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The Impact of Elementary Mathematics Workshops on Mathematics Knowledge for Parenting (MKP) and Beliefs About Learning Mathematics

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THE IMPACT OF ELEMENTARY MATHEMATICS WORKSHOPS ON MATHEMATICS KNOWLEDGE FOR PARENTING (MKP) AND BELIEFS ABOUT LEARNING MATHEMATICS

by

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ABSTRACT

The purpose of this study was to investigate the extent to which parents of first, second, and third grade students who attended a two-day workshop on mathematics strategies differed on average and over time, as compared to parents who did not attend the workshops. The following areas were measured: mathematics content knowledge, beliefs about learning mathematics, ability to identify correct student responses regarding mathematics, and ability to identify student errors in solving mathematics problems. There were three instruments used to determine these differences. A researcher-created instrument generated from topics using 2^{nd}, 3^{rd}, and 4^{th} grade mathematics standards measured parent content knowledge. The abbreviated Mathematics Beliefs Scales (MBS) adapted by Capraro (2005), measured beliefs. The ability to identify correct student responses and student errors was measured by a researcher-created instrument that included possible correct and incorrect student responses. Parents identified whether the student response was correct or incorrect, and if incorrect attempted to determine the student's error.

The workshops used in this study were designed to impact parents' mathematics content knowledge, beliefs, ability to identify correct student responses and student errors, methods used to solve mathematics problems, and comfort level with tools. The findings from this study were similar to findings related to preservice and inservice teachers in the literature for belief change (Carter & Yackel, 1989; Liljedahl, Rolka, & Rosken, 2007) and increasing comfort level with manipulatives (Knapp, Jefferson, & Landers, 2013; Syropoulos, 1982).

These findings indicated that workshops for parents were beneficial. By giving parents the opportunity to engage in mathematics in ways similar to the way their children learn in the classroom, beliefs about mathematics were challenged. Prior to the workshops and according to the belief instrument that parents completed, parents' beliefs leaned more towards working *with* their child on homework instead of allowing their child to come up with their own strategies. When learning is student centered in the elementary classroom, students have a deeper understanding of mathematics (Carpenter, Franke, Jacobs, Fennema, & Empson, 1998; Carroll & Porter, 1997; Civil, Guevara, & Allexsaht-Snider, 2002; Vendlinski, Hemberg, Mundy, & Phelan, 2009). However, students also learn at home when working on homework. When working on homework with their children, should parents allow their children to work in a learner-centered environment, or should the parent take a more active role in helping their children with mathematics homework? This research demonstrates a need for more workshops like this for parents of elementary students. While the literature indicated more hours of professional development (PD) would be better (Frecthling, 2001; Quint, 2011), the three hours of material over a period of two sessions with parents in the current study indicated shifts in some areas. However, a longer PD could have increased parents' content knowledge. The workshops in this study included material on whole number concepts and operations, but parents may benefit from other topics.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

“At the end of the day, the most overwhelming key to a child's success is the positive involvement of parents.” Jane D. Hull

Parents are frustrated with the way their children are learning mathematics (Cleveland, 2014; Decarr, 2014; Garland, 2014; Richards, 2014). This is important because when a child is at home, his or her parents take on the role of teacher. Parents try to use strategies they are familiar with using, but sometimes their child is not taught those same strategies, causing frustration at home. The purpose of this research is to (a) help parents to have a more substantial understanding of the mathematics content their child is being taught, (b) shift parents’ beliefs from a parent-centered approach that focuses on using procedures to help their child solve problems, to a more learner-centered approach that focuses on conceptual understanding, and (c) provide parents with the knowledge necessary to identify errors in student work as well as to make sense of students’ solutions that are correct but different from how parents addressed the same content. The workshops in this study addressed whole number concepts and operations, specifically place value, addition, subtraction, multiplication, and division, because they are the foundation of elementary mathematics education (Verschaffel, Greer, & De Corte, 2007).

Parents opposing the Common Core State Standards – Mathematics (CCSSM) are vocal with their frustration with the way their children are learning mathematics. One example is from a parent who took a picture of his child’s homework problem and included his own response, and then posted it on Facebook. The homework stated that a fictional student “Jack” used the open number line to incorrectly solve 427 - 316. An open number line was shown with jumps that Jack made of hundreds and ones. First Jack started at 427 and made three big jumps, each 100 units, and the numbers below the number line were correct: 327, 227, 127. However, instead of making one jump of 10 and six jumps of one, Jack makes six jumps of one, subtracting 6 from 127 instead of 16 from 127. The parent, frustrated with the assignment and what his child was asked to do, responded to "Jack" in writing, stating " I have a Bachelor of Science Degree in Electronics Engineering which included extensive study in differential equations and other higher math applications. Even I cannot explain the Common Core mathematics approach" (Garland, 2014). This "Letter to Jack" was shared on Facebook, online blogs, and news channels.

How many elementary teachers have received something like this from a frustrated parent? The message might be delivered during a phone call, email, meeting, or even during a conversation at a birthday party or sporting event. Especially now, with the immediate postings that anyone can make on the Internet, parent frustration regarding the Common Core is prevalent in social media and other news sources online (Erickson, 2014; Garland, 2014; Richards, 2014). Most of this posted information can be read by anyone with access to the Internet, and can influence how people view the way an elementary child is learning mathematics.

Parents think that they should be able to help their child with elementary mathematics because it is supposed to be easy. After all, most parents graduated from elementary school without a problem. However, according to the Common Core and best practice for teaching, students are encouraged to come up with multiple strategies that would allow them to think flexibly about mathematics and some parents might not understand what these strategies are and why they are so important (Nerney, 2013). Once this 'letter to jack' was posted on Facebook and many parents, teachers, administrators, and politicians viewed it – it "went viral." The parent who posted it was interviewed on programs that debate current issues, such as Fox News and The Blaze and both videos were posted online, which may perpetuate the problem of parents' frustration due to the one sided or misinformed message from immediate postings on social media, news stations, or blogs (Charles, 2014).

Many parents are concerned with the elementary mathematics education of their child. This concern has been brought to the foreground most recently as the Common Core State Standards for Mathematics (CCSSM) have been implemented in the majority of the United States (Ryan, 2015). These standards, launched by state leaders in 2009 through two different organizations, the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) were developed to help prepare high school students for college, career, and life (CCSS, 2015). What does this have to do with parents of an elementary-aged child? With curriculum materials based on CCSSM when a child brings home mathematics homework, they are encouraged to solve problems using multiple strategies. This is different from the single, efficient strategy most parents were taught to follow (Erickson, 2014; Richards, 2014). Some parents do not understand the solution strategies that support the CCSSM, according to the progression documents (University of Arizona, 2015) and are unable to assist with their child's mathematics homework (Erickson, 2014; Nerney, 2013; Ryan, 2015). Other parents, when helping their child with homework, try to use the procedural "tricks" they were taught in elementary school (Cleveland, 2014; Garland, 2014), possibly because this is the only way they know how to respond to the homework problems.

According to the National Center for Education Statistics (NCES), most US curricula in place prior to the implementation of the CCSSM were described as easy and focused more on procedural rather than conceptual understanding (NCES, 1996). Procedural fluency is when students can solve problems accurately and efficiently, while conceptual understanding is when students can make connections between mathematics facts, procedures, and ideas (NRC, 2001). Before the CCSSM were implemented, the curriculum focused on developing students' surface knowledge instead of the deep understanding they are now expected to achieve (TIMSS, 2015). The CCSSM claim to have fewer benchmarks, but teachers are expected to teach in-depth, with multiple strategies to solve each type of problem instead of eliciting just one solution strategy from the students (CCSS, 2015). Expectations of the CCSSM within the classroom encourage students to learn multiple strategies to find which one makes the most sense to them, even if it takes more time than another student's strategy. Although students are still expected to learn efficient procedures, they should first have a conceptual understanding of the topic (Sfard, 1992; Vendlinski et al., 2009).

Parents want to help their child with homework, but only have their personal experiences, which are often very procedural, upon which to base the support they provide (Garland, 2014; Richards, 2014). Parents who have not pursued careers in education can be reasonably compared to preservice teachers entering education programs. Both have a stake in education although one group's interest is in support of their child and the other is in anticipation of a career helping a child learn as a student. When preservice teachers enter education programs, many believe that students learn best using traditional methods where the teacher is the authority figure and tells students how to solve problems (Ambrose, 2004; Swars, Smith, Smith, & Hart, 2009; Philipp, Ambrose, Lamb, Sowder, Schappelle, Sowder, Thanheiser, & Chauvot, 2007). In this aspect, parents are like preservice teachers (PSTs) because both populations view student learning through the perspective of how they were taught as students, by solving mathematics problems in ways that are efficient and procedural (Garland, 2014; Richards, 2014).

PSTs differ from parents in several ways: they have access to instructional methods that support multiple approaches to solving problems; they have coaching from veteran teachers within their educational communities; and they pursue professional development to adopt new strategies and sustain their skill sets. Parents may lack these resources – particularly professional development – and are at a deficit when supporting their child's mathematics studies at home. The purpose of this study is to examine how parents react to professional development focused on solving problems in ways similar to what is available to preservice and inservice teachers. Unfortunately, parents are typically not offered those same opportunities to learn about these new methods and strategies through any formal means (Associated Press, 2014).

Although websites are available for parents to peruse, it is difficult for parents to know which websites will provide information helpful in supporting their students to learn the CCSSM. The negative publicity surrounding the CCSSM related to elementary school mathematics provides some indication that the current methods parents are using to prepare themselves to support their child and the CCSSM are not working. This could be because research shows that in order to have a deeper understanding of mathematics, people need to be engaged in "doing" the mathematics in ways similar to those used in elementary classrooms (Vendlinski et al., 2009). In this research, "doing" mathematics means, "the use of complex, non-algorithmic thinking to solve a task in which there is not a predictable, well-rehearsed approach" (Stein & Lane, 2006, p. 58). The researcher hopes to determine if parents - using similar strategies and manipulatives to what their child uses - will have a better understanding of how to support their child *and* their child's teacher with implementation of the CCSSM.

Workshops will be designed to attempt to increase parent mathematics knowledge, increase understanding of possible student responses, and shift mathematics beliefs about student learning and teacher practices.

The goal is to shift parents' beliefs from a parent-centered approach that focuses on using procedures to help their child solve problems, to a more learner-centered approach that focuses on conceptual understanding. Teachers are trained to focus on helping students achieve conceptual understanding, and their content knowledge and beliefs impact how students learn mathematics (McClain & Bowers, 2000). This research is important because parents' beliefs also influence the beliefs of their child (Frome & Eccles, 1998). When the parent helps their child with homework, they take on the same role as the teacher. If parents demonstrate disdain for the way their child is learning mathematics, the child could bring that negativity to their own learning experiences (Frome & Eccles, 1998). Furthermore, if the goal is for students to make sense of concepts related to number prior to learning procedures for efficient computations, this sequence of how students should learn may be disrupted if parents teach their child the "procedural tricks" before their child's teacher is ready to address procedural knowledge in general.

Statement of the problem

Many parents of elementary school students were likely taught mathematics in a way different from the technique that incorporates a focus on multiple strategies students are learning as part of the CCSSM (Nearney, 2013). Based on what is shared so pervasively on the Internet, on the news, and in many social situations it can be deduced that some parents are frustrated with the excessive amount of time it takes to solve a problem and the variety of strategies students are using to do so (Richards, 2014). Parents show their child tricks that they learned to solve problems, and that child may come to class the next day with those procedures (Ryan, 2015). Sometimes students know how to explain and justify what they did. Other times they are not able to complete another problem that same way. This creates friction between the parents and teachers, because teachers then need to "un-teach" the tricks taught by the parents and return the focus to conceptual understanding (Erickson, 2014; Nearney, 2013).

While there is quantitative research on parent programs to support parents to help their child with reading, writing, and science, (Rivera, 2012; Senechal & Young, 2008; Van Voorhis, 2003) most research studies in mathematics education regarding parent workshops have been qualitative (Civil et al., 2002; Cotton, 2014; Ginsburg, Rashid, & English-Clarke, 2008; Kreinberg, 1989; Marshall & Swan, 2010; Menendez & Civil, 2008; Mistretta, 2013). This research differs in the sense that it uses quantitative methods. More specifically, the goal of this research is to determine if completing a two-session workshop on mathematics pedagogy and content related to whole number concepts and operations shifts parents' content knowledge regarding whole number concepts and operations, parents' beliefs about learning mathematics, and their understanding of possible student responses.

The purpose of this research was to answer the following questions:

1. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their mathematics content knowledge as compared to parents who do not attend?
2. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their beliefs about learning mathematics as compared to parents who do not attend?

3. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify whether student responses to 2nd, 3rd, and 4th grade mathematics content are correct as compared to parents who do not attend?
4. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify student errors in incorrect solutions for 2nd, 3rd, and 4th grade mathematics content as compared to parents who do not attend?

This introduction includes a background for why these workshops were created and what questions the research attempted to answer. Next, literature related to topics in the current study will be discussed, including previous research on parent workshops. The design of the current study, instruments used, the sample population, and the intervention will be described. Data analysis will be explained using tables and graphs from analyses run using SPSS. Finally, the findings will be discussed and any limitations, implications, and possibilities for future research will be addressed.

CHAPTER TWO: LITERATURE REVIEW

Research on mathematics content knowledge and mathematics beliefs about student learning will be examined in this literature review. Different types of parental involvement and parents' mathematics knowledge, level of understanding in regard to student solutions, and beliefs about learning and teaching mathematics, will also be discussed. This research is important because there is a gap in research on quantitative studies determining whether parents make a shift regarding content knowledge, beliefs, ability to identify correct student responses, and ability to identify student errors, after workshops. The beliefs parents hold about how to help their child, in addition to their mathematics content knowledge, could impact the way they help their child with mathematics homework in elementary grades. This literature review presents evidence that parental involvement increases student achievement (Cooper, 1989; Cooper, Robinson, & Patall, 2006; Deslandes, Royer, Potvin & Leclerc, 1999; Yap, 1987). Further questions regarding how researchers can improve parental support and draw attention to teaching strategies supportive of CCSSM implementation in elementary school mathematics classrooms arise from these findings.

As a result, this study expands research on parents' beliefs about teaching and learning mathematics, parents' mathematics content knowledge, and parents' understanding of student responses. This will help to determine if workshops focused on elementary mathematics content will impact mathematics content knowledge, ability to identify student responses, and the ability to identify student errors in addition to changing beliefs of parents. In addition, parental involvement and how it relates to student achievement will be discussed, along with the need to support parents to improve their content knowledge related to current teaching strategies similar to the need for increased content knowledge among teachers (Ball, Lubiensi & Mewborn, 2001; Ball, Thames, Phelps, 2008; Hill, Schilling & Ball, 2004; Hill, Rowan & Ball, 2005; Hill, Ball & Schilling, 2008; Thanheiser, 2009; Thanheiser, 2010; Thanheiser, Browning, Moss, Watanabe & Garza-Kling, 2010; Thanheiser, Whitacre & Roy, 2014). Parental involvement in terms of the reasons why parents feel like they need to be involved, what has changed in mathematics education that makes parents feel frustrated, and how workshops may help increase mathematics knowledge and shift beliefs will be discussed.

Some researchers (Balli, Wedman, & Demo, 1997; Desimone, 1999; Epstein, 1988; Fan & Chen, 2001; Horn & West, 1992) report a negative relationship between parental involvement and student achievement related to mathematics content. In other words, the more involved a parent is, the lower their child's mathematics achievement. This negative relationship could be affected by parent frustration because mathematics is being taught differently from when parents were children. If this is considered in terms of increasing mathematics knowledge for parenting (MKP), it may become possible to increase student achievement, lessen parental frustration, and lessen parent opposition to the CCSSM.

