights that explain the possible interpretations of this finding. Because this analysis did not compare the daily disposition of mathematics instruction with and without the use of picture books, the findings should not be interpreted to mean that there is null treatment effect on student dispositions when picture books are used. Instead, due to the comparison of mean weekly dispositions, this analysis should be interpreted to mean that if the use of picture books has an effect on students' mathematical dispositions (either positive or negative), its effects do not have lingering effects that significantly impact students' overall mathematical disposition.

Although the null treatment effect of picture books on mathematical dispositions over time can be taken to mean that the use of picture books in mathematics instruction does not improve students' overall mathematical dispositions, alternative explanations are

possible. For instance, a review of Table 20 demonstrates that both the treatment and control group reported high dispositions at all six time points. In fact, no weekly mean disposition score from the treatment or control group was less than four on a five-point rating scale. Therefore, the null treatment effect, taken into account with the high reported dispositions, could also be taken to mean that the use of picture books in mathematics instruction does not negatively affect students who have positive dispositions towards mathematics.

Yet, others might interpret the validity of such high student reported mathematical dispositions, especially in light of the self-reported data collection method of the present study. As Colton and Covert (2007) warn, self-reported data can be influenced by participants' desire to please the researcher. In the context of the present study, the students likely did not aim to please the researcher, whom they did not know and who was not present when the SMDS was administered. Instead, students may have desired to please their teachers, who were administering the SMDS. To minimize this possibility, the researcher provided student friendly directions for teachers to read during each administration of the SMDS. These directions asked teachers to point to each face when reading the following definitions: the saddest face means "I hated math today", the sad face means "Math was not fun today", the neutral face means "I thought math was OK today", the happy face means "I liked math today", and the happiest face means "I loved math today". In spite of the researcher's best effort to minimize participants' desire to provide pleasing responses, the high dispositions of both groups might be explained by the limitations of self-reported data.

Even though there are some inherent challenges with self-reported data, this data collection method may also provide benefits. For instance, reporting their dispositions by means of the SMDS may have positively influenced the instruction students (treatment and control) received. For example, asking teachers to collect students' self-recorded mathematical dispositions may have afforded teachers with a convenient way to become informed of students' dispositions. Consequently, the teachers may have, consciously or unconsciously, adjusted their instruction to develop higher mathematical dispositions. Therefore, an alternative explanation for the high mathematical dispositions reported by the students in both the treatment and control group could indicate that these students received instruction that cultivated positive mathematical dispositions. If this occurred, the National Research Council would affirm this practice, because they lament reporting that teachers often neglect the formation of positive student dispositions and instead focus solely on mathematical achievement (2001).

Chapter Summary

This chapter, cognizant of the study's purpose to investigate how using picture books in primary grades mathematics instruction impacted students' mathematical achievement and students' dispositions towards mathematics, detailed the data analysis to answer these research questions. In brief, the results of this study found that the use of picture books in mathematics instruction had a significant positive effect on STAR gain scores of the students in treatment group as compared to the control group. Similarly, kindergarten students in the treatment group demonstrated significantly higher

mathematical achievement on chapter tests, yet a null treatment effect was found for first and second grade students as measured by chapter tests.

When the STAR gain scores of first and second grade students were delineated by subgroups, no significant treatment effects were found by gender, ethnicity, or ELL status. However, the kindergarten chapter test data divided by subgroup revealed that the treatment had no effect by gender, higher effects for Black students as compared to Hispanic students, and non-ELL students in both the treatment and control group had higher achievement than ELL students. In addition, the results of this study revealed that the use of picture books in mathematics instruction did not have a significant effect on students' mathematical dispositions and that effect did not change over time. To better understand the possible interpretations of these findings, this chapter presented a discussion that described and explained the results within the context of the study.

Chapter 5

Conclusions and Recommendations

Although it was once thought that mathematical knowledge was necessary for only a select few, it is now understood that mathematical knowledge is used in everyday life and thus valuable knowledge for all (NCTM, 2000). Despite this understanding, NAEP reports that less than half of fourth graders in the United States are reaching a proficient level in mathematical achievement (2013). Furthermore, students from minority backgrounds, low socioeconomic status, and ELL students are outperformed by their counterparts, thus placing such students at a greater risk for academic failure in mathematics. Mindful of this, the present study evaluated the effects of using picture books in mathematics instruction on a student population that had an overrepresentation of students from minority backgrounds (91%), low socioeconomic status (93%), and ELL students (47%).

More specifically, the purpose of the study was to investigate how using picture books in kindergarten, first, and second grade mathematics instruction impacted students' mathematical achievement and students' dispositions towards mathematics. A quasi-experimental research design was used to compare student scores on chapter tests, the STAR Assessment, and student self-reported mathematical dispositions recorded on a five-point emotion scale between a treatment and control group. The treatment group teachers engaged in bi-weekly collaborative professional development meetings with the researcher over an 18-week period to select and discuss how to use, at least, one picture book per week in their mathematics lessons. In light of the research questions, the

picture books were selected to align with the mathematics curriculum and with students' interest. For comparison, the teachers from the control group were asked to follow the districts' mathematics curriculum without the use of weekly picture books.

Conclusions

Presenting the findings of the current study within the wider context of literature regarding the use of picture books in mathematics instruction brings meaning to the present findings (Bunton, 2005). Therefore, the results of each research question are situated within the context of the current body of knowledge.

Research Question #1

Is there a relationship between the mathematics achievement of students taught through regular mathematics instruction and those taught with the use of picture books as measured by the STAR Assessment and chapter tests accompanying the selected textbook?

The findings of the present study indicate that primary grade students taught mathematics with picture books can meet, at least, the same levels of mathematical achievement as those taught without such books. In fact, in some instances, the mathematical achievement of students who receive mathematics instruction with the use of picture books surpasses that of those who receive the regular instruction without the weekly use of picture books. These findings suggest that the use of picture books in primary grade mathematics instruction does not interfere with robust mathematics instruction and subsequent student learning as measured by standardized assessments. The present study, therefore, extends the findings of previous research establishing that

the use of picture books in kindergarten mathematics instruction can help students reach higher levels of mathematical achievement to now also include first and second grade students (Jennings et al., 1992; Hong, 1996; Van den Heuvel-Panhuizen et al., 2014).