Parent Involvement

Parental involvement is important because when parents are involved in their child's education, students have a more positive behavior (Sanders, 1998). However, some researchers (Domina, 2005; Mattingly, Prislin, Mckenzie, Rodrigues, Kayzar, 2002; McNeal, 1999) found no positive or negative relationships between parental involvement and student achievement. There are several ways parents can be involved. Some say encouraging parents to help their child with homework, is one way to attain increased communication between parents and teachers (Epstein

& Van Voorhis, 2001). Parents could also be involved by meeting with the teacher, getting progress reports about grades and any behavioral issues from the school, encouraging their child to learn, or helping with homework (Hornby & Lafaele, 2011). According to Epstein (2001) the ways parents can be involved in their child's education are described in the following categories: (1) collaborating with the community, (2) parenting, (3) communicating, (4) volunteering, (5) learning at home, and (6) decision making.

Even though all aspects of parental involvement are important, this research focuses on the part of Epstein's (2001) model described as "learning at home" because the workshops created in this study directly relate to that aspect of parental involvement. The part of parental involvement that focuses on parents helping with homework is the basis of this research, and, for the purpose of this research is called mathematics knowledge for parenting (MKP). A more precise meaning is important because it is necessary to determine if the study (a) increased parents' mathematics knowledge; (b) improved parents' ability to identify correct student responses; (c) shifted beliefs to be more child-centered if parents had pretest beliefs that were more parent-centered; and (d) increased parents' ability to identify student errors, which could directly relate to helping their child with homework. Workshops might give parents sufficient content knowledge to keep from inhibiting student achievement through the introduction of procedures too early. This is important because research shows that when students are shown the procedures to solving problems without any meaning behind those procedures, their understanding is limited and can lead to student errors (Fuson, 1990; Hiebert & Wearne, 1993; Steffe, 1983). Thus, sufficient knowledge acquired through the workshops could improve parental conceptual understanding.

When a child asks his or her parent for help on homework, the parent wants to show support for his or her child's education (Balli, Demo, & Wedman, 1998; Epstein, Sanders, Simon, Salinas, Jansorn, & Van Voorhis, 2002; Levin, 1997). Parents think that they should be able to help their child with elementary mathematics, but then they realize mathematics is being taught differently (Richards, 2014). Some parents do not understand the justification behind why these new strategies are being used, and think they are a waste of time. Parents try to use the procedural strategies they learned instead of the new strategies (Garland, 2014; Richards, 2014); parents might not have been given an opportunity to learn about these strategies in the ways their child is exploring mathematics. For example, some adults would look at a problem like 43 + 19 and say, "3 and 9 is 12, carry the 1, 1 and 4 and 1 is 6. So the answer is 62." However, when asking if they understand why they are "carrying the 1" their response is that their teacher told them to. However, students are taught place value concepts in depth, so they understand that when they are adding 3 and 9 they are regrouping. It is the same as one group of ten and two more ones. This is why the one is now in the tens place. Parents not understanding the concepts could have a negative impact on their child's learning (Dauber & Epstein, 1993). Teachers have opportunities to gain a deeper understanding of the mathematics they are to teach through their education classes or professional development (Vendlinski et al., 2009). By creating workshops that allow parents to work through the strategies their child uses, this study investigated a parental professional development plan that would provide parents with a better understanding of those strategies. After all, a parent is the child's teacher when the child is at home.

Education Reform Movements

Parents in the United States had a different role in the education of their child in the past than they do today. In the early 1640's, parents had full control over their child's education, and were expected to teach him or her how to read and write (Hiatt, 1994). Either the parents, or the child's master if they were apprenticed, were required by a Massachusetts law passed in 1642 to take on this task (Hiatt, 1994). However, because some children were not being taught to read, a law was passed in 1647 known as the Old Deluder Satan Act (Hiatt, 1994). It required towns that had more than 50 families to hire a schoolmaster to teach the children, and towns with more than 100 families to hire a grammar schoolmaster so students would be prepared to attend Harvard College, the new college in Massachusetts at that time (Hiatt, 1994). Parents in towns with a population of 50 or more families began to hand over the education of their child to these schoolmasters. This was one of the first steps towards public education.

Through the next two hundred years, education evolved, and by 1860 most states had some type of public education system. Two leaders in public schools, Horace Mann and Henry Barnard, believed, "parents did not possess the time, knowledge, or talents necessary for a child to meet the challenges of the emerging technology" (Hiatt, 1994, p. 32). This could be one reason why parents felt that public education was the best choice for their child. However, some children were unable to attend school because their families depended on the income their child earned while working in the mines and factories (Hiatt, 1994). In addition to child labor laws, states passed truancy laws so parents could not take advantage of their child working long hours and not getting the education they needed. This is when parents lost control of making many decisions associated with their child's education (Hiatt, 1994).

By 1900, mothers, who were unhappy with the lack of input they had in making decisions pertaining to their child's education, formed the National Congress of Mothers (NCM), which later became the Parent/Teacher Association in 1907 (PTA, 2015). The PTA continued to grow and create a sense of community in the schools; they were intent on improving schools (Butts & Cremin, 1953). According to their website the purpose of the PTA (2015) is to, "make every child's potential a reality by engaging and empowering families and communities to advocate for all children."

The mid 1900's brought the Life-Adjustment Movement, where the curriculum focused on teaching life skills instead of the rigorous academic curriculum previously in place. During the Life-Adjustment Movement, more parents who opposed this movement became vocal about their child's education but despite that, the Life-Adjustment Movement had sufficient support from educators (Klein, 2003). The opposing parents wanted their child to learn the academic content that was lacking from the curriculum in the Life-Adjustment Movement (Klein, 2003). These dissatisfied parents rebelled, even taking their cases to court in some states. This is one example of how parents have influenced reform movements.

Another example of parental influence on a reform movement was during the New Math Reform Movement (NMM) that occurred in the 1950s – 1970s. Reformers used a large amount of federal funding to create projects to determine how to shift the way mathematics was taught (Davis, 1990). Researchers created curriculum and then teachers were expected to implement it (Davis, 1990). This is why some described this reform movement as being implemented with a "top down" approach. People that helped create the NMM were interviewed and came up with four common themes for reasons why it failed (Bosse, 1995). One was the lack of professional development (PD) for teachers (Bosse, 1990). Bosse (1995) discussed the fact that teachers and researchers had different ideas for how teachers should teach, and they suggested that PD should be set up to more clearly align the teachers' beliefs with those of the researchers. Another reason was that parents felt like their child was not getting enough practice with basic arithmetic skills (Klein, 2003). Parents were vocal about their disapproval, which contributed to the failure of this reform movement.

The ending of the NMM led to the "Back to Basics" movement in the 1970s and 1980s (Ravitch, 2000). Classrooms were set up where teachers were the center, the authority figure telling students whether they had the correct answer, and a lot of information was quickly passed from the teacher to students (Ellis & Berry, 2005; Klein, 2003). Teachers focused on giving students the information they needed by showing students efficient strategies. Multiple strategies to solve problems were not shared by the teacher, only the strategy the teacher thought was most efficient. Teachers taught this way because they wanted to give their students a lot of information in a short amount of time (Klein, 2003).

It was during this movement that most parents of current elementary students were being educated. They were taught in a teacher-centered environment, where skill and drill problems were the focus of learning mathematics (Klein, 2003). Their experiences with education were that students should listen, follow directions, and practice a lot of procedures in order to remember how to solve problems (Klein, 2003). Mathematical proficiency, which is discussed in more detail in a later section of this chapter, was not encouraged. Multiple strategies were not encouraged.

In 1989, the focus on how students should learn changed again, when the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics*, which became known as the 1989 *Standards* (Klein, 2003).

This publication focused on problem solving, communication, connections, and reasoning, stating "the study of mathematics should emphasize reasoning so that students can…believe that mathematics makes sense" (NCTM, 1989, p. 29). Due to the public campaign surrounding the 1989 *Standards*, policy makers and politicians did not resist the movement as much as the NMM (Bosse, 1995). NCTM also published *Principles and Standards for School Mathematics* in 2000 to address misconceptions from the 1989 *Standards*, which demonstrates how important this reform movement was to NCTM. However, parents' attitudes towards reform movements became more negative due to the fact that the textbooks their child was using had much less content in them compared to what parents were accustomed, and parents were vocal about their discontent (Schmid, 2000).

The CCSSM are state standards for mathematics that address the problem that was identified in the 1995 Trends in International Mathematics and Science Study (TIMSS) report, which stated the US students were only "average" when compared to other countries (TIMSS, 2015). Curriculum in the U.S. was a "mile wide and an inch deep" and needed to address fewer topics per grade level, but go more in-depth with those topics (Schmidt, Wang, & McKnight, 2005). Researchers looked at the way mathematics education was occurring in countries whose students outperformed US students and considered those methods when creating the CCSSM. Once there was a draft of the CCSSM, states had the option of whether or not they wanted to implement these standards, and most states did. Elementary teachers that are implementing CCSSM according to prescribed best practice are teaching mathematics differently from the way it was taught 30 years ago, which could contribute to low parental support of the CCSSM. One possible reason that parents who resist CCSSM give for their opposition is that the traditional method worked before, and the NMM, which is like the CCSSM, failed so the CCSSM will fail too (Bonagura, 2014).

Even today, after CCSSM has been adopted, teachers and parents are vocal about the fact that they do not support CCSSM because they cannot understand the mathematics their student or child is doing (Erickson, 2014; Garland, 2014; Ryan, 2015). This is a common complaint regarding reform movements, because people that were taught mathematics traditionally through procedures without conceptual understanding, might not value this method of instruction because solving problems this way takes longer than using the procedural strategies they remember (Richards, 2014). This study examined the extent to which workshops focused on MKP impacted parents' beliefs about how students should learn mathematics. Possibly in response to one of the issues with the NMM - that there was no clear focus, creators of the CCSSM claimed in the tagline of CCSSM that it has, "rigor, coherence, and focus" (CCSS, 2015).

Researchers wanted students to be given high cognitive demand tasks (HCDTs) in the classroom, because with HCDTs students made the greatest learning gains (Boaler & Staples, 2008; Hiebert & Wearne, 1993; Stein & Lane, 1996; Stigler & Hiebert, 2004). Cognitive demand can be defined as, "how much thinking is called for in the classroom…[and] understanding mathematical concepts involve high cognitive demand" (Resnick & Zurawsky, 2006, p. 2). Researchers wanted the curriculum to be more focused instead of trying to complete too much in one school year, so teachers had fewer standards they needed to cover in one year (CCSS, 2015). In addition, there were connections between the standards in each year, instead of repeating the same material year after year. Fewer topics were covered but more time was spent helping students build connections between ideas instead of having them feel like each topic was its own isolated idea (CCSS, 2015).

However, some of the same reasons for the failure of past reforms are influencing the current movement. Parental resistance is building (Erickson, 20114; Garland, 2014; Ryan, 2015), which is one way the CCSSM could fail. Angry parents that are vocal talk to school boards and politicians and post videos online to gain more support for the types of teaching methods and content they support (Decarr, 2014).

Both the New Math Reform Movement and the standards movement were a "complete and radical overhaul of the existing mathematical educative system" (Bosse, 1995, p. 200). Researchers claim reform-based research projects are beneficial for students, but that the importance of PD should also be stressed (Bosse, 1995). With the implementation of the CCSSM, parents are realizing that their child is not being taught in ways similar to how they were taught (Erickson, 2014; Garland, 2014; Ryan, 2015). This creates friction and causes teachers to need to overcome extra hurdles when students come in with mathematics tricks their parents taught them (Nearney, 2013). This research is important because schools and districts are attempting to hold parent nights, but they need guidance to plan workshops that meet parents' needs in supporting their child.

There are many resources for parents online to help them with their child's homework (Arlington Independent School District (AISD), 2015; Teachers Involve Parents in Schoolwork (TIPS), 2015). Some states have offered different types of parent development programs, either resources that parents can print out or workshops they can attend, but the effectiveness of these programs were not measured. The current study allowed parents to attend workshops where they engaged in mathematics by learning about the strategies their child is learning. Parents were given the opportunity to attend two days, one on addition and subtraction, and another on multiplication and division. It is likely that the topic of whole number concepts and operations are the topics where parents are first faced with the new strategies their child is using, and need resources to help them understand the strategies.

Another resource available to parents is pamphlets, created by the US Department of Education, which discuss different activities that parents can use with their child. The National Network of Partnership Schools at Johns Hopkins University created “TIPS math” which allows teachers to download worksheets so they can be sent home to parents (TIPS, 2015). These teacher-created worksheets help parents understand the content covered in the classroom, and allow parents the opportunity to communicate with the teachers. Arlington Independent School District (AISD) in Texas created Parent University where parents can sign up for a workshop that covers many topics like helping with mathematics, reading and writing, transitions to middle school, and even General Education Development (GED) and English as a Second Language (ESL) resources (AISD, 2015). While many states are creating resources that can help parents and sometimes those resources can be printed out so parents can take them home and use them with their child, this research intended to demonstrate the effectiveness of workshops where parents engage in the mathematics content.

If parents looked through the Florida Department of Education (FLDoE) website in August, 2015, there were links they could click to give them tips when helping their child, but there were no workshops specifically geared for helping parents understand mathematics consistent with the intent of the CCSSM (Florida Department of Education, 2015). The results of this study implied that teachers and administrators could hold workshops focused on mathematics content to help parents understand the importance and rationale of this new way of teaching so parents can see how valuable it is for the development of their child’s learning process.

Social Media

Even though parents complained during past reform movements, the ways in which they were able to share their thoughts were much slower than they are today because social media has been used to quickly share opinions (Lee & Sprague, 2015), particularly in regard to the implementation of the CCSSM (Decarr, 2014; McKenna, 2015; Nerney, 2013; Supovitz, Daly, & del Fresno, 2015). In addition, online publications are essentially free, because people have access to computers and the Internet at public libraries (Lee & Sprague, 2015). People can post in blogs and opinion articles online and when comments are allowed, they can create momentum for others to support or oppose their cause (Lee & Sprague, 2015). Furthermore, anything can be written on Facebook or a blog. These ideas can gain momentum and cause other peoples' opinions and attitudes to shift (Lee & Sprague, 2015; Nerney, 2013), either for or against the CCSSM. In some states, social media posts have become a platform, building off the negative feelings from the community towards CCSSM (Erickson, 2014; McKenna, 2015).

One way the public (parents, politicians, and any other person in society that thinks they are experts on the subject) will be reached to increase buy in for the CCSSM is by giving them opportunities to engage in the mathematics, as this is how *teachers* shift *their* beliefs (Lerman, 2002). Teachers are an important part of reform movements and they need to be implementing the reform ideas correctly, however parents and other people in society also have an impact on the success of this reform through social media. This population might benefit from learning mathematics according to the intent of the CCSSM as well.

Why Parents get Involved

Hoover-Dempsey, Battiato, Walker, Reed, DeJong, and Jones (2001) reviewed research articles that focused on how and why parents become involved in their child's homework. From the 58 articles they reviewed regarding all content areas and grade levels, these authors came up with eight ways parents help their child with homework. The two that most closely align with this research will be discussed in detail.

One of the ways parents are involved with their children is when they help their child link what they already know to the current task. This refers to when the parent helps their child by breaking down the mathematics in a way that is more understandable to the student so the student can make sense of the mathematics (McDermott, Goldman, & Varenne, 1984). Parents also need to be able to observe and understand the level of their child mathematically, so they can scaffold the material (DeBaryshe, Buell, & Binder, 1996; Shumow, 1998; Xu & Corno, 1998). In order to do this they need to have more than just a surface understanding of the mathematics their child is learning.

Another way parents help their children is by helping them to understand concepts, not just the procedures (McDermott et al., 1984; Shumow, 1998). When children gain a conceptual understanding of the content, they are able to solve problems that are more complex by using the flexible strategies they learned about in class (NRC, 2001). Parents can also discuss problem-solving strategies with their child and help him or her with different strategies (McDermott et al., 1984; Shumow, 1998). However, if parents are not aware of these different strategies their potential to be effective is diminished.

Parent Involvement and Student Achievement

Parental involvement in regard to their child's homework has been linked to student achievement (e.g. Balli et al., 1997; Cooper, 1989; Fan & Chen, 2001; McNeal, 1999). Many studies show that parental involvement and student achievement have a positive relationship (Cooper, 1989; Cooper et al., 2006; Deslandes et al., 1999; Yap, 1987). By providing parent workshops, parents may feel more comfortable helping their child, which could lead to increased student achievement. When parents help their child with homework, students find homework more enjoyable, less difficult, and more manageable (Coleman, 1991; Comer, 1986; Cooper, Lindsay, Nye & Greathouse, 1998; Frome & Eccles, 1998; Lareau, 1989; McNeal, 1999; Shumow, 1998; Walberg, 1984).

Parental involvement also helps students understand the material, have an overall knowledge of the topic, and encourages students to be persistent when working on completing homework (Callahan, Rademacher, & Hildreth, 1998; Natriello & McDill, 1986). A positive relationship has also been found when parents are knowledgeable about the content (McDermott et al., 1984; Xu & Corno, 1998), and when parents support the child's independence (Cooper, Lindsay, & Nye, 2000; Pomerantz, Grolnick, & Price, 2005). Increasing parents' content knowledge provides motivation for creating parent workshops because these workshops will be designed to improve parents' mathematical content knowledge and strategies to help their child without just giving the answer or showing him or her the tricks they learned to solve problems.

Some studies found no relationship between parental involvement, specifically related to checking homework and homework help, and student achievement (Domina, 2005; Mattingly et al., 2002; McNeal, 1999). Although students have their homework completed the next day, the results of long-term improvement is mixed (Pomerantz & Eaton, 2001). Parents help their child complete the homework that is due the next day, but students are just completing it to finish it, not for conceptual understanding. It is possible that these results are due to the type of support parents offer. It could be that the support is entirely procedural rather than conceptual in nature.

However, a negative relationship was found between parental involvement and student achievement in other studies (Balli et al., 1997; Desimone, 1999; Epstein, 1988; Fan & Chen, 2001; Horn & West, 1992; Muller, 1993). The reactive hypothesis could explain the negative effect. This is a term to describe the increase in parental involvement when students perform poorly (Epstein 1988; McNeal, 2012). When students start performing poorly in a class, parents feel like they need to help their frustrated child. However, without the tools needed to better help their child, this could have a negative effect, especially if the parents do not understand the skills (Dauber & Epstein, 1993), if parents have their own time constraints (Kay, Fitzgerald, Paradee, & Mellencamp, 1994), when parents just give their child the answer or show him or her how to do the problem without giving their child a chance to fully understand the problem (Cooper et al., 2000), or when parents initiate helping their child and the child feels like the parent is taking control (Levin, 1997).

Professional Development Workshops for Parents

The current research was created to determine whether parent professional development workshops (PD) impacted parents' mathematics knowledge and beliefs. Research studies on PD were reviewed to plan an appropriate amount of time for the workshops and to determine what recommendations participants in previous studies made. Previous research studies were more qualitative in nature, which supported the need for a quantitative study, similar to the nature of the current study. Some research on mathematics workshops for parents is summarized in the following sections.

“When it comes to mathematics, parents often feel inadequate to help their children with homework tasks, let alone teach them important content” (Knapp et al., 2013, p. 433). Math and Parent Partnerships in the Southwest (MAPPS) workshops were created to help parents, “act as mathematical resources for their children” (Knapp et al., 2013, p. 434). MAPPS was a four-year K-12 project funded by NSF and was based on three principles: (a) parents’ awareness of the changes in the way their child learns mathematics, (b) parents’ awareness that the child should take an active role in their learning through hands-on activities, and (c) parents’ awareness that knowledge is constructed by building on relationships created together (Menendez & Civil, 2008). In addition, these sessions were created to build upon the idea of mathematical knowledge for teaching by Ball et al. (2008) by inviting all parents, teachers, paraprofessionals, and children to participate. The current research is based on ideas similar to the MAPPS principles.

Civil et al., (2002) used data collected from MAPPS modules. Their module consisted of eight sessions, each lasting two hours where participants met once each week and covered topics relating to fractions, decimals, and percents. Researchers videotaped the sessions and interviewed the participants. During the workshops and due to the focus on discourse within the group, participants tried to make connections between mathematics and the real world and communicated these topics with each other. For example, when looking at 75%, one parent started to make sense of this percent by using money. Starting with one dollar, she knew that 25% was one quarter, so 75% was three quarters. Participants also commented on how they were more comfortable with the mathematics so would be able to help their children with homework. The findings indicate that, "giving parents opportunities to actively construct their own understanding of mathematics concepts provides a critical foundation for their work with their own children" (Civil et al., 2002, p. 9). The current research used context in the problems posed to parents to relate mathematics to real word contexts. However, the current research used whole numbers instead of fractions, decimals, and percents. Additionally, the current research included two sessions versus the eight in this study.

Menendez and Civil (2008) used data collected in MAPPS modules. There were six modules over a two-year time frame. Each module included 7 sessions; each session was 1.5 hours long. The number of participants varied from 3 to 22 over the span of two years. Participants worked in groups to solve problems, as the researchers used questioning techniques to encourage participants to think about the problem more deeply, and then groups shared solution strategies. Researchers used content from the students' textbooks in the workshops because parents attended workshops to better help their children. Over the course of the two-year research, the time changed from a morning session to a night session so spouses could attend. The amount of time it took for planned material to be covered was flexible to allow more time on content parents asked for such as fractions. Later modules included children so researchers could assist parents while helping their child with problems. One suggestion researchers made for offering longer sessions was to plan for parents entering at different points throughout the module. For example, having material that a parent could benefit from right away, instead of being lost for the first part of the session if they came several sessions after the workshops started (Menendez & Civil, 2008). The current research is similar regarding the focus on group work and the amount of time for each session, 1.5 hours. This research is different from the current study because there were only two sessions for each series. In the study by Menendez and Civil (2008), each module consisted of seven sessions.

Knapp et al. (2013) used data collected from eight sessions, once a week, each lasting two hours. There were eight separate mini-courses repeated over the course of three years. Topics for each of the 8-week sessions were: number and operations, algebra, geometry and measurement, and data analysis and probability, and the focus of each session was engaging in mathematics by incorporating hands on activities. The topic of number and operations was repeated twice for base ten, and repeated three times for fractions, decimals, and percents. The remaining three topics were only offered once. Researchers found parents and teachers improved their content knowledge and attitude towards mathematics over the three years in addition to their use of manipulatives. They concluded that PD should include both content and pedagogical aspects that allow participants to explore using manipulatives, share strategies, and collaborate to find solutions.

Parent Institute for Quality Education (PIQE) was created to help low-income parents be better prepared to advocate for their children by helping them with homework and increasing communication between home and school (Ochoa & Mardirosian, 1996). Workshops provided were 1.5 to three hours each session, with a different issue and different content area discussed at each session. Parents of kindergarten through grade 9 students were invited to participate in either the morning or evening session. There were 16 interventions analyzed, each six weeks long, and 1360 participant evaluations were completed. Researchers determined that 92% of the participants found the six-week intervention to be beneficial with helping their child at home with homework and communicating with the school. In addition, students were tracked and researchers determined the workshops had a positive effect on students' reading and homework scores. (Ochoa & Mardirosian, 1996). The current study is different because the focus was not on low-income parents. The current study had fewer sessions (two) than the study by Ochoa and Mardirosian (six). Additionally the current study included parents of 1st, 2nd, and 3rd grade students, unlike the bigger range of K – 9 in the study by Ochoa and Mardirosian. Similar to the current study there were both morning and evening sessions offered.

The Family Math Program (FMP) was designed for parents and their kindergarten through grade 9 children. The four to six-week workshop series were about two hours each, and focused on providing activities to help parents and children engage in mathematics together. In addition, parents were given a resource book with clear instructions on how to continue doing these types of activities at home. Parents did not need to attend the workshops to use the resource book, but researchers recommended attending the workshops so parents could benefit from group work and the discussion that came from it. Since 1981 there have been more than 40,000 families who participated in FMP classes. The workshops helped create relationships between parents, their child, and their child's teacher. Participation in the FMP workshops showed an increase in parents' confidence and their understanding of the importance of mathematics. In addition, parents no longer were fearful of mathematics, and the FMP helped them increase communication between home and school (Kreinberg, 1989). Unlike FMP, the current research intended to measure content knowledge and shift beliefs after participating in the workshops. Additionally, the current research was designed for parents, while the FMP was created for both parent and child.

Arkansas Parents: Partners in Learning Experiences (APPLE) was created in 1981 to help parents work with their children and with the school. One goal of this program was to train parents as teachers by offering training sessions on TV. Parents were given materials that went along with those videos. Of the 10 workshops offered, most parents attended four of the two-hour sessions. Each session was offered during the day and again at night. The sessions covered one topic for each session; mathematics, study skills, reading and language, so parents could attend the session that was most relevant to them. Parents suggested a lecture format instead of videos because of the discourse involved when a person is presenting the material instead of watching the material on the television. After implementing these workshops, parents became more involved in their child's education and researchers found that student achievement improved when the child's parent attended the sessions (Walberg & Wallace, 1992). Parents in the current study met face-to-face, there were no training sessions on TV or online. This decision was made to include discourse as a focus for learning mathematics in the workshops.

Federally Assisted Staff Training (FAST) was created to help Title 1 schools: (a) improve instruction, (b) improve self-evaluation and initiation, (c) develop new ways to teach students, and (d) train teachers and administrators to continue this work. Implemented in 1981-1982, over 4500 parents and staff participated in the workshops. Syropoulos (1982) evaluated this program by analyzing data collected from questionnaires. The majority of parents who attended workshops said the workshops were useful and indicated they would recommend the workshops to someone else. The focus of the mathematics portion of the series was on manipulative use, and the parent training session focused on ways to help their child in academics. Some suggestions parents made for future workshops were: (a) instead of three 55 minute sessions have two sessions that are 1.5 hours long, (b) parents should be more involved during the workshops, and (c) offer more workshops like this. Some parents suggested that there was too much material involved and the workshops were too theoretical – they should have been more practical. The current study is similar regarding the total amount of time for the workshop series.

Additionally, the current study also focused on manipulative use similar to FAST. Unlike FAST, parents were engaged in learning the mathematics in the current research study.

Whiteford (1998) created workshops to help parents become better able to help their children at home. There were seven workshops, each lasted one hour, which met every other week over the duration of a semester. Although each meeting time was shorter in this study, there were more workshops than the current study. Workshops in Whiteford's study covered the following topics, one for each session: (a) number sense and counting skills, (b) place value and base ten, (c) addition and subtraction, (d) multiplication and division, (e) common fractions, (f) decimal fractions, and (g) problem solving. The amount of time allotted for the topics in the workshops and the content in the current study are similar to Whiteford's study because the addition and subtraction topics session was one hour long. There was one session that consisted of multiplication and division, and it lasted one hour. Activities were chosen to deepen conceptual understanding. Of the 18 total participants, each session ranged in sample size from six to 12. Parents learned about using correct language in mathematics, for example the researcher used the word "rename fractions" to simplify, rather than "reduce" due to the meaning of the word reduce. Parents reported on a survey that they felt more confident helping their child with mathematics homework after completing the workshops. Whiteford (1998) claimed, "parents who have a conceptual understanding of elementary school mathematics will be stronger advocates for effective teaching strategies and more active partners in their children's education" (p. 66).

Ginsburg et al. (2008) interviewed 50 parents of second through fifth grade students to see how they felt about helping their child at home with reform mathematics. Researchers indicated the learning that occurred while parents worked with their children on homework could be grouped into three themes about learning – for their children, from their children, and with their children. In other words, parents believed that their children needed their help, and they learned about the mathematics from their child because mathematics was different from when they were children. If parents were not confident with their abilities they took on the role of a teacher and as a learner at different times, depending on what the situation called for, as they worked with their children. When parents were asked if they would participate in a workshop designed to help them understand the new and different mathematics activities, parents suggested they would attend if their child were included to participate as well. Because parents felt like they were learning about mathematics at home with their child, they would likely not attend workshops if their child were not included. Unlike this study where the focus was learning about parents current beliefs, parents in the current study participated in a workshop series.

Marshall and Swan (2010) conducted a qualitative study through interviews and surveys. Parents completed six workshops during the summer on the following topics: (a) playing *Numero*, (b) place value, (c) multiplication, (d) fractions, (e) addition and subtraction, (f) playing advanced *Numero*. Parents who attended the first session played *Numero*, a game that focuses on number facts and problem solving. The group chose the other five workshop topics during the first workshop session. Each workshop lasted 45 minutes, and was held during the same time their children attended a different workshop at the same site. Parents were asked to fill out a survey and after the workshops approximately 81% of the parents said they were confident helping their child with homework whereas only 22% of parents said they were confident before the workshops. Additionally, when participating in interviews, parents generally said they were confident with their own mathematics, but not as confident when helping their child. Many said they felt like the workshops helped them in that area. Marshall and Swan met with parents six times for 45 minutes each time. Three topics (place value, multiplication, and addition/subtraction) were similar to topics in the current research study. Unlike the current study, Marshall and Swan collected more qualitative data. Quantitative data was related to confidence whereas quantitative data in the current study was related to content knowledge, beliefs, identifying student errors, methods used, and tools.

Mistretta (2013) conducted a study where 18 of her preservice teachers, enrolled in a master's program, interacted with 34 families as part of the requirement for the course. They participated in a program geared towards engaging parents using *In Collaboration*. Each PST worked with one or two families, which consisted of one adult and one child. They met four times, once a month, for two hours each session. Parents worked with their child on fourth grade standards using different manipulatives. PSTs used data collected by observing the collaboration between parent and child, surveys, and interviews. Before the program, parents perceived their role in helping their child with mathematics to be passive and traditional – quiet settings and checking homework for correctness. After the workshops parents focused more on communication, where the child discussed strategies and parents used questioning techniques to delve more into the students' understanding. The PSTs realized that parents need assistance with content and pedagogy, so they are better able to assist their child. Mistretta's study included fourth grade topics, whereas the current study included topics across more grades. Additionally, data in Mistretta's study was more qualitative in nature whereas the current study was primarily quantitative.

Cotton (2014) conducted a study where there were 4 sessions, each lasting 30 minutes, for parents to help them develop mathematical language and support their child's learning in mathematics. Each of the following topics was covered in one of the sessions: number recognition, addition, multiplication, and division. Cotton found that parents increased their confidence in being able to help their child with homework. In addition, parents valued being included in learning situations and enjoyed discovering that learning mathematics could be fun. Cotton's study covered similar topics as the current research study, but the current study had more face-to-face time with participants.