Likewise, the present study expands the finding of Jennings et al. (1992) and Van den Heuvel-Panhuizen et al. (2014) that mathematical achievement gains are possible when teachers use picture books in mathematics instruction from prescribed lessons to now also indicate that increased students' mathematical achievement is also possible when teachers voice and choice is honored through collaborative professional development to select picture books and instructional strategies. In addition, the current finding also broadens the pool of learners that we now know can learn mathematics through the use of picture books to include students from minority backgrounds, low socioeconomic status, and ELL students. Moreover, the present findings, due to the sample population, indicate that students displaying multiple risk factors for academic failure can demonstrate mathematical achievement when picture books are used in mathematics instruction (NAEP, 2013).

Establishing that students can learn mathematics when picture books are used and that, in some instances, the use of such books can help increase students' mathematical achievement is essential in light of current education trends that place data at the forefront of many decisions regarding education in the United States (Dunn, Airola, Lo, & Garrison, 2013). To that end, the current research coupled with previous research (Jennings et al., 1992; Hong, 1996; Van den Heuvel-Panhuizen et al., 2014) provides decision makers seeking data to make instructional decisions, the necessary quantitative

findings to validate the use of picture books in mathematics instruction as a sound instructional strategy. Furthermore, because it is also the practice in some states to measure teachers' individual performance by the annual student learning gains students demonstrate on standardized assessments, teachers can also be confident that not only can their students learn mathematics through the use of picture books, but that the use of such books will not negatively affect their teacher effectiveness score (Stronge, Ward, & Grant, 2011).

Moreover, the benefits associated with the use of picture books in mathematics instruction may not be limited to mathematical achievement gains. For instance, Hong (1996) found through qualitative analysis that students taught with picture books displayed more mature mathematical thinking as evidenced by their ability to use multiple solution paths to solve problems. Similarly, gains in student use of mathematical vocabulary and communication have been connected to the use of picture books in mathematics instruction (Jennings et al., 1992). Additionally, other identified benefits of picture books used in mathematics instruction include fostering students' ability to build mathematical connections (Clark, 2007; Golden 2012; Shatzer, 2008; Shiro, 1997; Ward, 2005), visually presenting abstract mathematical concepts (Shatzer, 2008; Tucker, Boggan, & Harper, 2010; Whitin & Whitin, 2004), and presenting mathematics from a real world context to which students can relate (Clark 2007; Columba, 2013; Golden, 2012; Thatcher, 2001; Whitin & Whitin, 2011).

Research Question #2

Is there a relationship between the effect of the treatment and student demographics?

The results from the present study found no statistically significant difference between the mathematics achievement of first and second grade students taught with or without the use of picture books when evaluated by gender, ethnicity, or ELL status as measured by STAR gain scores. These findings are important, because they suggest that first and second grade students from various demographics can meet the same level of mathematics achievement when picture books are used. This finding is supported by previous research (van den Heuvel-Panhuizen et al., 2014) that investigated the treatment effect of picture books on mathematics achievement by kindergartners' age, gender, mathematics ability, language ability, home language, and socioeconomic status. In that study, only a marginal positive treatment effect was found for girls but not boys; all other demographics evaluated yielded no statistically significant difference, and thus supporting the present finding that students from various demographics can meet the robust demands of mathematics instruction when picture books are used to enhance the curriculum.

This finding is particularly important for ELL students, whom NAEP reports only 14% of ELL students as compared to 44% of non-ELL students attained mathematical proficiency in fourth grade. The current findings, however, demonstrated no significant difference between ELL and non-ELL students when picture books were used, and therefore demonstrating that ELL students can continue learning mathematics while potentially broadening their English vocabulary. Research indicates that shared picture

book readings with students expand students' overall vocabulary while simultaneously deepening their background knowledge (Fletcher & Reese, 2005; Wasik & Bond, 2001). More specifically, it has been found that picture books read during mathematics instruction increase students' use of mathematical vocabulary (Hong, 1996). Based on the finding of the present study and the previous research, it is proposed that ELL students can demonstrate sustained mathematical achievement while also strengthening their mathematical and overall vocabulary when picture books are used in mathematics instruction (Hong, 1996). The significance of these vocabulary gains are explained by Ballantyne, Sanderman, and Levy (2008) who assert that broader vocabulary is needed for ELL students to attain academic success in all subject areas.

Along these same lines, the ELL kindergarten students also demonstrated mathematical achievement gains compared to those who received instruction without the weekly use of picture books. Therefore, indicating that they can learn mathematics while also being exposed to the aforementioned benefits. Yet, the non-ELL students' statistically significant higher mathematical achievement than ELL students across both the treatment and control group illustrates the importance language ability can play in mathematics achievement (NAEP, 2013).

Although the findings of this study did not compare if the use of picture books in mathematics instruction can narrow the mathematical achievement gap between White and minority students, the Black kindergarten students' statistically significant higher mathematical achievement as compared to Hispanic students suggests that the use of picture books in mathematics instruction might aid Black students in attaining higher

levels of mathematical achievement from the onset of their educational careers. This could be an important discovery given that NAEP (2013) reports only 18% of Black fourth grade students demonstrated mathematical proficiency. In addition, this investigation, by being the first to delineate the findings of student achievement when picture books are used in mathematics instruction by ethnicity, highlights the importance of continued research investigating culturally relevant pedagogy (Ladson-Billings, 1995) to aid minority students to attain the same levels of proficiency as their white counterparts.

Research Question #3

Is there a relationship between students' disposition towards mathematics of students taught through regular mathematics instruction and those taught with the use of picture books as measured by students' self-report dispositions over time?

This study found that students taught mathematics both with and without the use of picture books had relatively positive dispositions towards mathematics. Moreover, the use of picture books did not have a statistically significant effect on students' self-reported high dispositions towards mathematics and that this did not change over time. This finding coupled with the research question one's finding that students can learn mathematics when picture books are used demonstrates that students can not only learn mathematics when picture books are used, but that this type of learning does not produce negative dispositions. This is important, because it has been reported that negative mathematical dispositions are associated with students being less motivated, higher mathematical anxiety, and lower confidence levels (Ashcraft, 2002; National Research

Council, 2001). Given that the use of picture books does not negatively impact students' mathematical dispositions, teachers who believe they can improve their own disposition towards the teaching of mathematics by using picture books can do so knowing that their students can learn and enjoy mathematics when picture books are used. As Wood (1988) explains, fostering positive dispositions towards the teaching of mathematics is important, because it could break the perpetual cycle of students learning from teachers who display negative dispositions towards mathematics.

In conclusion, this research adds to the body of knowledge that the use of picture books does not interfere with the robust learning of mathematics for primary grade students and, in fact, can cultivate higher mathematical achievement. This finding holds true for students who are at a greater risk for academic failure, such as ELL students and students from minority and low socioeconomic backgrounds. This study also found that mathematics learned through the use of picture books does not produce negative student dispositions towards mathematics.