Previous research findings suggest that parents who participate in parent workshops have a better understanding of the importance of mathematics (Kreinberg, 1989) and increase their content knowledge and improve their attitude towards mathematics (Knapp et al., 2013). Additionally, relationships between parents and their child (Kreinberg, 1989; Mistretta, 2013; Walberg & Wallace, 1992) and between parents and the school (Kreinberg, 1989; Ochoa & Mardirosian, 1996) can be improved by participating in parent workshops. Parents may be more comfortable with mathematics if they are involved in their child's education (Walberg & Wallace, 1992) especially if parents use hands on activities (Knapp et al., 2013; Syropoulos, 1982). Parents who engaged in this type of learning through discourse were more comfortable with the mathematics (Civil et al., 2002). Although parents may not be confident when helping their child with mathematics homework before workshops, after participating in workshops parents were confident with their mathematics ability when helping their child (Cotton, 2014; Kreinberg, 1989; Marshall & Swan, 2010; Whiteford, 1998). Previous research offered suggestions for future research in this area such as including parents and their child in the workshop (Ginsburg et al., 2008). Additionally, future research should be planned in such a way where parents can enter the workshop series at any time and not feel lost (Menendez & Civil, 2008). The researcher in the current study chose not to include students in the workshops due to the frustration of how mathematics is being taught. The researcher wanted to allow parents the freedom to ask questions freely, without worrying about how their child would react to the questions.

Similarities in the Background of Parents and Teachers

Due to the lack of quantitative research on parents regarding shifts in beliefs and learning about mathematics (Cotton, 2014; Kreinberg, 1989; Marshall & Swan, 2010; Mistretta, 2013, Whiteford, 1998), the researcher proposes a connection between parents and preservice teachers. The way PSTs think in terms of solving mathematics problems could be tangentially related to the way parents think about solving mathematics problems. PSTs come to their education courses with experiences in learning mathematics procedurally, similar to the way parents help their child and may only rely on their past experiences which could be procedural (Garland, 2014; Richards, 2014). Ball (1988) reported that elementary teachers had an acceptable level of procedural knowledge but lacked conceptual knowledge and could not make connections between the two.

Tsao (2005) reported that high-ability PSTs used number sense strategies to solve problems, while low-ability PSTs used rule-based methods. Zazkis and Campbell (1996) found that PSTs heavily relied on procedures when solving multiplication and division problems. It is likely that these findings may be consistent with parents who experienced a teacher-centered classroom when learning mathematics as a child. This is noteworthy because PSTs and inservice teachers (ISTs) rely on their past experiences when making decisions about how to teach (Beswick, 2012; Bray, 2011; Nettle, 1998).

A child should learn mathematics by constructing his or her own knowledge, according to best practice. Children enter elementary school with some conceptual understanding (Baroody, 1987; Carpenter, Hiebert, & Moser, 1983). Teachers may give students opportunities to make sense of their conceptual understanding by allowing them time to solve problems without direct instruction. If teachers use direct instruction in the classroom, students might be able to follow the steps used to solve the problem, but they may not have the conceptual understanding of *why* they are using those steps (Burton, 1984). This is important because students might get the correct answer when solving one problem, but if they do not have the conceptual understanding of the process, students might get an incorrect answer when solving a similar problem using different values (Erlwanger, 1973). When students learn mathematics in a learner-centered environment, they can be actively engaged in the problem, in ways that make sense to them. Parents may gain a deeper understanding of this type of learning if they are given opportunities to construct their own knowledge as well (Civil et al., 2002).

Even though ISTs might not be in a graduate program or taking classes at a university, they can learn about how to teach with students constructing their knowledge in the foreground, by participating in workshops, attending sessions at conferences, or discussing new strategies with their mathematics coach (FCTM, 2015; NCTM, 2015; WMC, 2015). Whether or not ISTs decide to take advantage of these opportunities does not change the fact that parents may not be given the same opportunities. Because parents are their child's teacher when working on homework, the researcher proposes a connection between preservice teachers who are beginning their education program and parents who do not have a background in teaching. Once PSTs become teachers, they are expected to attend PD, but again these resources may not be as readily available for parents. Research indicates that longer PD sessions, and ongoing PD are better than short-term sessions, but they are not often used (Birman, Desimone, Porter & Garet, 200; Garet, Porter, Desimone, Birman, & Yoon, 2001; Frechtling, 2001; Quint, 2011). Two factors leading to shorter PD series could be issues with attrition for longer PD series and funding issues.

The researcher proposes a connection between inservice teachers who need to stay current with new methods of teaching mathematics and parents who need to understand the new methods as well. Parents, like ISTs, could benefit from PD to better assist their child with homework. The next three sections focus on beliefs, content knowledge, and mathematics strategies of preservice teachers and inservice teachers, as the link between parents and teachers has been established.

Content Knowledge

"Despite the common myth that teaching is little more than common sense or some people are born teachers, effective teaching practice can be learned" (NRC, 2001, p. 369).

This quote demonstrates why improving teacher content knowledge in education programs has been a topic debated among educational researchers, especially in mathematics education (Ball et al., 2001; Ball et al., 2008; Hill et al., 2004; Hill et al., 2005; Hill et al., 2008; Thanheiser, 2009; Thanheiser, 2010; Thanheiser et al., 2010; Thanheiser et al., 2014). While traditionalists believe mathematics education should focus on learning procedures to complete a task quickly, current educators need to realize that the world is changing and students are being asked more demanding tasks, to make sure their education prepares them for real life (NRC, 2001). Unfortunately, some preservice teachers are graduating from education programs without the deep conceptual knowledge they need to teach their elementary students (Ball et al., 2001; Hill et al., 2004; Hill et al., 2008).

Preservice and inservice teachers need to have a deep understanding of content knowledge in order to be prepared to teach the concepts. Additionally, they should understand how and why students come up with different strategies and whether or not the student's strategy will work all the time (Ball, 1988; Shulman, 1986). To help improve teaching practice, Ball et al., (2008) suggest, "connections between subject matter knowledge and teaching be made explicit" (p. 5). This is why teacher pedagogical content knowledge (PCK) has been discussed in mathematics education (Ball et al., 2001; Ball et al., 2008; Hill et al., 2004; Hill et al., 2005; Hill et al., 2008). Mathematical content knowledge can be described as having a strong sense of the mathematics that teachers need, both procedural skill and conceptual understanding (Ball et al., 2008). On the other hand, PCK can be thought of as understanding the types of errors students commonly make, knowing what mathematics students will need to learn to make connections to future mathematics topics, and knowing the standards that need to be met and what tools teachers can use to teach them (Shulman, 1986).

Teachers can become more effective by increasing their content knowledge through mathematics education courses and workshops because increasing teachers' content knowledge positively affects student achievement (Hill et al., 2005). Shulman (1986) suggested "the teacher is not only a master of procedure but also of content and rationale, and capable of explaining why something is done" (p. 13). His idea of PCK served as a catalyst for researchers to dig deeper into combining content knowledge and knowledge of pedagogy, instead of just focusing on each part separately.

Due to the fact that reform movements foster a shift in the way mathematics is taught, teachers need PD to increase their understanding of reforms (Ball & Cohen, 1999; Sykes, 1999; Thompson & Zeuli, 1999). Hawley and Valli (1999) go one step further, stating, "one of the most persistent findings from research on school improvement is, in fact, the symbiotic relation between professional development and school improvement efforts" (p. 129). Graeber, Tirosh, and Glover (1989) imply that during education courses preservice teachers need to learn and understand efficient strategies because they come to teacher education programs with limited conceptual knowledge (Ball, 1988; Ball et al., 2001; Ma, 1999). Flexibility with learning these strategies leads to a deeper conceptual understanding of mathematics.

Even though presenting PD to teachers could help them to gain a deeper understanding, sometimes other factors need to be taken into consideration. Sometimes when teachers implement something they learned about in PD, it is not always how the researcher intended it to be implemented (Barmby, Bolden, Raine, & Thompson, 2013; Cohen, 1990). Sometimes schools send one teacher or administrator to participate in PD, and that person is expected to then teach the rest of the school. However, if a new idea is being implemented, researchers need to present the PD if they want their ideas to be implemented and not the teachers' interpretation of those ideas. This is because sometimes the teacher's interpretation of the researcher's ideas is different from those of the researcher. Cohen (1990) conducted a case study on one elementary teacher in California. This teacher was excited about the activities she learned in her PD, and believed she implemented them correctly. Cohen observed that her activities in the classroom were adopted from the PD, but she still ran a teacher-centered classroom. He stated that teachers "cannot simply shed their old ideas and practices… As they reach out to embrace or invent a new instruction, they reach out with their old professional selves… Some sorts of mixed practice, and many confusions, therefore seem inevitable" (p. 339). As states move forward with CCSSM, PD should be offered for teachers and administrators, but this research focused on the idea that workshops should also be provided for parents because parents work with their child on homework.

Teachers can help students gain a deeper understanding of mathematics by giving them high cognitive demand tasks (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996). When teachers choose tasks that foster conceptual learning, students perform as well or better in regard to procedural fluency, as students whose teachers only taught procedures (Boaler, 1998; Fuson & Briars, 1990; Hiebert & Wearne, 1993; Stein & Lane, 1996). Procedural fluency and conceptual understanding are only two out of five strands that need to be included in instruction to help students attain mathematical proficiency (NRC, 2001). Conceptual understanding is when students can make connections between mathematics facts, procedures, and ideas (NRC, 2001). Procedural fluency is when students can solve problems accurately and efficiently (NRC, 2001). Procedural fluency is different from knowing how to solve a problem using procedures, but not understanding why, which is a low cognitive demand task (Smith & Stein, 2011). In the context of this paper strong mathematics content knowledge will be defined as understanding both the procedures and the concepts so parents are able to explain what the procedure is and why it works (NRC, 2001).

Beliefs

A third strand of mathematical proficiency is productive disposition, which is related to beliefs held about mathematics. Having a productive disposition in mathematics includes being able to see mathematics as useful and worthwhile. In order for a learner to develop a productive disposition, they need "frequent opportunities to make sense of mathematics" (NRC, 2001, p. 131). These opportunities may influence learners' beliefs, especially when the beliefs are called into question. This shift is important because “changes in beliefs are assumed to reflect development” (Oliveria & Hannula, 2008, p. 14). In order to shift beliefs about mathematics, teachers need their current beliefs challenged. One way might be through discourse of different solution strategies. Teachers can do this by solving problems in ways that call existing beliefs into question or by making mathematical discoveries on their own (Carter & Yackel, 1989; Liljedahl et al., 2007). Changing teachers’ beliefs about mathematics can be difficult because many preservice teachers think mathematics is about memorizing formulas and procedures (Szydlik, Szydlik, & Benson, 2003). One example is of a prospective elementary teacher enrolled in a mathematics content course that focused on problem solving. Even though she began the course with traditional views about mathematics, through this type of learning and making connections between tasks, her beliefs about mathematics shifted. Through journaling about these beliefs at three times throughout the semester, her beliefs about mathematics shifted from memorizing towards understanding the process (Liljedahl et al., 2007).

One reason why reforms have failed in the past is due to the fact that teachers have not been given enough PD (Bosse, 1995), but PD focused on PCK could help alter this trend (Hill et al., 2008). Teachers’ PCK has a positive effect on student achievement (Hill et al., 2005; Rowan, Chiang, & Miller, 1997), so by increasing PCK in PSTs and ISTs, their future students are being helped. While there is research on beliefs regarding PSTs and ISTs, more needs to be examined in relation to parents because parents are a child’s resource outside of school.

The prevalence of studies on beliefs in mathematics education increased in the 1980s, when teachers were expected to include problem solving in the classroom. A person’s beliefs evolve over time, and are influenced by his or her experiences (Op’t Eynde, DeCorte, & Verschaffel, 2002). Richardson (2003) implied there were three different experiences that influenced beliefs: personal experiences, experiences in an instructional situation, and experiences with specific content knowledge. These beliefs shape how a person views different situations, one being the way children learn about mathematics (Richardson, 2003). Most parents of today's elementary grade students were taught mathematics in a more teacher-centered classroom, where the teacher was the one who told students whether or not they had the correct answer (Garland, 2014; Richards, 2014). When most of these parents were elementary students, they were not encouraged to work with their peers so they were not in charge of their own learning (Ertmer & Newby, 2013; Maher & Alston, 1990). However, classrooms today should be more student-centered, where the teacher acts as a facilitator not a transmitter of information (Ertmer & Newby, 2013).

One weakness of the research in this area is the lack of one clear definition for beliefs (Pajares, 1992; Philipp, 2007; da Ponte, 2011). When defining beliefs, different researchers use a variety of definitions (Clore & Ortony, 2008; Clore & Palmer, 2009; Corsini, 1984; Cross, 2009; Forgas, 2000; Forgas, Bower, & Moylan, 1990; Frijda & Mesquita, 2000; Goldin, 2002; Lazarus, 1994; Nespor, 1987; Pajares, 1992; Pekrun, 2006; Petty, Desteno, & Rucker, 2001). In the Second Handbook of Research on Mathematics Teaching and Learning, Philipp (2007) discussed beliefs as,

> Psychologically held understanding, premises, or propositions about the world that are thought to be true. Beliefs are more cognitive, are felt less intensely, and are harder to change than attitudes. Beliefs might be thought of as lenses that affect one's view of some aspect of the world or as dispositions toward action. Beliefs, unlike knowledge, may be held with varying degrees of conviction and are not consensual. (p. 259)

There are two categories when looking at beliefs in terms of mathematics: beliefs about teaching and learning mathematics and beliefs about mathematics (Thompson, 1992). These two categories intersect, as some researchers found the way a teacher understands mathematics influences their beliefs about how they should teach it and how students should learn it (Beswick, 2012; Bray, 2011; Cai & Wang, 2010; Cross, 2009; Ernest, 1989).

For the purpose of this research, beliefs were defined as, “implicit assumptions about students, learning, classrooms, and the subject matter to be taught” (Kagan, 1992, p. 66). Furthermore, teacher beliefs can be split into two different categories: “teachers’ sense of self-efficacy, and content specific beliefs” (Kagan, 1992, p. 67). This research primarily focused on content specific beliefs. In addition, the focus was on beliefs about teaching and learning mathematics because these beliefs have a strong impact on how a teacher sets up tasks in his or her classroom (Kagan, 1992). This could relate to parents as they interact with their child when helping him or her with homework.

PSTs enter education programs with beliefs formed by their experiences as students (Pajares, 1992; Richardson, 1996). Initially they are resistant to constructing their own knowledge because of their traditional experiences in elementary and secondary school (Swars et al., 2009). Even if they shift their beliefs during teacher preparation programs, during student teaching PSTs tended to revert back to a traditional model of teaching (Ambrose, 2004; Beswick, 2012). This is why PSTs are encouraged to take classes that create dissonance, which forces them to challenge their current teaching practices and beliefs (Hawley & Valli, 1999; Swars et al., 2009). This could be accomplished by giving PSTs new tasks that encourage them to engage in mathematics that allows them to come up with new and different ways to solve problems (Lavy & Shriki, 2008; Swars et al., 2009).

PSTs learned more from experiences in education courses that included both solving mathematics problems and learning about different possible student responses (Charalambous, Panaoura, & Philippou, 2009; Philipp et al., 2007). By allowing PSTs to read through and discuss different student responses with their peers, they were able to develop beliefs related to mathematics that were more complex (Kaasila, Hannula, Laine, & Pehkonen, 2008; Philip et al., 2007). One problem with dissonance, however, is that teachers were not able to grasp the material immediately, which could lead to lower self-efficacy, attitudes towards mathematics, and beliefs and perhaps generate negative memories of past experiences in mathematics (Charalambous et al., 2009).