Implications

The results of this study have implications for classroom teachers, teacher educators, administrators, and authors of picture books. To begin with, literature indicates that elementary teachers often prefer the teaching of literacy to mathematics (Lakes, 2009). Therefore, classroom teachers wishing to use picture books to enhance the mathematics curriculum should feel comfortable doing so with the assurance that this practice will allow their students to attain, at least, the same levels of mathematical achievement as the regular mathematics curriculum, and, in some instances, their students

may even attain higher levels of mathematical proficiency. Similarly, if teachers wish to use picture books, because it may help their own disposition towards the teaching of mathematics, they can use these books without fear of negatively impacting students' mathematical dispositions. Taken together, the findings of this research support teachers in building students mathematical proficiency and mathematical dispositions when picture books are used. Therefore, teachers may want to consider expanding their classroom library to include picture books that can be used to enhance the mathematics curriculum. In fact, teachers and librarians can work together to not only expand classroom libraries but also school libraries.

Given that administrators conduct evaluations of elementary teachers' performance, the findings of this research also have implications for administrators. As an illustration, if a picture book is used during an administrators' evaluation of a mathematics lesson, the administrator can acknowledge the use of the picture book as a sound instructional strategy that promotes students' mathematical achievement without negatively impacting students' mathematical dispositions. Therefore, the administrator can reinforce the use of picture books in mathematics instruction as a sound instructional practice. Respectful of this and the assertion that the use of picture books in mathematics instruction remains an underutilized teaching strategy (Van den Heuvel-Panhuizen et al., 2014), administrators may want to consider providing professional development that promotes the use of picture books in mathematics instruction.

In much the same manner as professional development can assist veteran teachers in using picture books in mathematics instruction, so too can teacher educators provide

pre-service teachers with exposure to this teaching practice to promote the integration of mathematics and literacy through picture books. Although teacher educators may be hesitant to feature this teaching strategy due to the pre-service teachers lack of classroom experience, it should be noted that two of the five teachers in the treatment from this study were first year teachers in the first semester of their teaching career. Therefore, this indicates that teachers new to the profession can successfully utilize picture books in mathematics instruction when supported by professional development or university instruction and/or mentoring. For this reason, teacher educators can feel comfortable teaching this strategy to pre-service teachers who have minimal, if any, classroom teaching experience. In addition, mathematics and literacy teacher educators can work together to build mathematics picture book libraries in order to expose pre-service teachers to the variety of picture books which can be used to integrate mathematics and literacy.

Lastly, the findings of this research have implications for authors of picture books. The authors can note that research indicates that students can learn mathematics when picture books are used and that some teachers may enjoy using such books in their mathematics instruction. These authors can, therefore, write such books cognizant of the ways in which these picture books can be used in mathematics and potentially market them to teachers as a useful tool for the teaching of mathematics. In addition, these authors can seek advice from teachers about mathematics content that can be included in their picture books. In light of the current findings and this study’s student sample that included a diverse pool of learners, authors, in order to allow students to identify with the

characters in these picture books, can aim to write books that contain equal representation of male and female characters and characters from diverse ethnic and socioeconomic backgrounds.

Future Research

Few research studies have investigated the effects of picture books used in mathematics instruction, and thus leaving much still to be learned about this teaching practice. This research provided new insights about the use of picture books in mathematics instruction while also bringing about additional questions that can be addressed in future research.

For instance, the sample population of this study, which had an overrepresentation of students from minority backgrounds, low socioeconomic status, and ELL students, allowed for an investigation regarding how the use of picture books impacted these students who face a greater risk of academic failure (NAEP, 2013). Yet, this study, due to the lack of adequate representations of White students and students who do not come from low socioeconomic status backgrounds, was unable to compare how the use of picture books affects the achievement gap between those who face a greater risk of academic failure and their counterparts. A future study could, by using multiple research sites with varying student demographics, investigate how the use of picture books affects a broad range of students, and, therefore, provide insights as to how this instructional strategy impacts the mathematical achievement gap. In addition, in order to better understand the higher mathematical achievement of kindergarten Black students as compared to Hispanic students, a future study could conduct a qualitative analysis to

better understand what factors may have influenced this finding. An investigation such as this could also provide rich data to understand if the use of picture books provides mathematics instruction that is culturally relevant (Ladson-Billings, 1995).

Given the overrepresentation of students from minority backgrounds, the present study was able to explore how the use of picture books impacted the mathematical achievement of ELL students. The results of the present study suggest that the use of picture books in mathematics instruction does not negatively impact the mathematics achievement of ELL students, yet the treatment effect on students' mathematical and overall vocabulary was not measured. To understand how the use of picture books impacts students' mathematical and overall vocabulary, future studies could evaluate these measures. This would be an important finding, because broadening ELL students' vocabulary is a necessary catalyst to academic success in all subject areas (Ballantyne, Sanderman, & Levy, 2008).

In light of the chapter test data from the current study that depicted varying degrees by which either the treatment or the control group attained higher levels of mathematical proficiency, future studies might consider conducting a content analysis to discover if patterns existed among the mathematical content. In other words, a study of this nature could explain if certain mathematical concepts were better suited for mathematics instruction that was enhanced with the use of picture books.

To build upon this study's finding that the use of one picture book per week did not significantly affect students' mean weekly mathematical disposition, future studies could evaluate if there is a difference between students' daily dispositions when picture

books were used in mathematics instruction to days in which no picture books are used. In addition, future studies could use qualitative measures to interview students to understand what factors they considered when reporting their mathematical disposition.

Given that this study found that the use of picture books did not have negative effects on students' mathematical dispositions, future studies could investigate the effect of picture books on teachers' dispositions towards mathematics instruction. An investigation of this nature could address the perpetual cycle of elementary students' learning mathematics from teachers who report disliking mathematics (Wood, 1988).

The current study, based on a pre and posttest assessment of the 18-week treatment period, found that students can learn mathematics when picture books are used to enhance the curriculum and that students' dispositions towards mathematics are not negatively affected by the use of such books. Yet, it is unknown what, if any, long-term effects may be associated with the use of picture books and students' mathematical achievement. Therefore, future research could conduct a longitudinal study to investigate how the use of picture books in mathematics instruction impacts students understanding of mathematics as they reach higher levels of mathematics where mathematical connections play a greater role. Similarly, a longitudinal study could provide insights about how the use of picture books over a greater period of time impact students' mathematical dispositions.

List of References

Akey, T. M. (2006). School Context, Student Attitudes and Behavior, and Academic Achievement: An Exploratory Analysis. MDRC.

Ashcraft, M.H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 1818-185.