Mathematics Strategies

By understanding student solution strategies, teachers have a deeper understanding of mathematics (Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996; Franke, Webb, Chang, Ing, Freund, & Battey, 2009; Knapp & Peterson, 1995). This study intended to aid parents in their learning about mathematics and understanding how their child thinks while solving mathematics problems. The mathematics strategies for the workshops in this study were chosen based on what research says about how children think about addition, subtraction, multiplication, and division to ensure that the workshops would be worthwhile. In the late 1980s, Cognitively Guided Instruction (CGI), one type of professional development for teachers, was developed. CGI emerged in the 1990s as an alternative to the PD that had previously been used (Carpenter, Fennema, Franke, Levi, & Empson, 1999). Instead of focusing on solving problems, CGI focused on helping teachers understand student solutions, which is why the researcher chose to loosely model the workshops after CGI. Research was conducted on how CGI PD affected teachers' mathematical knowledge because if teachers do not understand students' struggles, the way they teach is hindered (da Ponte & Chapman, 2006).

The CGI problem types were used in this study so they will be described now. There are four different categories of addition and subtraction problems: join, separate, compare, and part-part-whole, and all these problem types could have different unknowns (Carpenter et al., 1999). Within a multiplication and division problem, the missing part can be the total, the number of groups, or the number of items in each group. The first describes a multiplication problem and the last two describe division problems. If the number of groups is missing this is called measurement or quotitive division, but if the number of items in each group is missing this is called sharing or partitive division (Carpenter et al., 1999). A mixture of these problem types were used for both the researcher-created instrument as well as the workshops.

When a child is given an opportunity to solve problems using a variety of invented strategies, they have a deeper understanding of addition and subtraction, and are more flexible in the way they solve problems (Carpenter et al., 1998; Carroll & Porter, 1997). This is important because with the implementation of the CCSSM students are expected to solve problems flexibly, and share those solution strategies with their peers. Sfard (1992) suggested students who are comfortable solving problems without the teacher giving them procedures should continue solving them in those ways. Other researchers have found that students who are given standard algorithms before the students can invent their own algorithms might not understand important concepts (Kamii & Dominic, 1998). This demonstrates the importance of letting students invent their own strategies. The different problem types for addition, subtraction, multiplication, and division problems according to Carpenter et al. (1999) from their book *Children's Mathematics: Cognitively Guided Instruction* are discussed below to better explain the type of problems used in the workshops and the researcher-created instrument.

Addition and Subtraction

Students who struggle with place value also struggle with standard algorithms for addition and subtraction, because these strategies involve regrouping which is why students need to have a conceptual understanding of place value before they can conceptually understand addition and subtraction computation (Cobb & Wheatley, 1988; Steffe, 1983). Some errors for solving addition and subtraction computation problems stem from the issue of place value misconceptions. For example, if students cannot see 36 as 3 tens and 6 ones, when adding or subtracting they might see the three and six as equal units (Cobb & Wheatley, 1988; Steffe, 1983). Participants discussed student errors regarding place value during the addition portion, as all other operations build off of this conceptual knowledge.

According to Carpenter et al. (1999), addition and subtraction problems can be broken into action and non-action problem types. When writing an equation that models the situation directly and an action occurs in the problem, for example when wording includes changes to the initial quantity such as "gave marbles" or "ate some cookies," the problem type is a join problem or a separate problem, and the equation can be written as an addition or subtraction equation. Within these two types, the unknown in the problem can be the start, change, or result, which could affect how the child solves the problem. Consider this problem: "*Jon has 3 marbles. Nicole gave him some more. Now Jon has 8 marbles. How many marbles did Nicole give Jon?"* Students can identify that this is an action problem, and because Jon is getting some marbles, it is a join problem. The start is three marbles, because that is how many Jon had to start with. The change is our unknown part, because the problem does not state how many Nicole gave Jon. The result is eight marbles because that is how many Jon had after Nicole gave him some. A join problem could have the unknown part in any of these three places. Likewise, a separate problem could be, “*Jon has some marbles. Nicole took 4 from him. Now Jon is left with 5 marbles. How many marbles did Jon start with*?” This is a separate start unknown problem because the reader does not know how many marbles Jon had to start (Carpenter et al., 1999).

On the other hand, the addition or subtraction problems could be non-action problems. These problem types are called compare and part-part-whole problems. One example of a compare problem is, *“Heather is 62 inches tall. Joe is 5 inches taller than Heather. How tall is Joe?”* This problem is a compare problem because it is comparing Joe’s height to Heather’s. Similar to the action problem types, the unknown could be one of three pieces. It could be Joe’s height, Heather’s height, or the difference between the two. For part-part-whole problems, either the part or the whole could be the unknown. One example of a part unknown is, “*Twenty three students are going on a field trip. There are 9 boys and the rest are girls. How many girls are going on the field trip?”* This is a part unknown problem because one of the parts, the number of girls, is unknown. The problem could have stated the number of boys and the number of girls and asked for the total number of students for it to be a whole unknown problem (Carpenter et al., 1999). Problems posed to parents were created based on problem types and solutions strategies to maximize the amount of content and strategies parents might use.

Carpenter et al. (1999) discussed that even though all the previous problems represent addition and subtraction problems, sometimes students see them differently and use different strategies to solve these problems. In addition, students may use a situation equation to make sense of the problem, but use a different solution equation to solve the problem. Some problem types elicit common strategies from students, but others do not. Furthermore, students might use a combination of different strategies to solve problems that are more difficult (Carpenter et al., 1999). Students can use direct modeling, verbal counting, and number fact strategies when solving addition and subtraction problems (Carpenter et al, 1999). When comparing a group of elementary students who learned different addition and subtraction strategies to a group of students who learn mathematics traditionally, the students who learned different strategies performed better (Thornton, 1990). This is important to the current study because if parents only support their child to use one strategy when solving addition and subtraction problems, it could hinder their child's performance. As a result of this research, a plan was made so that when participants in the workshop did not come up with the targeted solution strategies, those targeted strategies were discussed as a group to help the participants make sense of the new strategies.

Some common strategies students can use to solve addition and subtraction problems by direct modeling are joining all, joining to, separating from, and trial and error (Carpenter et al., 1999). Depending on the problem type, students can use different strategies to solve them. For example, students may use the joining all strategy when they are given a join result unknown, or part-part-whole, whole unknown problem. The joining all strategy could be used when students are trying to add two numbers, for example 6 + 2, and they count 6 objects (1, 2, 3, 4, 5, 6), then 2 objects (1, 2,), and finally put them together to count again (1, 2, 3, 4, 5, 6, 7, 8).

Joining to and separating from are related strategies. They can be used with join change unknown and separate change unknown problem types respectively. These strategies can be used with problems where students know the starting amount and they know the ending amount. Similarly, these strategies can be used with problems where students do not know the starting amount but do know the change and the ending amount. Students may count out how many items they are starting with, then either take items away with separating from, or add items with joining to, until they get to their ending amount. If using this strategy, their answer is how many items they took away or added (Carpenter et al., 1999).

Separating from can be used in separate result unknown problem types. Students may count out the amount of items they are starting with, and then they physically remove the number of items given in the problem. If they used this strategy, their answer would be the number of remaining items. For join start unknown and separate start unknown problem types, students might use trial and error to determine the solution. Research indicates these problem types were most difficult for students (Carpenter et al., 1999). If a certain manipulative or strategy was not used by one of the participants in the current study, the researcher intended to guide parents to use manipulatives and drawings to make sense of the problems in ways similar to that of their child.

Some common strategies to solve addition and subtraction problems by counting strategies could be counting on, counting down, and trial and error (Carpenter et al., 1999). The counting on strategy could be used when students are trying to add two numbers, for example 6 + 2, and instead of counting 6 objects (1, 2, 3, 4, 5, 6), then 2 objects (1, 2,), and finally putting them together to count again (1, 2, 3, 4, 5, 6, 7, 8), students are able to count on from 6 (6, 7, 8). This strategy may commonly be used with join result unknown problem types (Carpenter et al., 1999). Children can use fingers, tally marks, or other tools to remember the first number and then count the value of the second number (Fuson, 1984). Students may initially use this method if the first number in the number sentence is large (Carpenter & Moser, 1984). Later, students might only use their fingers or other tools for the final answer. In a previous research study, one student used the strategy “counting on” to solve 28 + 13 by first taking 28 and adding 2 to get to a multiple of ten, 30, then adding 10 more which gave him 40. Then, the student noticed he still had one left to add so his answer was 41 (Cobb & Wheatley, 1988).

These counting on and counting down strategies may be also used with join change unknown and separate change unknown respectively. Students can use a forward or backward counting sequence from their starting amount to get to their ending amount. They keep track of the, "number of words in the counting sequence" (Carpenter et al., 1999, p. 23), which is their answer. Trial and error methods might be the counting strategies students use with join and separate start unknown problem types, like the direct modeling strategies described previously.

One extension of the counting on strategy for addition problems is counting up, but it can also be used for subtraction problems. Counting up and counting down are two related subtraction strategies, but some students find counting down more difficult (Baroody, 1984; Fuson, 1984). Given the problem 37 - 12, students can solve it using an open number line in three different ways. If they use counting up, they could start at 12, then use strategies to make a ten, or add tens to get to 37. One possible counting up strategy could be starting at 12, adding eight to get to 20, and then adding 17 to get to 37. The numbers that the students added, eight and 17, could then be added to get the difference between 37 and 12, which would be 25. This strategy, along with the following two, will be addressed while working with an open number line.

Another possible strategy, counting down, could be used if the student started at 37 and counted down the number of units it would take to get to 12. For example, a student could take 37 and subtract seven to get to 30, and then they could subtract 10 to get to 20, then eight more to get to 12. Students would add up the numbers they subtracted, seven, 10, and eight, to get their answer of 25.

A third strategy, take away, could be if the student started at 37 and took 12 away, which is a direct model of the situation. For example, the student could start at 37 then take 10 away to get to 27, and notice they still need to take two away so they get 25 for their answer. Encouraging students to understand all three strategies allows them to be more flexible when solving problems so they can move between one strategy and another in case they find one easier in a certain situation. Furthermore, parents should also understand these three strategies and the differences between them so they are able to assist their child when asked to help with homework.

Multiplication and Division

Carpenter et al. (1999) also described problem types for multiplication and division. As described before, multiplication and division problems are related. For example, for multiplication and division problems the number sentence can be: “number of groups” x “number of objects in each group” = “total number of objects.” If the total number of objects is the unknown part, students have a multiplication problem type. If either the number of groups, or the number of objects in each group is unknown, then students have a division problem. Division problems can be further broken into two groups, partitive (sharing) and quotitive (measurement) division. If the number of groups is unknown, then the problem type is a measurement division problem. However, if the number of objects in each group is unknown, it is a sharing division problem (Carpenter et al., 1999).

Each pair of words, measurement/quotitive and sharing/partitive, are used interchangeably in research. One example of a quotitive division problem could be, “*Jessi has 12 candies. She wants to give each friend 4 candies. To how many friends can Jessi give candies to?”* One example of a partitive problem could be, ““*Jessi has 12 candies. She wants to share her candies equally between four friends. How many candies will each friend get?”* In the first example, the number of objects in each group is known, and we are trying to find the number of groups. In the second example we know the number of groups, but are trying to find the number of objects (candies) in each group.

Research also shows that quotitive division problems have constraints like the divisor must be smaller than the dividend, when trying to model the situation (Fischbein, Deri, Nello, & Marino, 1985). In addition to being able to model partitive division problems easily, the constraints on quotitive division problems could also contribute to why students initially see division problems as partitive division (Fischbein et al., 1985). Furthermore, when given a division problem like 18 ÷ 3 and asked to write a word problem, the majority of teachers wrote a partitive division problem (Fischbein et al., 1985; Graeber et al., 1989). Because teachers tend to write partitive division problems, and students tend to see more partitive problems, teachers need to have deeper content knowledge so they can provide quotitive problems to students as well. Students need to see both problem types, as students see them as very different and solve them in different ways, as this can help develop understanding with fractions which they will learn about in later grades (Fischbein et al., 1985).

Similar to addition and subtraction strategies, students can use direct modeling, counting, and derived fact strategies when solving multiplication and division problems (Carpenter et al, 1999). Students can use direct modeling to solve problems by drawing pictures or using concrete manipulatives. Students might use concrete tools when solving multiplication problems by grouping. Because students think of multiplication as groups of something, students might put counters into groups and then count up the total number of counters they have. Students might solve division problems by sharing counters into the different groups, or counting out how many items are in each group and then counting the number of groups made (Carpenter et al., 1999).

Possible drawings students might use when solving multiplication problems are of items that represent the total number of objects or the number of groups, an array, or an area model (Carpenter et al., 1999). Parents in the workshops used beans and drawings, to help them make sense of these problem types and solution strategies during the workshop session.

These concrete tools and drawings help students make sense of the problems because sometimes they do not see traditional multiplication and division as multiplication or division problems. Graeber et al. (1989), found that some students saw multiplication problems as repeated addition. Furthermore, some students might initially see division problems as repeated addition or repeated subtraction (Ambrose, Baek, & Carpenter, 2003; Baek, 1998). Carpenter et al. (1999) describes the use of repeated addition, or later skip counting, as a transition from direct modeling to counting strategies. Conceptual understanding of multiplication leads to the flexibility between multiplication and division facts. As students move from counting strategies to derived facts, their strategies become more efficient (Carpenter et al., 1999).

The problem types described in CGI guided the material used in the workshops in this research. Research supports that when teachers have knowledge of different types of problems, they are more intentional about the questions that they ask their students (Franke et al., 2009), the solutions they choose to have students share with the class (Steinberg, Empson, & Carpenter, 2004), and what they notice about student responses (Kazemi & Franke, 2004). Students are expected to solve a variety of problem types, according to best practice and parents may not be aware of these different problem types. Furthermore, common student errors may hinder student understanding. The researcher felt that just like with teachers, parents' behaviors when supporting their child will be positively informed by this knowledge. Therefore, different problem types were selected and incorporated into the parent workshops.

Manipulatives

Successful manipulative use is dependent on how students understand these manipulatives, because manipulatives should not be used to help the teacher, but instead to help the student to make sense of the concepts (Nuhrenborger & Steinbring, 2008). In order to help students use manipulatives effectively, students need to make connections between the manipulatives and their corresponding concepts (Fischbein, 1977). Initially, elementary students used concrete manipulatives or representations of those manipulatives to make sense of contextual problems dealing with whole number operations (Fuson & Briars, 1990). However, students used counting strategies once they moved to the abstract level, but those counting strategies were very similar to the mathematics students did if they used concrete tools or a representational drawing (Carpenter, Fennema, & Franke, 1996). For example, when solving the problem, "*Jane has 3 cookies. Mary has 9 cookies. How many cookies do they have altogether*?" the student might draw three circles and nine circles and then count them. Another student might write 3 + 9 down and use their fingers to count on. Another student might notice that nine is the bigger number so used the commutative property to write 9 + 3 and count on from the larger number. More advanced students may use compensating strategies and notice nine is very close to 10. They break the three up into one and two and combine the nine and one to make 10. Then they add 10 + 2. A less advanced student may use the ten-frame or base ten blocks to make sense of this compensating technique. Manipulatives are tools that students can use to help them with their explanations and justifications, so their peers are able to make sense of what they are doing.

Research findings show that manipulatives improve elementary students' understanding of mathematics (Cramer, Post, & delMas, 2002; Smith & Montani, 2008), have no effect (Nishida, 2007), or have a negative effect (Fennema, 1972). The inconsistencies could be affected by how teachers are using manipulatives in the classroom. McIntosh (2012) reported that teachers believed they were not given sufficient time to learn about manipulatives in their undergraduate program. Swan and Marshall (2010) surveyed teachers and reported that very few learned about manipulative use in professional development opportunities. Similarly, parents may not have been given the opportunities to learn about manipulatives either.