Arizpe, E., & Styles, M.(2004). *Children Reading Pictures. Interpreting Visual Texts.* London: Routledge.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10-20.

Ball, D. L. (1996). Teacher Learning and the Mathematics Reforms: What We Think We Know and What We Need to Learn. *Phi Delta Kappan, 77*(7), 500-08.

Ball, D. L. (1999). Crossing boundaries to examine the mathematics entailed in elementary teaching. *Contemporary mathematics, 243*, 15-36.

Ball, D.L., & Cohen, D.K. (1999). Developing practice, developing practitioners: toward a practice-based theory of professional education. In G. Sykes, & L. Darling-Hammond (Eds.), *Teaching as the learning profession; Handbook of policy and practice* (pp.3-32). San Francisco: Jossey Bass.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching what makes it special? *Journal of Teacher Education*, *59*(5), 389-407.

Ballantyne, K. G., Sanderman, A. R., & Levy, J. (2008). Educating English Language Learners: Building Teacher Capacity. Roundtable Report. National Clearinghouse for English Language Acquisition & Language Instruction Educational Programs.

Battista, M. T. (1994). Teacher beliefs and the reform movement in mathematics education. *Phi Delta Kappan*, 462-470.

Beard, V. (1962). Mathematics in kindergarten. *Arithmetic Teacher, 9*, 22-25.

Beswick, K. K. (2006).The importance of mathematics teachers' beliefs. *Australian Mathematics Teacher*, *62*(4), 17-22

Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for Research in Mathematics Education*, 41-62.

Borman, G. D., & Overman, L. T. (2004). Academic resilience in mathematics among poor and minority students. *The Elementary School Journal*, 177-195.

Bower, G.H., & Clark, M.C. (1969). Narrative stores as mediators for serial learning. *Psychonomic Science, 14*, 181-182.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn*. Washington D.C.: National Academies Press.

Brett, P. (1994). A genre analysis of the results section of sociology articles. *English for Specific Purposes, 13*(1), 47-59.

Brown, J.S., Collins, A., & Duguid, S. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Brophy, J. (2010). *Motivating students to learn* (2nd ed.). Madison, WI: McGraw Hill.

Bruner, J. (1987). Life as narrative. *Social Research, 54*, 11-32.

Bunton, D. (2005). The structure of PhD conclusion chapters. *Journal of English for Academic Purposes, 4*(3), 207-224.

Burns, M. (2010). As Easy as Pi: Picture Books Are Perfect for Teaching Math. *School Library Journal*, *56*(5), 32-41.

Bursal, M. & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to reach mathematics and science. *School Science and Mathematics*, *106*(4), 173-180.

Campbell, D. T., & Stanley, J. C. (2015). *Experimental and quasi-experimental designs for research.* Ravenio Books.

Carney, M. B., Brendefur, J. L., Thiede, K., Hughes, G., & Sutton, J. (2014). Statewide Mathematics Professional Development Teacher Knowledge, Self-Efficacy, and Beliefs. *Educational Policy*, 1-34.

Casey, B., Erkut, S., Ceder, I., & Young, J. (2008). Use of a storytelling context to improve girls' and boys' geometry skills in kindergarten. *Journal of Applied Developmental Psychology,29*(1), 29-48.

Casey, B., Kersh, J.E., & Mercer Young, J. (2004). Storytelling sagas: An effective medium for teaching early childhood mathematics. *Early Childhood Research Quarterly: Special Issue on Mathematics and Science, 19*, 167-172.

Clark, J. (2007). Mathematics saves the day. *Australian Primary Mathematics Classroom*, *12*(2), 21.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. Wittrock (Ed.), *Handbook of research in teaching* (3rd ed.) (p. 255-296). New York: MacMillan.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26*(6), 673-682.

Cochran-Smith, M., & Lytle, S. (1999). The teacher research movement: a decade later. *Educational Researcher, 28*(7), 15-25.

Colton, D., & Covert, R. W. (2007). *Designing and constructing instruments for social research and evaluation.* San Francisco, CA: Jossey-Bass.

Columba, L. (2013). So, Here's the Story. *Teaching Children Mathematics, 19*(6), 374-381.

Conley, D. T. (2011). Building on the common core. *Educational Leadership, 68*(6), 16-20.

Cook, T. D. (1979). *Quasi‐Experimental Design*. Wiley Encyclopedia of Management.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative*. New Jersey: Upper Saddle River.

Dajani, M.F. (2014). Learning Circles: Promoting Collaborative Learning Culture for Teacher Professional Development. *Arab World English Journal*, *5*(3).

Darling-Hammond, L. (2008). Teacher learning that supports student learning. *Teaching for intelligence, 2*, 91-100.

Darling-Hammond, L & McLaughlin, M.W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan, 76*(8), 597-604.

Dewey, J. (1997). *Experience and education*. Tourchstone.

Dimitriadis, G., &Kamberelis, G. (2006). *Theory for education*. Routledge.

Donaldson, M. & Hughes, M. (1979). *Children's minds*. New York: Norton.

Douville, P., Pugalee, D. K., & Wallace, J. D. (2003). Examining instructional practices of elementary science teachers for mathematics and literacy integration. *School Science and Mathematics*, *103*(8), 388-396.

Draper, R. J. (2002). School mathematics reform, constructivism, and literacy: a case for literacy instruction in the reform-oriented math classroom. *Journal Of Adolescent & Adult Literacy*, *45*(6), 520-529.

Dunn, K. E., Airola, D. T., Lo, W. J., & Garrison, M. (2013). Becoming data driven: The influence of teachers' sense of efficacy on concerns related to data-driven decision making. *The Journal of Experimental Education*, *81*(2), 222-241.

Ellis, A.K., & Fouts, J.T. (2001). Interdisciplinary curriculum: The research base. *Music Educators Journal*, *87*(5), 22-26.

English, L., & Bartolini Bussi, M. G. (2008). *Handbook of international research in mathematics education* (2nd ed.). New York: Routledge.

English, L. D., & Kirshner, D. (Eds.). (2008). *Handbook of International Research in Mathematical Education*. Routledge.

"enVisionMATH Common Core" (2012) Pearsonschool.com: Pearson Education, n.d. Web.23 Aug. 2015.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *The Teachers College Record, 103*(6), 1013-1055.

Fletcher, K.L. & Reese, E. (2005). Picture book reading with young children: A conceptual framework. *Developmental Review, 25*, 64-103.

Flevares, L.M. & Schiff, J.R. (2014). Learning mathematics in two dimensions: a review and look ahead at teaching and learning early childhood mathematics with children's literature. *Frontiers in Psychology, 459*(5), 1-12.