Research indicates that if teachers have more opportunities to engage in mathematics while using manipulatives that are meaningful, their students may have increased mathematics knowledge (Cramer et al., 2002; Smith & Montani, 2008). Without providing meaningful activities to help preservice and inservice teachers understand the value of using manipulatives, it might be more difficult for them to successfully incorporate meaningful use of manipulatives in their classrooms (Fischbein, 1977). This could also hold true when parents help their child with mathematics homework because parents might not have had these opportunities, so might not understand how their child is using these tools. This could affect the level of support they could give their child in helping them to make sense of mathematics using these tools. This study intended to better assist parents in this area by using manipulatives that helped the parents engage in the mathematics in a similar way their child does.

Student Invented Algorithms

Students who invent their own algorithms have a better understanding of addition and subtraction operations and perform better on mathematics assessments than students who are taught one particular way to solve the problem (Fuson, Wearne, Hiebert, Murray, Human, Olivier, Carpenter, & Fennema, 1997). In addition, when students are taught the standard algorithms without having a conceptual understanding of how and why their strategies work, they have a greater chance of making an error while solving the problem (NRC, 2001). When students are asked to solve problems using one standard algorithm provided by the teacher, students try to remember how they were told to solve the problems instead of attempting to come up with solutions on their own (McClain, Cobb, & Bowers, 1998).

When students are encouraged to invent their own strategies many different solutions are presented to students by their peers. Students take ownership in their own learning in addition to teaching their peers, and are expected to find different ways to solve problems that make sense mathematically. Students begin solving problems by using concrete manipulatives. Students might use base ten blocks to solve multi-digit addition or subtraction problems by combining or taking away the largest denomination first (Madell, 1985). For example, when finding the solution to 42 - 17, the student might start by subtracting 10 from 40, or modeling 42 by using four tens and two ones, then taking away a ten. Students then realize they cannot take seven ones from two ones, so need to break apart a ten into 10 ones. Once students have the conceptual understanding of *why* they are regrouping, when they start using algorithms that are more efficient they are less likely to make an error (Baroody, 1985). Students also move from the need to manipulate concrete tools to find a solution, to more abstract solution strategies (Baek, 1998).

Students can use direct modeling, number strategies, partitioning, or compensating when inventing multiplication algorithms (Baek, 1998), although these strategies can be used to describe other whole number operations as well. Direct modeling uses concrete manipulatives or drawings of the problem. Two examples of a number strategy are using repeated addition or using doubling strategies. Partitioning is when the student breaks numbers apart. For example, 19 x 14 could be thought of as (10 + 9) x (10 + 4). The area model helps students to make sense of breaking numbers apart when multiplying two digit numbers. Compensating allows students to adjust one or both values when multiplying, to make the problem easier. For example, if the student is multiplying 120 x 5, he or she can multiply 120 x 10 to get 1200, and realize he or she only needs half of this number. On the other hand, the student could take half of 120 and then multiply that number by 10. Either way the answer will be 600. The researcher-created instrument described later in this paper includes possible student solutions that use each of these four categories.

Student Errors

Subject matter knowledge (SMK) includes the knowledge about student errors that teachers need in order to teach well and is one of the categories under PCK described by Ball et al., (2008). Tirosh (2000) stresses the importance of preservice teachers identifying and making sense of student errors, because knowledge of common errors, "is strongly related to prospective teachers' SMK" (p. 329). When preservice teachers try to make sense of student errors, they are also thinking "about the meanings of some elements of their subject matter knowledge and pedagogical content knowledge" (Llinares, 2002, p. 205).

One area where preservice and inservice teachers struggle with making sense of students' errors, is in solving multiplication and division problems (da Ponte & Chapman, 2006; Simon, 1993). This is important because the common ways elementary students think about problems should be included in instruction to increase PCK (da Ponte & Chapman, 2006). Even though it is easier for preservice teachers to learn about questioning techniques and how to teach using manipulatives than to learn about possible student solutions (Simon, 1993), learning about student solutions and the errors students might make along the way is an important part of increasing a teachers' PCK.

This relates to the current study because parents may not have experience in identifying student errors because their background might not be in education. Parents take on the role of teacher when students are at home and ask for help, so the workshops supported by this research put parents in that role. Identifying student errors was included in the whole group discourse, to connect those errors with correct strategies. Making connections between strategies, and identifying student errors are two of the practices that Smith and Stein (2011) describe in the next section - discourse.

Discourse

Research on discourse in mathematics education has increased in recent years because in the past teachers controlled the majority of the classroom discourse (Falle, 2004; Mehan, 1979; Ryve, 2011). This could be because "Teachers have responsibility for moving the mathematics along while affording students opportunities to offer solutions, make claims, answer questions, and provide explanations to their colleagues" (NRC, 2001, p. 345). Mehan (1979) found that teachers generally ask questions that allow students to give brief answers during whole class dialogue. These questions asked by teachers do not encourage students to think about the question in a deep way, but rather they focus on students' surface knowledge (Mehan, 1979).

Studies indicate students should not receive information passively, but rather actively construct new information through classroom activities and discussions (Fosnot & Perry, 1996, Nathan, Eilam, & Kim, 2007). Instead of teacher led discussions, students lead discussions by listening to their peers and asking questions (Bennett, 2013; Hiebert & Wearne, 1993; Imm & Stylianou, 2011). Students may use different strategies to solve the problem, and sharing these strategies with their peers helps them to make sense of the problem, which in turn leads to a more rich discussion (Nathan et al., 2007). This is why students should be expected to be able to explain and justify their solution strategies and the solution strategies of their peers (Imm & Stylianou, 2011). These explanations and justifications are important because they help students have a better understanding of those strategies and allow them to make connections between concepts. Discourse should be perceived as the process students go through to make sense of mathematics, not as the tool students use to talk about mathematics (Hiebert & Wearne, 1993; Imm & Stylianou, 2011). This is a shift in the role of the student and the role of the teacher, because in the past teachers controlled much of the class conversation (Falle, 2004).

Teachers can increase discourse in the classroom by organizing students in groups, or communities of learners. Ding, Li, Piccolo, and Kulm (2007) found that teachers in their study struggled with the balance between allowing students to learn from the group and learn from the teacher. Students should not work on mathematics by themselves, but instead they should look to their peers as a resource if they are struggling with a problem. Together, through discourse, students should find the solution to the problem, instead of expecting the teacher to supply them with the answer (Imm & Stylianou, 2011).

When a child asks his or her parent for help at home, he or she might also see the parent as a facilitator, because in the classroom the teacher is no longer the authority figure during whole class discussions, instead he or she is a facilitator (NRC, 2001). In addition, the teacher should manage mathematical discussions in the classroom, being purposeful in the questions posed to students by being aware of possible student errors and bringing them to light (NRC, 2001). This is a shift in how parents think they need to help their child because the new expectation is that students are accustomed to being in charge of their learning instead of sitting passively at school waiting for a teacher or, at home, waiting for a parent, to explain a concept to them (Bennett, 2013). Smith and Stein (2011) discuss five teacher practices to promote productive discourse. The five practices are listed and explained below.

Anticipating: Teachers need to determine how students might solve a problem which includes possible strategies students might use, identifying possible student errors, and ordering strategies in the way the teacher wants students to see the strategies. These errors and strategies could be created alone, but working with colleagues could be better by allowing teachers to use discourse to come up with more strategies and student errors. By coming up with a comprehensive list of strategies and solutions before the lesson starts, the lesson may run more smoothly.

Monitoring: Observing how students think about the problem as they solve it by walking around the classroom and interacting with the groups helps teachers to determine how the whole class discussion should go, who to call on to share their strategy, and in what order. If the list in the “anticipating” phase was comprehensive, the “monitoring” phase is more focused because the teacher knows which strategies he/she wants students to share. This helps teachers quickly identify student strategies they want shared with the rest of the class. The teacher then can ask questions from those students that would help the students better explain their strategies. The teacher can also ask questions that encourage students to clarify their explanations and justifications. This is important so when students share strategies with the rest of the class they understand them well enough to be able to answer questions from their peers.

Selecting: The “anticipating” and “monitoring” phases help the teacher identify students to share strategies in a way that is most beneficial for the class. It is a good idea to have the order in which to share strategies in mind before the task is given. This assists in determining which strategies to share, which will help move the mathematics discussion along, in addition to identifying strategies that are repetitive and should not be shared.

Sequencing: The teacher needs to be purposeful when choosing the order in which student solutions should be shared. By starting with the strategy the majority of students used first, the teacher can help validate students’ mathematical thinking. On the other hand, if a teacher starts with a more concrete student solution and works towards more abstract solutions, the class is engaged in making connections between different levels starting with the most basic to more sophisticated strategies. The workshops in this study sequenced parent solution strategies in order from more concrete to more abstract, to help them to make connections between strategies.

Connecting: Helping students make connections between strategies allows them to understand each solution not as a separate strategy, but as part of one big idea. Students can make connections between strategies by explaining what is different between their strategy and the previous strategy shared. Or, students can make connections by looking at two different strategies and discussing what is common between them. By helping students to make connections between different solutions, they will have a deeper understanding of the material.

These five practices were taken into consideration when the researcher planned for the parent workshops. The researcher anticipated possible strategies the parents might use to solve the problem and then prepared to order the anticipated strategies in a way that would encourage parents to make sense of the problem. When parents worked on a task, the researcher made a plan to monitor which strategies the parents used, select parents who used those strategies to share them in a specific sequence, and help parents make connections between strategies. By including these five practices in the planning of the workshops, the researcher intended to give parents an opportunity to gain insight into the way current classrooms are being run, according to best practice.

Conclusion

In this chapter, different workshops that have been offered to parents were discussed. Findings suggest that ongoing PD is better than a shorter amount of time (Frechtling, 2001; Quint, 2011), but some research indicates findings with as little as two hours of workshops (Cotton, 2014). Additionally, beliefs were defined and research on changing beliefs was examined, specifically related to parents' beliefs about teaching and learning mathematics. Incorporating teaching practices such as discourse, manipulative use, and multiple strategies into workshops for parents could be beneficial when trying to shift parents' content knowledge and beliefs about mathematics.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

In this section the research questions will be stated and the research design will be shared. The population and sample will be discussed. Data collection for the pilot, treatment, and control groups will be reviewed. The instruments used, the Mathematics Beliefs Scales (MBS) and a researcher-created mathematics content test, will be described. Finally, the plan for data analysis, as related to each research question, will be examined.

Research Questions

1. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their mathematics content knowledge as compared to parents who do not attend?
2. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their beliefs about learning mathematics as compared to parents who do not attend?
3. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify whether student responses to 2^{nd}, 3^{rd}, and 4^{th} grade mathematics content are correct as compared to parents who do not attend?
4. To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify

student errors in incorrect solutions for 2nd, 3rd, and 4th grade mathematics content as compared to parents who do not attend?

Research Design

The current study used a quantitative, quasi-experimental, non-equivalent control group design (Gall, Gall, & Borg, 2007). The research design was chosen because participants self-selected either the control or intervention groups. The control group included participants who were unable to attend the workshop, but still participated in testing. For both the control and intervention groups, all interactions were conducted face-to-face at the same school site. The school site allowed the researcher to set up a table during school hours to meet with participants in the control group. The control group attended two face-to-face meetings. During the first meeting participants completed pretests, and during the second meeting they completed posttests. The majority of control group participants completed pretests and posttests within a two week period, similar to the time between pretest and posttest for the treatment group.

The treatment group participated in two workshop sessions during spring 2015. Three 2-day workshops were conducted. Each 2-day workshop was repeated a total of three times, and the material in each series was identical. The first series was conducted on two consecutive Tuesdays from 6 - 8 p.m. The second series was conducted on the following two Tuesdays from 6 - 8 p.m. The third series was conducted on Tuesday and Thursday of the same week, from 9 - 11a.m.

Procedure

Pilot Study

Before holding the parent workshops in the current study, the researcher conducted a pilot study with parents at a school with similar demographics to the schools used in the current study. The five participants in the pilot study were not included in the treatment and control groups for the current study. A timeline for the pilot workshops is provided in Table 1.

Table 1

Data Collection of Pilot Study

Day	Information	
1	1.	Participants completed pre beliefs and demographic instruments
	2.	Participants attended workshop 1 – addition/subtraction strategies
2	1.	Participants attended workshop 2 – multiplication/division strategies
	2.	Participants completed post content and beliefs instruments

Workshops for the pilot study, displayed in Table 1, were scheduled for two consecutive days, each workshop lasted 90 minutes. The dates and times for the workshops were discussed and agreed upon by the researcher and school site administrators. The 90-minute workshops were designed to include 30 minutes for participants to complete the pretest the first day, and posttest the second day. The first session during the pilot study lasted 70 minutes, due to participants arriving after the designated start time. As a result, the researcher administered only the demographic and beliefs pretest instruments during the first workshop. The second session lasted the entire 90 minutes and participants completed the two content tests and the beliefs posttest instruments.

The pilot workshops included material regarding the four operations, which were also included in the current study. The researcher determined that one hour for each workshop was insufficient to cover the material, which resulted in making the workshops longer for the current study. The pilot study also assisted the researcher to determine if other revisions to the training materials and pretest/posttest instruments were needed.

Although there were five total participants in the workshop, only two completed both sessions; therefore, only two participants completed both the pretest and posttest beliefs' instruments. The two participants completed less than two hours of content in the workshops, but both shifted their beliefs. The MBS was administered to determine beliefs that the participants held about learning mathematics. This instrument will be described in more detail in the instrumentation section, but the belief scores could range from 18 - 90, where a score of 45 is between learner-centered and teacher-centered. A higher score means the participant holds beliefs that are more learner centered. The first parent had a pretest score of 46 and a posttest score of 57 (+11), and the second parent had a pretest score of 49 and a posttest score of 71 (+22). Both parents had higher scores at posttest, which showed a shift in each participant's beliefs that leaned more towards students constructing their own knowledge. However, due to the small sample size inferential statistics could not be run.

Current Research Study

The current research study involved workshops and instruments similar to the ones used in the pilot study. The workshops were created to help parents engage in mathematics the way their child is expected to learn mathematics, according to best practice such as allowing students to come up with multiple strategies that would allow them to think flexibly about mathematics.

The current study included a two-day workshop, as opposed to a longer series, to lower the risk of attrition for ongoing PD. Each workshop was held for two hours, including the time spent on pretests and posttests, and the workshop series was offered at three different times to accommodate different schedules. Dates for the three series were as follows: series 1 was May 12 and 19 from 6 – 8 p.m., series 2 was May 26 and June 2 from 6 – 8 p.m., and series 3 was May 26 and 28 from 9 – 11 a.m. Each participant in the treatment group was engaged in learning mathematics content for approximately 90 minutes, as the other 90 minutes in the three hour period was used for administrating tests. Pretests for the treatment group was on the first day of the session – May 12 or 26, and posttests were administered on the second day of the session – May 19, 28, or June 2. Table 2 describes the timeline for the control and treatment groups; the material was identical in each workshop series.

Table 2
Important Dates for Treatment and Control Groups

Group	Date	Information	*N*
Control	May 4 - 15	Control group participants completed pretest instruments (demographics, beliefs, and both content), at the school site where the intervention was held	18
	May 18 - 29	Control group participants completed posttest instruments (beliefs and both content)	17
Treatment 1	May 12	Day 1 of first p.m. series	6
	May 19	Day 2 of first p.m. series	6
Treatment 2	May 26	Day 1 of a.m. series	5
	May 28	Day 2 of a.m. series	4
Treatment 3	May 26	Day 1 of second p.m. series	3
	June 2	Day 2 of second p.m. series	2

Control group participants completed pretest and posttest instruments in May 2015, as displayed in Table 2. The researcher allowed two weeks for participants in the control group to complete the pretests, specifically the first two weeks in May. The last two weeks in May were allotted for the same control group participants to complete the posttest. The three treatment group series were held over the course of four weeks, the last three weeks in May and the first week in June. Participants in both the treatment and control groups took between 25 and 40 minutes to complete the pretest, and between 25 and 40 minutes to complete the posttest. Table 3 describes the data collection sequence for each day of the two-day workshop series.

Table 3

Data Collection of Treatment Group

Session	Information
Day 1	1. Participants completed pre content, beliefs, and demographic instruments 2. Participants attended workshop 1 – addition and subtraction strategies 3. Participants completed open ended post questions
Day 2	1. Participants attended workshop 2 – multiplication and division strategies 2. Participants completed post content and beliefs instruments

Table 3 includes information about the administration of the pretests, posttests, and workshop material. The open-ended questions (see Appendix A) took app imately five minutes for participants to complete. The open-ended questions at the end of the first workshop session for the treatment group served two purposes. It gave the researcher an idea of which strategies participants understood best, and on which strategies they still had questions. This allowed the researcher to email all participants to address any misconceptions or confusing strategies before the next workshop and to research online aids that participants could use to help clarify a topic. If one tool or part of a strategy was confusing, participants asked about that specific part of the session, to make sure the appropriate tool, strategy, or part of the strategy was addressed.

Population and Sampling

Any parent or guardian of 1st, 2nd, and 3rd grade students at three neighboring public elementary schools in Central Florida were invited to participate. For the purpose of this research, “parents” will include any person who takes on that role. First, second, and third grades were chosen because this is when the mathematics homework first represents mathematics that is likely different from instruction most parents received when they were in elementary school (Nearney, 2013). Schools in the current research study have implemented standards similar to the CCSSM, so for the purpose of this research the standards will be referred to as the CCSSM (FLDoES, 2015). The sample was one of convenience, given the location of the participating schools was near the researcher’s residence, and parents volunteered to participate.

To determine the minimum number of participants needed in the treatment and control group, the researcher used G*Power version 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). After choosing F - test, repeated measures ANOVA with two groups (treatment and control), two times of measurements (pre and post), a medium effect size ($f = .25$), and power, denoted by $1 - \beta = .8$, the researcher determined at least 17 participants were needed in each group, so a total sample size of 34 at the 0.05 level (Faul et al., 2007). If a power = 0.9 is chosen, the sample size increased to 23 in each group, or 46 for a total sample size. The researcher attempted to obtain at least 23 participants in each group because using a higher power lowers the chance of making a Type II error (Lomax & Hahs-Vaughn, 2013).

Data Collection

Before collecting data for the study, the researcher acquired Institutional Review Board (IRB) approval (see Appendix B). Then, the researcher contacted the principal of each of the three schools to determine the most efficient way to communicate information to the parents. Following instructions from the principals, the researcher emailed each principal the flyer. Next, two weeks before the workshops were held, the principals of the three schools emailed their respective parents of 1^{st}, 2^{nd}, and 3^{rd} grade students the flyer, which included only information about the workshops. This flyer was an invitation for parents to participate and included all the important information for the treatment and control groups such as dates, times, and content of the workshop (see Appendix C). One week later parents of 1^{st}, 2^{nd}, and 3^{rd} grade students were given a reminder paper which asked if parents wanted to participate and asked for a phone number or email so the researcher could contact them. In addition, the researcher's email address was included so parents were able to email the researcher to sign up for the control or treatment group. "Participants" will be used for the remainder of this research paper instead of parents.

Intervention

During the first day of the workshop for the participants in the treatment group, or the first time the researcher met with each participant in the control group, participants were given the informed consent to read and provided an opportunity to ask questions (see Appendix D). At that time confidentiality of the data was established by telling participants the researcher would be the only person collecting data, coding the data, and running analyses. Then, participants completed the demographic instrument and the pretest instruments for mathematics content and beliefs. After completing the pretests, participants in the treatment groups participated in the workshop series, which was the intervention. The researcher provided participants with light refreshments at each session and provided a math kit at the end of the second workshop for participants who attended both sessions and completed the instruments. This math kit included a small set of base ten blocks, a handout that included pictures of the different tools discussed in the workshops, and a few mathematics games to play that could help increase procedural fluency for their child.

First Session

The first workshop session began approximately 30 minutes after the starting time of the workshop session, to account for the pretest instruments. Participants were asked to solve the following problem, "*Andrea has 14 cookies. Jamie gave her some more. Now Andrea has 32 cookies. How many cookies did Jamie give Andrea?*" Participants were asked to use two different methods to solve this problem. Solving the problem using a second strategy was a difficult task initially. Participants solved by subtracting 14 from 32 using the standard algorithm and did not know how to solve using a second strategy. However, students may see this as an addition problem, because Jamie *gave* Andrea some more. Students may start at 14 and use tally marks or circles to determine how many more they need to get to 32. Or, they may use an open number line and count the jumps. Through questioning techniques participants used drawings, concrete tools, and other computational strategies to solve problems. Participants made sense of base ten blocks, ten frames, the hundred chart, and an open number line.

Then, participants were given another problem. After participants tried to solve a problem on their own using at least two different strategies, they shared their strategies with a partner, and each participant made sense of the strategies the other participant used. Participants used the tool that made the most sense to them, and through sharing with a partner they had a better understanding of another strategy. The researcher chose the order in which to have participants share their strategies from more concrete to more abstract, to help participants make connections between the different strategies. For example, participants shared strategies using tally marks or circle for cookies in the initial problem. Then the researcher asked participants who used the open number line to share their strategy. Finally, participants who used number strategies, like compensating, were asked to share their strategy.

After asking participants to solve a third problem, the researcher discussed possible student errors if using the standard algorithm. Participants were given an example of student work and asked to discuss with a partner. The first example, which involved regrouping, was difficult for participants to communicate the error. They knew the answer was incorrect, but were unable to explain why. Through questioning techniques, participants were able to make sense of why the answer was incorrect. The goal was to encourage participants to "think outside the box" when supporting their child at home.

Second Session

During the second workshop session, participants were given a multiplication problem and asked to solve it in two different ways. One example was when participants solved the multiplication problem “Amy has 4 boxes. Each box has 7 bags of chips. How many bags of chips does Amy have?” First, a participant shared a strategy that involved using repeated addition. The participant drew four boxes and put the number 7 in each one. Then the participant wrote 7 + 7 = 14, 14 + 7 = 21, and then 21 + 7 = 28. Another participant wrote 7, 14, 21, 28 and we had a discussion on the similarities and differences between the two strategies. Later strategies included finding doubles. For example, one participant wrote 7 + 7 = 14, 14 + 14 = 28. Participants made a connection between this strategy and the first two strategies, repeated addition and skip counting. Because participants had worked through several solution strategies in the previous workshop, they were able to construct new strategies much easier than when they began the first session. Participants were comfortable sharing with a partner, and then sharing with the group when asked by the researcher. If a tool was not brought up, the researcher would ask a question like, “how could we use ten frames to help us solve the problem?” Through discussion, participants made sense of using an open number line, ten frames, an array, and an area model, in addition to some number strategies. For example, when participants were given the problem 7 x 12 to solve, pictures were discussed, and then number strategies were shared such as doubles, multiply by ten, and the distributive property. One number strategy a participant used was to break up the 7 into 2 + 2 + 2 + 1. The participant changed the multiplication 7 x 12 to (2 + 2 + 2 + 1) x 12 and multiplied each of the numbers in parentheses by 12. Then the participant added each product (24 + 24 + 24 + 12) to find the solution. Another strategy a participant used was repeated addition. The participant used repeated addition by adding groups of 12 to find the solution. Another strategy a participant used was to break up 12 into 10 and 2 because the participant said multiplying by 10 was easy. The structure of the problem changed from 7 x 12 to 7 x (10 + 2). Then the participant multiplied 7 x 10 and added that to 7 x 2. The researcher then asked how the array and area model could be used to make sense of these number strategies.

Participants were then given a division problem to solve, and again asked to share their strategies with a partner. The researcher helped participants to make connections between multiplication and division problems through questioning techniques. In addition, participants made connections between division and addition as well as division and subtraction. For example, participants were asked to use two different methods to solve "*Ted has 24 pieces of candy that he wants to share with his study group. There are 8 people in Ted's study group. If everyone gets the same amount, how many pieces of candy will each person get*?" Base ten blocks, ten frames, beans (as counters), and extra paper were at each table so participants could use any of these materials when they solved the problem. One participant started with 24 beans and put eight in a line to represent the eight people in the study group. Then, she took the remaining 16 and distributed them to each of the 8 "people." This participant counted the number of beans in each of the eight groups and found that each person would receive three pieces of candy.

Another participant wrote the number eight down three times. When he shared this strategy with the rest of the participants, the researcher asked the group what the number eight represented. One person responded that it represented the number of candies each person will get. Another participant suggested that might be incorrect, because she determined that each person should receive three pieces of candy, so eight was incorrect. Through discussion, participants made sense of what the number eight represented, as the number of people. By allowing participants to share strategies and make sense of other strategies, they were engaged in the discussion. Finally, participants were given example solutions to determine student errors while using the standard algorithm for multiplication and long division. After the group discussion, participants were given the posttests, which included beliefs and mathematics content instruments. The researcher administered the posttest instruments to the participants during the last 45 minutes of the workshop time.

Control Group

The control group was given the informed consent, demographic questionnaire, and pretests for mathematics content and beliefs as early as one week before the treatment group's first workshop session, and as late as the end of the week of the first workshop session, so control participants had a two week period to complete the pretests. These pretests were completed at the same school site as the workshop sessions. The researcher was given permission to set up a table in the lobby of the office so participants could meet during a time convenient for them. The treatment group received the posttest for the mathematics content and beliefs near the end of the last workshop session for the first series. Both the pretest and posttest were the same for the content knowledge and beliefs instruments.

Instrumentation

Three instruments were used in this research, the abbreviated Mathematics Beliefs Scales (MBS) (Capraro, 2005), a demographic instrument, and the researcher-created *Math for Parents* instrument, which was further used for two instruments – a student version and a parent version. The first part of the researcher-created instrument intended to measure parents' content knowledge while the second part intended to measure their ability to identify correct student solutions and ability to identify student errors. Content in the workshops covered student solution strategies so participants were able to discuss possible reasons why students made common errors. All instruments are discussed next.

Mathematics Beliefs Scales

The MBS, originally created by Fennema, Carpenter, and Loef (1990), was developed under a grant funded by the National Science Foundation through the University of Wisconsin, Madison, to measure the mathematical beliefs of teachers. Responses to questions were measured using a five point Likert scale, ranging from strongly agree to strongly disagree. The original MBS had 48 items, and because researchers commented that participants complained about the length and repetitiveness of the instrument, an exploratory factor analysis was run on all 48 items (Capraro, 2001a). The 18 questions that were chosen because of the analysis explained 46% of the variance and could be split into three factors with six items in each.

The three factors were student learning, stages of learning, and teacher practices. One sample question in the student learning subscale is, “Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts” (Capraro, 2005, p. 86). One sample question in the stages of learning subscale is, “Children should understand computational procedures before they master them” (Capraro, 2005, p. 86). One sample question in the teacher practices subscale is, “Teachers should allow children to figure out their own ways to solve simple word problems” (Capraro, 2005, p. 87). Although the original MBS had a reliability of .93, the abbreviated MBS only had coefficient-alpha reliability of .68 for inservice teachers (n = 123). Capraro (2005) administered this shortened version to a group of preservice teachers (n = 54), and found reliability of .86.

The researcher suggested that the inservice teachers were a more homogeneous sample than the preservice teachers in the abbreviated MBS study. She suggested this was one possibility for the discrepancy in coefficient-alpha reliability. The abbreviated MBS has been used in several studies (Capraro, 2001a, 2001b, 2005; Ghazali & Sinnakaudan, 2014; Zhao, Valcke, Desoete, Zhu, Sang, & Verhaegne, 2012). However, there is no research on this instrument being used with parents. See Appendix E for the MBS used in this study.

Demographic Instrument

The researcher chose questions from different demographic instruments to identify background information from participants to create the demographic instrument (see Appendix F). Questions used were similar to ones found on accessible instruments on the UCF Qualtrics website (Qualtrics, 2015) in addition to demographic questions asked in the census (United States Census Bureau, 2015). This instrument, along with the *Math for Parents* instrument, went through formatting changes as they were emailed to two professors for feedback. During this time wording of questions were modified and questions were added to collect appropriate data from the participants.

Questions were asked about gender, race, age, marital status, the number of people living in the household, highest degree completed, employment status, and whether or not the participant's educational background or employment was related to mathematics or science, or another K-12 education related field. In addition, the researcher used a Likert 5-point scale to ask participants about their satisfaction with the implementation of the CCSSM, how often participants help their child with homework and whether or not it is a positive experience, and how confident participants are when helping their child with mathematics homework. Finally, an open-ended question was asked of each group. Participants in the treatment group were asked what they hoped to learn in the workshops, and participants in the control group were asked what they would want to learn if they attended workshops.

Math for Parents Instrument

To determine the effect of the intervention on content knowledge in addition to participants' understanding of student responses, the researcher created an instrument using questions similar to those in the teachers' editions for grades two through four of the *Go Math!* Series (Dixon, Levia, Larson, & Adams, 2013). Students of the participants in this study used this textbook series. Feedback on the instrument was generated using informal interviews and cognitive interviews with a variety of subjects, and revisions were made as necessary. Due to the small sample size, reliability and validity tests were not completed.

Cognitive interviews were employed by asking participants to think out loud when they read through and solved the problems. The researcher took notes and upon completion of the instrument, the researcher asked clarifying questions about what participants had said during administration of the test. The cognitive interview protocol is included in Appendix G. The researcher also asked for suggestions on formatting and clarification issues, so participants in the current study would not have similar problems. The process this instrument went through is described in Table 4.

Table 4

Cognitive Interview Iterations

Iteration	Number of Participants	Background of Participants	Changes made
1	5	Mathematics education faculty and doctoral students, parent, statistician	Made changes to the format, some changes in the directions, student solutions, and values in the problem
2	5	Mathematics education doctoral students, parent	Changes in student solutions and values in questions posed
3	7	Parents of elementary students that were not in the pilot or the treatment or control groups	Changes in directions and student solutions
4	4	Mathematics education faculty, statistician	Took out two questions, changed some values, made some formatting changes, changed the order of the questions
5	4	Parents in the pilot study	Changed wording on two questions to make the student explanation shorter

Table 4 shows that each iteration of the instrument had between four and seven participants who provided feedback. Some changes participants suggested were on formatting, directions, the numbers being used in the problems, student solution explanations, the order in which the problems were given, and the length of the instrument. The goal of this instrument was to measure mathematics knowledge for parenting (MKP) by asking them to solve different mathematics problems that their child may have been asked during the current school year or might be asked during the next school year. Then, participants were asked to analyze a possible student solution. This solution may be correct or incorrect, where incorrect solutions addressed common student errors. This part of the instrument attempted to measure the participants' flexibility in thinking about how to solve problems to account for the different strategies their child might use to solve the same problems. By increasing MKP, participants would have a better understanding of the content and would be better prepared to help their child make sense of the child's solution.