Flint, A. S., Zisook, K., & Fisher, T. R. (2011). Not a one-shot deal: Generative professional development among experienced teachers. *Teaching & Teacher Education, 27*(8), 1163-1169.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What Makes Professional Development Effective? Results from a National Sample of Teachers. *American Educational Research Journal, 38*(4), 915-45.

Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. *Journal of Instuctional Psychology, 37*(1).

Giorgis, C. (1999). The power of reading picture books aloud to secondary students. *The Clearing House, 73*(1), 51-53.

Golden, L. (2012). Children's Literature in Mathematics Instruction. *Library Media Connection, 31*(2), 40-41.

Graesser, A.C., Hauft-Smith, K, Cohen, A.D., & Pyles, L.D. (1980). Advanced outlines, familiarity, text genre, and retention of prose. *Journal of Experimental Education, 48*, 209-220.

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576.

Gravetter, F. J., & Wallnau, L. B. (2005). *Essentials of statistics for the behavioral sciences.* Belmont, CA: Thomson/Wadsworth.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, *2*, 163-194.

Guskey, T. R., & Huberman, M. (1995). *Professional Development in Education: New Paradigms and Practices.*

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education*, 19-29.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational studies in Mathematics, 49*(1), 25-46.

Hargreaves, A., & Moore, S. (2000). Curriculum integration and classroom relevance: A study of teachers' practice. *Journal of Curriculum and Supervision*, *15*(2), 89-112.

Hatch, J. A. (2002). *Doing qualitative research in educational settings*. Albany, NY: State University of New York Press.

Henry, Gary T., Bastian, K., & Fortner, C. (2011). Stayers and Leavers: Early-Career Teacher Effectiveness and Attrition. *Educational Researcher, 40*(6), 271-280.

Herrera, T. A., & Owens, D. T. (2001). The" new new math"?: Two reform movements in mathematics education. *Theory into Practice, 40*(2), 84-92.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing Measures of Teachers' Mathematics Knowledge for Teaching. *Elementary School Journal, 105*(1), 11.

Hong, H. (1996). Effects of mathematics learning through children's literature on math achievement and dispositional outcomes. *Early Childhood Research Quarterly, 11*(4), 477-494.

Huck, S., McLean, R., & Hernstein, R .J. (1975). Using a repeated measures ANOVA to analyze the data from a pretest-posttest design: A potentially confusing task. *Psychological Bulletin, 82*(4), 511-518.

Jennings, C. M., Jennings, J. E., Richey, J., & Dixon-Krauss, L. (1992). Increasing interest and achievement in mathematics through children's literature. *Early Childhood Research Quarterly, 7*(2), 263-276.

Kivikunnas, S. (1998). Overview of process trend analysis methods and applications. In ERUDIT Workshop on Applications in Pulp and Paper Industry (pp. 395-408).

Koestler, C., Felton-Koestler M., Bieda, K., & Otten, S. (2013). Connecting the NCTM process standards & the CCSSM practices. National Council of Teachers of Mathematics.

Kraemer, H., & Thiemann, S. (1987). *How many subjects? : Statistical power analysis in research.* Newbury Park: Sage Publications.

Kurz, T. L., & Bartholomew, B. (2012). Supporting Math Skills with Children's Stories. *Kappa Delta Pi Record, 48*(4), 184-188.

Lake, J. A. (2009). *Math memories you can count on: a literature-based approach to teaching mathematics in the primary classrooms.* Pembroke Publishers Limited.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-491.

Leonard, J. (2008). *Culturally Specific Pedagogy in the Mathematics Classroom : Strategies for Teachers and Students*. New York: NY: Routledge.

Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: a review of research. *Educational Communication & Technology, 30,* 195-232.

Library of Congress (2008). Library of congress collections policy statement: children's literature. Retrieved from http://www.loc.gov/acq/devpol/chi.pdf

Lieberman, A. (1995). Practices that support teacher development: Transforming conceptions of professional learning. *Phi Delta Kappan, 76,* 591-596.

Little, R. J., & Rubin, D. B. (2014). *Statistical analysis with missing data*. John Wiley & Sons.

Ma, L. (1999). *Knowing and Teaching Elementary Mathematics: Teacher's Understanding of Fundamental Mathematics in China and the United States*. Mahwah, NJ; LawerenceErlbaum Associates.

Malinsky, M.A., & McJunkin, M. (2008).Wondrous tales of measurement. *Teaching Children Mathematics, 14*(7), 410-413.

Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. *The lancet, 358*(9280), 483-488.

Mayer, R.E. (2011). *Applying the science of learning*. New York, NY: Pearson.

Mishra, A. (2003). Age and school related differences in recall of verbal items in a story context. *Social Science International, 19,* 12-18.

Moyer, P. S. (2000). Communicating mathematically: Children's literature as a natural connection. *The Reading Teacher*, 246-255.

Nagy, W. E., Herman, P. A., & Anderson, R. (1985). Learning words from context. *Reading Research Quarterly, 20*, 233-253.

National Academy of Sciences-National Research Council, Washington, DC. Mathematical Sciences Education Board. (1989). Everybody Counts. A Report to the Nation on the Future of Mathematics Education.

National Center for Education Statistics (2013). The nations report card. Department of Education, Washington, DC.

National Council of Teachers of English and International Reading Association (1996). Standards for the English language arts. Reston, VA: National Council of Teachers of English.

National Council of Teachers of Mathematics (1989). Curriculum and evaluations standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics (2000). Principals and standards for school mathematics. Reston, VA: Author.

National Governors Association Center for Best Practices & Council of Chief State School Officers (2010). Common Core State Standards for Mathematics. Washington, DC: Authors.

National Research Council (2001). Adding it up: Helping children learn mathematics. J. Kilpatrick, J. Swafford, & B. Findell (Eds.). Washington, DC: National Academies Press.

Padilla, A. M. (2001). Issues in culturally appropriate assessment. *Handbook of Multicultural Assessment: Clinical, Psychological, and Educational Applications, 2*, 5-27.

Pellowski, A. (1990). *The world of story-telling: Art and technique*. New York: R.R. Bowker.

Phillips, D.C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher, 24*(7), 5-12.

Radebaugh, M.R. (1981). Using children's literature to teach mathematics. *The Reading Teacher, 34*, 902-906.

Rameau, P., & Louime, C. (2007). Mathematics phobia: Are the mathematical sciences a pothole in the road of life? *Current Science-Bangalore, 93*(11), 1481.

Randolph, J. J. (2009). A guide to writing the dissertation literature review. *Practical Assessment, Research & Evaluation, 14*(13), 2.

Raths, J., & McAninch, A. R. (2003). *Teacher beliefs and classroom performance: The impact of teacher education* (Vol. 6). Information Age Publishing.

Rhodes, C.S. & Smith, J. (2009). Enhancing learning; Implementing content area children's and young adult literature. In D.A. Wooten & B.E. Cullinan Editor (3rd ed.), *Children's literature in the reading program* (pp. 110-120). International Reading Association.

Salkind, N. J. (2006). *Encyclopedia of measurement and statistics*. Sage Publications.

Sarason, S.B. (1990). *The predictable failure of educational reform*. San Francisco: Jossey-Bass.

Schank, R.C., & Abelson, R.P. (1995). Knowledge and memory: The real story. In R.S. Wyer (Ed), *Knowledge and memory: The real story* (pp. 1-85). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schiro, M. (1997). *Integrating children's literature and mathematics: Children as problem-solvers, literary critics and meaning-makers*. New York: Teachers Collage Press.

Schiro, M. (2004). *Oral storytelling and teaching mathematics: Pedagogical and multicultural perspectives.* Thousand Oaks, CA: Sage Publication.

Shatzer, J. (2008). Picture book power: Connecting children's literature and mathematics. *The Reading Teacher, 61*(8), 649-653.

Shroyer, G., Yahnke, S., Bennett, A., & Dunn, A. (2007).Simultaneous renewal through professional development school partnerships. *The Journal of Educational Research, 100*(4), 211-225.

Smylie, M. A. (1997). From bureaucratic control to building human capital: the importance of teacher learning in education reform. *Arts Education Policy Review, 99*, 35-38.

Spann, M.B. (1992). *Multicultural activities: An integrated approach*. New York: Scholastic.

Stronge, J. H., Ward, T. J., & Grant, L. W. (2011). What makes good teachers good? A cross-case analysis of the connection between teacher effectiveness and student achievement. *Journal of Teacher Education, 62*(4), 339-355.

Swars, S.L., Meyers, B., Mays, L.C., & Lack, B. (2009). A two-dimensional model of teacher retention and mobility: classroom teachers and their university partners take a closer look at a vexing problem. *Journal of Teacher Education, 60*(2), 168-183.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). *Using multivariate statistics.* Boston, MA: Pearson.

Thatcher, D. H. (2001). Reading in the Math Class: Selecting and Using Picture Books for Math Investigations. *Young Children, 56*(4), 20-26.

Timperley, H., Wilson, A., Barrar, H, & Fung, I. (2007). *Teacher professional learning and development: Best evidence synthesis iteration.* Wellington, New Zeland: Ministry of Eduation.

Tobias, S. (1998). Anxiety and mathematics. *Harvard Education Review, 50*, 63-70.

Tsui, J.M., & Mazzocco, M.M. (2006). Effects of math anxiety and perfectionism on timed versus untimed math testing in mathematically gifted sixth graders. *Roeper Review, 29*(2), 132-139.

Tuan, H., Chi-Chin, S. & Shyang-Horng, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639-654.

Tucker, C., Boggan, M., & Harper, S. (2010). Using children's literature to teach measurement. *Reading Improvement, 47*(3), 154-161.

U.S. Department of Education: National Center on Student Progress Monitoring. (2006). Review of progress monitoring tools [Review of STAR Math]. Washington, DC: Author

U.S. Department of Education: National Center on Intensive Intervention. (2015). Review of progress monitoring tools [Review of STAR Math]. Washington, DC: Author.

Uy, F. L., & Frank, C. R. (2004). Integrating Mathematics, Writing, and Literature. *Kappa Delta Pi Record, 40*(4), 180-182.

Vacca, R.T., &Vacca, J.L. (2005). *Content area reading: Literacy and learning across the curriculum* (8th ed.). Boston: Pearson Education.

Vacca, R. T., Vacca, J. A. L., & Mraz, M. E. (2014). *Content area reading: Literacy and learning across the curriculum*. Pearson.

Van den Heuvel-Panhuizen, M., Van den Boogaard, S., & Doig, B. (2009). Picture Books Stimulate the Learning of Mathematics. *Australasian Journal of Early Childhood, 34*(3), 30-39.

van den Heuvel-Panhuizen, M., & van den Boogaard, S. (2008). Picture Books as an Impetus for Kindergartners' Mathematical Thinking. *Mathematical Thinking & Learning, 10*(4), 341- 373.

van den Heuvel-Panhuizen, M., & Elia, I. (2012). Developing a framework for the evaluation of picture books that support kindergartners' learning of mathematics. *Research In Mathematics Education, 14*(1), 17-47.

van den Heuvel-Panhuizen, M., Elia, I., & Robitzsch, A. (2014). Effects of reading picture books on kindergartners' mathematics performance. *Educational Psychology*, (ahead-of-print), 1-24.

Van de Walle, J. (1994). *Elementary School Mathematics: Teaching Developmentally*.

Van de Walle, J.A., Lovin, L.H., Karp, K.S., & Bay-Williams, J.M. (2014).*Teaching student centered mathematics* (2nd ed.) (Vol. 1). Upper Saddle River: Pearson.

Verschaffel, L., De Corte, E., Lasure, S., Van Vaerenbergh, G., Bogaerts, H., & Ratinckx, E. (1999). Learning to solve mathematical application problems: A design experiment with fifth graders. *Mathematical thinking and learning*, *1*(3), 195-229.

Ward, R. A. (2005). Using Children's Literature to Inspire K–8 Preservice teachers' future mathematics pedagogy. *The Reading Teacher*, *59*(2), 132-143.

Wang, Wen-Chung, & Chyi-In, Wu. (2004). Gain Score in Item Response Theory as an Effect Size Measure. *Educational and Psychological Measurement*, *64*(5), 758-780.

Wasik, B.A., & Bond, M.A. (2001). Beyond the pages of a book: Interactive book reading and language development in preschool classrooms. *Journal of Educational Psychology*, *93*, 243-250.

Wegner, G. R. (2008). *Partnerships for Public Purposes: Engaging Higher Education in Societal Challenges of the 21st Century*. National Center for Public Policy and Higher Education.

Welchman-Tischler, R. (1992). *How to use children's literature to teach mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Wesley, P., & Buysse, V. (2001). Communities of practice: expanding professional roles to promote reflection and shared inquiry. *Topics in Early Childhood Special Education, 21*(2), 114-123.

West, L. & Staub, F.C. (2003). *Content-focused coaching: Transforming mathematics music lessons*. Portsmouth, NH: Heinemann.

Whitaker, W.L. (1962). Individualized arithmetic: an idea to improve the traditional arithmetic program. *Arithmetic Teacher, 9*, 134-137.

Whitin, D. J., & Wilde, S. (1992). *Read Any Good Math Lately?: Children's Books for Mathematical Learning, K-6* (Vol. 6). Portsmouth, NH: Heinemann.

Whitin, D. J., & Wilde, S. (1995). *It's the Story That Counts: More Children's Books for Mathematical Learning, K-6*. Portsmouth, NH: Heinemann.

Whitin, D., & Whitin, Phyllis. (2004). *New Visions for Linking Literature and Mathematics*. The National Council of Teachers of English.

Whitin, P., & Whitin, D. J. (2011). Mathematical Pattern Hunters. *Young Children, 66*(3), 84.

Wilkins, J. L. (2008). The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices. *Journal of Mathematics Teacher Education, 11*(2), 139-164.

Wood, E. F. (1988). Math Anxiety and Elementary Teachers: What Does Research Tell Us? *For the Learning of Mathematics, 8*(1), 8-13.

Yoon, K.S., Duncan, T., Lee, S.W.Y., Scarloss, B., & Shapley, K.L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement*. Washington, D.C.: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance.

Zimmerman, D. W., & Williams, R. H. (1982). Gain Scores in Research Can Be Highly Reliable. *Journal of Educational Measurement*, *19*(2), 149–154.

Appendix

Appendix A

Name:____

How did you feel about math today?

Directions: Please place a X on the face that best describes your feelings about math today.

Monday					
Tuesday					
Wednesday					
Thursday					
Friday					

Appendix B

Weekly Teacher Math Journal

What day did you use a picture book in class this week?

What book did you use?

What was the math concept you were teaching?

Please answer the questions below using the scale provided, 1 represents the lowest score and 5 represents the highest score.

How effective was this lesson in helping student understand the mathematics concept outlined in the objective?				
1	2	3	4	5

How helpful was the picture book in helping students understand the concepts taught in today's lesson?				
1	2	3	4	5

How would you rate the class disposition towards mathematics during the picture book portion of the lesson?				
1	2	3	4	5

How would you rate the class disposition towards mathematics in today's lesson?				
1	2	3	4	5

Please write a brief response in the space provided. We will discuss these questionsand your responses at our next meeting so short annotations to spark your memory are suffice.

Tell me about this week's experience using picture books to teach math content. If possible, please provide student examples to explain your reasoning.

Did the picture book help motivate/engage your students in math class? Please provide a brief explanation and an example if possible.

Please provide any additional comments and or reflections on the lesson.

Appendix C

Mathematics Picture Book Library List

Book Title	**Author**	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
1, 2, 3	Basher	x													x							
10 Teddy Bears	Igloo Books						x															
100 Days of Cool *	Murphy		x		x			x										x				
100 Snowmen	Arena				x	x																
101 Dalmatians A Counting Book	Disney				x																	
12 Ways to Get to 11	Merriam	x				x																
20 Hungry Piggies	Harris	x	x																			
A Fair Bear Share	Murphy						x			x	x				x			x				
A Remainder of One	Pinczes									x												
A Tooth Story	McNamara						x												x			
Alexander Who Used to Be Rich Last Sunday	Viorst						x					x						x				

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
Animal Antics	Wojtowycz	x													x							
Animals on Board	Murphy					x																
Annie's One to Ten	Owen	x				x									x							
Anno's Counting Book	Anno	x													x							
Bear Wants More	Wilson					x																
Before After	Ramstein													x								
Benny's Pennies	Brisson						x					x										
But No Elephants*	Smath					x	x															
Captain Invincible and the Space Shapes*	Murphy												x									
Centipede's One Hundred Shoes	Ross				x																	
Count on Pablo	deRubertis							x														
Count the Monkeys*	Barnett	x													x							x

Book Title	**Author**	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
Double the Ducks	Murphy																				x	
Earth day-Horray	Murphy																	x				
Emily's First 100 Days of School	Wells							x														
Even Steven and Odd Todd	Cristaldi																			x		
Every Buddy Counts	Murphy	x																				
Feast for 10	Falwell	x																				
Fiesta	Guy	x																				
First Football Book	Sports Illustrated		x		x	x	x															
Fish Pattern	Harris															x						
From One to One Hundred	Sloat				x																	
Full House	Dodds					x					x											
Go Dog Go	Eastman													x								
Grandpa Gazillions Number Yard*	Keller		x																			

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
Henry the Fourth*	Murphy																					x
How Many Snails	Paul	x	x														x					
How many, how many, how many*	Walton														x							
I ain'tGonna Paint No More	Beaumont			x			x															
If you were a minus sign	Shaskan						x															
If you were a plus sign	Shaskan				x																	
Jack the builder*	Murphy												x									
Kindness is Cooler Mrs. Ruler	Cuyler				x	x																
Leaping Lizards	Murphy																					
Lemonade in Winter	Jenkins							x	x													
Let It Fall	Leffler					x	x								x							
Little Blue Truck Christmas*	Schertle	x				x	x								x							

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
Math for All Seasons	Tang	x	x			x		x	x	x											x	
Minnies' Dinner	Dodds			x				x	x						x							
Monster Musical Chair	Murphy						x													x		
Mrs. McTats and Her Houseful of Cats *	Capucilli						x															
My Granny Went to Market	Blackstone	x													x							
My Little Sister Ate One Hare	Grossman	x				x	x															
My Numbers/ MisNumeros	Emberley	x													x							
My Shape Book	Southwestern												x									
Once Upon a Dime	Allen											x										
One Bear at Bedtime	Inkpen	x																				
One Foot Two Feet	Maloney	x													x							
One Hundred Angry Ants	Pinczes				x					x												

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
One is a Snail Ten is a Crab	Sayre							x	x													
One Moose Twenty Mice	Beaton	x	x												x							
One Snowy Night	Butterworth					x									x							
One Watermelon Seed	Lottridge					x		x							x			x				
One, Two, Thee Oops	Coleman		x			x																
One, Two, Three	Usborne	x	x																			
Opposites	Filipek													x								
Opposites	Kightley													x								
Out for the Count *	Cave																					
Over Under	Jocelyn													x								
Quack and Count	Baker				x																	
Rainbow Fish	Pfister						x															
Roll Over!: A Counting Song*	Peek						x															
Rosie's Walk *	Hutchins													x								
Round is a Tortilla	Thong												x									

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
Shark Swimathon	Murphy						x												x			
Sir Cumference and All the King's Tens	Neuschwander																	x				
Skippyjon Jones Shape Up	Schachner												x									
Spaghetti and Meatballs for All	Burns														x							
Splash	Jonas				x																	
Teddy Bear Pattern	McGrath					x		x	x							x	x					
Ten Black Dots	Crews	x													x							
Ten Flashing Fireflies	Sturges						x															
Ten Little Ladybugs	Gerth						x															
Ten Little Puppies	Zubizarreta	x																				
Ten Seeds	Brown						x	x														
Ten, Nine, Eight	Bang	x																				

Book Title	**Author**	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
The Best Counting Book Ever	Scarry	x	x		x			x														
The Doorbell Rang	Hutchins	x	x			x	x		x	x					x							
The Grapes of Math	Tang	x	x			x		x	x	x											x	
The Great Divide	Dodds				x					x	x											
The Greedy Triangle	Burns												x									
The Icky Bug Counting Book	Pallotta	x	x																			
The Mission of Addition	Lerner				x																	
The Shape of Things	Dodds												x									
The Very Hungry Caterpillar	Carle	x				x									x							
There was an Old Lady Who Swallowed a Fly*	Taback					x																

Book Title	Author	Numbers 1-10	More than 10	0	100	Addition	Subtraction	Skip Counting	Multiplication	Division	Fractions	Money	Shapes	Positional Words	More/Fewer	Patterns	Sorting	Place Value	Charts/Graphs	Even/Odd	Doubles	Ordinals
There's a Square	Serfozo												x									
Too Many Balloons	Matthias	x													x							
Two of Everything	Hong																				x	
Two Ways to Count to Ten	Dee							x														
We All Went on Safari	Krebs	x													x							
We're Going on a Bear Hunt	Oxenbury													x								
What a Day*																						
What's New at the Zoo	Slade				x																	
Wheel Away	Dodds													x								
Which Way Bunny	Smith													x								
Zero, Zilch, Nada	Ulmer			x	x													x				

Appendix D

Picture Books Used by Treatment Teachers

Book Title	Author	Kindergarten Teacher #1	Kindergarten Teacher #2 More than 10	1st Grade Teacher #1	1st Grade Teacher #2	2nd Grade Teacher
1, 2, 3	Basher	X				
10 Teddy Bears	Igloo Books					X
100 Days of Cool *	Murphy				X	
12 Ways to Get to 11	Merriam				X	
A Fair Bear Share	Murphy					X
A Remainder of One	Pinczes					X
A Tooth Story	McNamara				X	
Alexander Who Used to Be Rich Last Sunday	Viorst					X
Animal Antics	Wojtowycz	X	X			
Animals on Board	Murphy				X	
Anno's Counting Book	Anno	X	X	X	X	
But No Elephants*	Smath				X	
Captain Invincible and the Space Shapes*	Murphy	X	X			
Centipede's One Hundred Shoes	Ross					X
Count the Monkeys*	Barnett		X			
Double the Ducks	Murphy					X
Emily's First 100 Days of School	Wells				X	
Feast for 10	Falwell		X			
First Football Book	Sports Illustrated					X
Full House	Dodds					X
Grandpa Gazillions Number Yard*	Keller		X			
Henry the Fourth*	Murphy				X	
If you were a minus sign	Shaskan			X	X	
If you were a plus sign	Shaskan			X		
Jack the builder*	Murphy	X	X			
Kindness is Cooler Mrs. Ruler	Cuyler					X
Leaping Lizards	Murphy				X	

Book Title	Author	Kindergarten Teacher #1	Kindergarten Teacher #2 More than 10	1st Grade Teacher #1	1st Grade Teacher #2	2nd Grade Teacher
Little Blue Truck Christmas*	Schertle			X		
Math for All Seasons	Tang					X
Minnies' Dinner	Dodds				X	X
Monster Musical Chair	Murphy					X
Mrs. McTats and Her Houseful of Cats *	Capucilli				X	
My Little Sister Ate One Hare	Grossman	X	X	X		
My Numbers/ MisNumeros	Emberley	X				
Once Upon a Dime	Allen					X
One Foot Two Feet	Maloney			X		
One Hundred Angry Ants	Pinczes					X
One is a Snail Ten is a Crab	Sayre					X
One Moose Twenty Mice	Beaton	X		X		
One Snowy Night	Butterworth				X	X
One Watermelon Seed	Lottridge			X		
One, Two, Thee Oops	Coleman					X
One, Two, Thee Oops	Coleman	X				
Over Under	Jocelyn	X	X			
Quack and Count	Baker			X		
Rainbow Fish	Pfister		X	X	X	X
Roll Over!: A Counting Song*	Peek				X	
Rosie's Walk *	Hutchins		X			
Round is a Tortilla	Thong	X	X			
Shark Swimathon	Murphy					X
Sir Cumference and All the King's Tens	Neuschwander					X
Teddy Bear Pattern	McGrath	X	X			
Ten Black Dots	Crews	X		X	X	
Ten Flashing Fireflies	Sturges					X
Ten Little Ladybugs	Gerth					X
The Best Counting Book Ever	Scarry			X		
The Grapes of Math	Tang				X	

Book Title	Author	Kindergarten Teacher #1	Kindergarten Teacher #2 More than 10	1st Grade Teacher #1	1st Grade Teacher #2	2nd Grade Teacher
The Shape of Things	Dodds	X	X			
The Very Hungry Caterpillar	Carle			X		
There's a Square	Serfozo	X				
Too Many Balloons	Matthias		X			
Two of Everything	Hong			X	X	X
Two Ways to Count to Ten	Dee					X
We All Went on Safari	Krebs	X	X			
What a Day*	Ralli				X	
Wheel Away	Dodds			X		
Zero, Zilch, Nada	Ulmer					X

Vita

Jessica Stone was born in Orange County, California, to Cuban immigrant parents that believed education was a catalyst to the realization of the American dream. Jessica attended La Sierra Academy for her elementary through high school years. She then continued her studies at Walla Walla University. As part of her undergraduate studies, she enrolled in an international study abroad program, which allowed her to strengthen her oral and written Spanish while concurrently learning about the Spanish culture. In 2004, Jessica was awarded a Bachelor of Science degree in Physical Education with a minor in Spanish from Walla Walla University. Upon completion of her teacher training, Jessica began her teaching career in Seattle, WA. Later, she accepted a teaching position in Southern California. While teaching in California, she continued her education and, in 2011, earned a Master of Arts degree in School Administration and Leadership from La Sierra University. Upon completing this degree, she became a school administrator in California. Next, Jessica moved to Tennessee where she worked as a graduate teaching associate while she completed her doctorate in philosophy.