Part 1 was the parent response test, where participants were given questions and expected to find solutions on their own. This instrument is included in Appendix H. Participants were asked questions like, "Jessi made 74 bracelets over summer break and then sold some. Now she has 45 bracelets left. How many bracelets did she sell?" Initially there were 14 questions on this test, but after the cognitive interviews, there were 11, including a mixture of addition, subtraction, multiplication, and division problems. Questions similar to the problems students see in their math textbook were used so participants could see the relevance of the instrument. The researcher chose fewer questions because during cognitive interviews this instrument took between 30 and 45 minutes to administer. With three fewer questions, the administration took between 20 and 30 minutes. Whole numbers were used, as this is when mathematics education begins to look different from when participants learned elementary mathematics. Participant responses were coded as correct (1) or incorrect (0). Each question response was also coded as using traditional methods, such as the standard algorithm (0) or new strategies, such as other representational and abstract strategies learned in the workshops (1) to determine if participating in the workshops increased parents' use of new strategies. The questions in the content instruments were ordered so there would be a mixture of different operations so that all the addition problems would not be first for example. Included in this part of the instrument was a one-page section on tools. Participants were asked about their level of comfort with base ten blocks, part-part-whole mats, open number lines, ten frames, hundred charts, and arrays. Responses were coded as not comfortable (1) to very comfortable (4).

The student response instrument, or part 2, had the same 11 content questions as the parent response test, in the same order, but the difference was that this instrument included one possible student response for each question. There were correct and incorrect responses. Participants were expected to identify whether or not the student response was correct. If the participant understood what the student did for incorrect responses, they were asked to identify the student's error. Each question on this instrument was coded as correct (1) incorrect (0) when participants identified whether or not the student solution was correct. Next, each question was coded on whether the participant understood (1) or did not understand (0) the student solution. Finally, each incorrect student solution was coded whether the participant correctly identified the student error (1) or did not (0). Similar to the parent response instrument, or part 1, there was a mixture of correct and incorrect student responses, and a mixture of the four operations. In addition, the student responses to questions in the content instruments were also taken into consideration so there would be a mixture of correct and incorrect student responses, because the researcher did not want a pattern to be evident when participants were completing the student response instrument. This instrument is included in Appendix I.

Data Analysis

Due to the fact that a non-equivalent control group design was used, group differences might affect the outcome. For this reason the researcher reported findings from running an independent t-test on the pretest scores. This helped insure that any gains made by the treatment group could be attributed to participation in the workshops. For the four research questions, the researcher used SPSS.v22 to run a two-factor split plot ANOVA, using profile plots and to describe any interaction. The researcher wanted to determine whether or not an intervention was effective given pretest and posttest scores on parents' content knowledge of whole number concepts and operations, beliefs related to mathematics, ability to identify correct student responses, and ability to identify student errors.

Ancillary Tests

During data collection, the researcher identified more questions, labeled "ancillary questions." The researcher wanted to determine if the workshops had any impact on participants' self-reported comfort level with different manipulatives. Part of the parent response instrument was a one-page section containing different tools. Participants were expected to choose their comfort level with each of them. Additionally, after observing how participants solved the problems on the posttest, the researcher realized many of the participants in the treatment group were using strategies that they learned about in the workshops to solve the problems. Problems where participants used the standard algorithm were coded as "0" and problems where participants used other strategies that were discussed were coded as "1". To ensure trustworthiness the researcher enlisted the help of another researcher with similar background to code each question. Finally, the researcher referred back to Capraro's (2005) study on the abbreviated MBS. Because there was statistical significance regarding the beliefs, and due to the fact that the MBS could be broken into three factors, the researcher looked at each of those factors separately. Ancillary questions follow.

1. Ancillary Question 1: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in how

comfortable they are with different manipulatives as compared to parents who do not attend?

2. Ancillary Question 2: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in using traditional or new methods to solve 2nd, 3rd, and 4th grade mathematics problems, as compared to parents who do not attend?

3. Ancillary Question 3: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their belief factors (1, 2, and 3) about learning mathematics as compared to parents who do not attend?

Summary

This chapter explained the research design, sample population, intervention, and data analysis procedures. Research questions were included and instruments were described, including the steps the researcher took to create the content test. The next section describes the data analysis in detail, including both descriptive and inferential statistics.

CHAPTER FOUR: DATA ANALYSIS

Due to the fact that a non-equivalent control group design was used, group differences could have affected the outcome. For the four research questions, the researcher used SPSS to run a two-factor split-plot Analysis of Variance, or ANOVA. This accounted for the treatment and control groups' scores being measured at the pretest and posttest. The researcher attempted to determine if there were differences, on average, on parents' content knowledge of whole number concepts and operations, beliefs related to mathematics, ability to identify correct student responses, and ability to identify errors in student responses based on participation (as compared to non-participation) in the workshops. When analyzing data from the original four research questions, three more questions to examine were identified. Those questions will be under the section labeled "ancillary tests" and will be reviewed after the discussion of the four initial research questions.

Introduction

The purpose of this study was to determine the extent to which parents or guardians who attended a workshop on mathematics strategies differed on average and over time with parents who did not attend the workshop in the following areas: parent mathematics content knowledge, beliefs about learning mathematics, ability to identify correct student responses, and ability to identify student errors. It is important to note that this workshop only lasted two days, with each session consisting of 1 ½ hours of material. Additionally, the sample size for each group, treatment and control, was very small requiring that the results be interpreted with caution.

Demographics of Schools

Participants in this study had students who attended one of three neighboring public elementary schools all with similar school demographics, and one additional participant from another school (School 4). Even though *School 4* did not have similar school demographics to the other three, the *participant* in the research study had demographic information that was in the highest frequency for the following categories: gender, race, age, marital status and number of people who live in the household which is why this participant was included in the research.

School 1 was the school site where the workshops were held, which could account for the majority of participants coming from this school. The location of *School 2* was approximately one mile from the location of *School 1,* which could account for the second largest number of participants coming from that school. *School 3* was approximately 5 miles from *School 1* and *School 2*. *School 4* was not one of the target schools, but this participant had a family member who planned to attend and asked if she could attend, too. School demographics for each of the four schools participating in the current study indicate similar demographics for these schools regarding the percentage of students in each of the following categories: White, Hispanic, Black, and Asian (see table 5). The first three schools had students enrolled who were primarily white with the next largest percentage of students being of Hispanic background. *School 4* enrolled students who were primarily Hispanic, but students who identified themselves as White were a close second. All four schools had a smaller student population that identified with Black or Asian background.

Additionally, the number of students in each grade were reported, according to the public schools K-12 website (PSK12, 2015). Note that while *School 4* had the highest preschool and grade 4 population, and lowest kindergarten population, they fell between the other three schools for grades 1, 2, and 3, which were the targeted grade levels for this research. This information provides insight on the number of students who attended each of the four schools and how many students were in each of the seven grade levels.

Finally, table 5 identifies total students, the student to teacher ratio, and the percent of students eligible for free or reduced lunch. *School 2* had the biggest population. The student to teacher ratio fell between 15 and 16.1, so all four schools were similar in that aspect. In addition, the percentage of students at *School 1* and *School 2* eligible for free or reduced lunch were similar. *School 1* indicate 14% of their students were eligible for free lunch and 6% of their students were eligible for reduced lunch, while *School 2* had 12% of students eligible for free lunch and 5% of students eligible for reduced lunch. On the other hand *School 3* had the smallest percentage for the four schools of students who were eligible for free lunch (7%) and for reduced lunch (2%), and *School 4* had the largest percentage for the four schools of students who were eligible for free lunch (35%) and reduced lunch (9%).

Table 5

Participating Schools' Demographic Information (Frequencies and Percentages)

	School 1*	School 2	School 3	School 4
Ethnic Background				
White	51%	64%	70%	37%
Hispanic	33%	26%	18%	44%
Black	6%	6%	7%	14%
Asian	10%	5%	5%	5%
Enrollment by Grade				
Preschool	4 (1%)	23 (3%)	19 (4%)	50 (7%)
Kindergarten	112 (16%)	135 (17%)	86 (16%)	79 (12%)
First	134 (19%)	141 (17%)	76 (14%)	89 (13%)
Second	100 (14%)	129 (16%)	80 (15%)	107 (16%)
Third	114 (16%)	132 (16%)	102 (19%)	102 (15%)
Fourth	111 (16%)	123 (15%)	94 (17%)	132 (20%)
Fifth	137 (19%)	124 (15%)	83 (15%)	117 (17%)
Total Enrollment	712	807	540	676
Total Full-time Teachers	47	53	36	42
Student-teacher Ratio	15.1	15.2	15	16.1
Students Eligible for Free Lunch	98 (14%)	98 (12%)	40 (7%)	239 (35%)
Students Eligible Reduced Lunch	41 (6%)	38 (5%)	10 (2%)	58 (9%)

Note. **Treatment site*

Demographics of Participants

The current research study began with 32 participants, but due to three participants not completing the posttest only 29 participants were used (see table 6). *School 1* had 18 participants (62%), *School 2* had eight participants (28%), *School 3* had two participants (7%), and *School 4* had one participant (3%). There were 17 participants (59%) in the control group, and 12 participants (41%) in the treatment group. The 12 participants in the treatment group were split further into three groups, one for each of the three series. Of the 29 participants in this study, seven were male (24%) and 22 were female (76%). Four males (14%) were part of the treatment group, and three (10%) were in the control group. There were eight females (28%) in the treatment group and 14 (48%) in the control group.

The majority of the participants (*n* = 25 or 86%) did not identify with Hispanic, Latino, or Spanish origin. One participant identified with Mexican or Mexican-American, two identified with Chicano, and four identified with other. When further asking about race, the majority of participants (*n* = 22 or 76%) identified as being "white." Two participants identified themselves as Black, two identified themselves as Asian Indian, one as Filipino, one as Japanese, and one as Korean. The demographic information was also broken apart by group to identify any differences. The treatment group was much more diverse than the control group, where all but one participant identified themself as "white."

The majority of participants (*n* = 22 or 76%) were in the 36 - 45 age range. There were two participants (7%) in the 26 - 35 age range, and three participants (10%) in the 46 - 55 age range. One participant (3%) was between 56 and 65 and one participant (3%) was 66 or over. This information shows 94% of the participants were between 26 and 55 years old.

The majority of participants (*n* = 24 or 83%) were either married or in a domestic partnership. Approximately 13% of the participants were either separated *n* = 1 or divorced, *n* = 3. One participant (3%) was widowed. The majority of the participants (69%) lived with two (*n* = 9) or three (*n* = 11) other people. One person lived alone, without their child, three participants lived with one other person, three participants lived with four other people, and two participants lived with five other people.

Table 6

Participant Demographic Information by School and Separated into Treatment and Control (Frequencies and Percentages)

	Total	Treatment	Control
Parent Participants			
All Participants	29 (100%)	12 (41%)	17 (59%)
Male	7 (24%)	4 (14%)	3 (10%)
Female	22 (76%)	8 (28%)	14 (48%)
School 1			
Total	18 (62%)	8 (28%)	10 (34%)
Male	6 (21%)	4 (14%)	2 (7%)
Female	12 (41%)	4 (14%)	8 (28%)
School 2			
Total	8 (28%)	2 (7%)	6 (21%)
Male	1 (3%)	0	1 (3%)
Female	7 (24%)	2 (7%)	5 (17%)
School 3			
Total	2 (7%)	1 (3%)	1 (3%)
Male	0	0	0
Female	2 (7%)	1 (3%)	1 (3%)
School 4			
Total	1 (3%)	1 (3%)	0
Male	0	0	0
Female	1 (3%)	1 (3%)	0
Race			
White	22 (76%)	6 (21%)	16 (55%)
Black	2 (7%)	2 (7%)	0
Asian Indian	2 (7%)	2 (7%)	0
Filipino	1 (3%)	1 (3%)	0
Japanese	1 (3%)	0	1 (3%)
Korean	1 (3%)	1 (3%)	0
Age			
26 - 35	2 (7%)	0	2 (7%)
36 - 45	22 (76%)	9 (31%)	13 (45%)
46 - 55	3 (10%)	2 (7%)	1 (3%)
56 - 65	1 (3%)	0	1 (3%)
66 or over	1 (3%)	1 (3%)	0
Relationship Status			
Married or Domestic Partnership	24 (83%)	9 (31%)	15 (52%)
Separated	1 (3%)	1 (3%)	0
Divorced	3 (10%)	2 (7%)	1 (3%)
Widowed	1 (3%)	0	1 (3%)
Living with how many other people			
Alone	1 (3%)	0	1 (3%)
One	3 (10%)	3 (10%)	0
Two	9 (31%)	1 (3%)	8 (28%)
Three	10 (34%)	5 (17%)	6 (21%)
Four	3 (10%)	2 (7%)	1 (3%)
Five	2 (7%)	1 (3%)	1 (3%)

Six participants (21%) attended the first two-day workshop, 6 p.m. – 8 p.m. sessions on Tuesday May 12 and Tuesday May 19 (refer to table 7). Four participants (14%) attended the second two-day workshop, 9 a.m. – 11 a.m. sessions on Tuesday May 26 and Thursday May 28. Two participants (7%) attended the third two-day workshop, 6 p.m. – 8 p.m. sessions on Tuesday May 26 and Tuesday June 2. While 17 participants were needed in both the treatment and control group to obtain a power = 0.9, only 17 control participants completed both pretests and posttest instruments, and 12 treatment participants completed both pretests and posttests before summer vacation began.

Table 7

Treatment Group Participant Information for Workshop (Frequencies and Percentages)

		Total
Workshop	Series 1	6 (21%)
	Series 2	4 (14%)
	Series 3	2 (7%)

The majority of participants (*n* = 24 or 83%) earned at least a bachelor's degree, with *n* = 13 (45%) earning a bachelor's degree, eight (28%) earning a masters degree, one (3%) earning a professional or specialist degree, and two (7%) earning a doctorate degree. In addition, four (14%) participants attended some college and one (3%) earned an associate's degree. The results show all of the participants in this study attended at least some college. The demographic information was also broken apart by group to identify any differences. The treatment group had fewer participants who earned higher than a bachelor's degree (*n* = 2, or 7%) than the control group (*n* = 9, or 31%)

Most participants (n=21 or 72%) were working, where four (14%) were working part time and n = 17 (59%) were employed full time (refer to table 8). Five participants (17%) were not working and not seeking work, one (3%) was not employed but seeking work, one (3%) was retired, and one (3%) responded “other”.

Table 8

Educational Background and Employment (Frequencies and Percentages)

	Total	Treatment	Control
Educational Background			
Doctorate	2 (7%)	1 (3%)	1 (3%)
Professional/Specialist	1 (3%)	0	1 (3%)
Master	8 (28%)	1 (3%)	7 (24%)
Bachelor	13 (45%)	8 (28%)	5 (17%)
Associate	1 (3%)	0	1 (3%)
Some College	4 (14%)	2 (7%)	2 (7%)
Employment			
Full Time	17 (59%)	7 (24%)	10 (34%)
Part Time	4 (14%)	0	4 (14%)
Not working and not seeking work	5 (17%)	2 (7%)	3 (10%)
Not employed but seeking work	1 (3%)	1 (3%)	0
Retired	1 (3%)	1 (3%)	0
Other	1 (3%)	1 (3%)	0

The majority of participants (n = 22 or 76%) never had a teaching related position, and the same number of participants had never been employed in a mathematics or science related position (refer to table 9). Seven participants (24%) had been employed in a teaching related position and seven (24%) had been employed in a mathematics or science related position. The majority of participants (n = 27 or 93%) did not have a major or minor that was related to K-12 education, but two participants (7%) did have a major or minor related to K-12 education. The majority of participants (n = 20 or 69%) did not earn a major or minor in a mathematics or science field, but nine participants (31%) did earn a major or minor related to mathematics or science.

Table 9

Educational Background Related to Education, Mathematics, or Science (Frequencies and Percentages)

		Total	Treatment	Control
Had a Teaching Related Position	Yes	7 (24%)	3 (10%)	4 (14%)
	No	22 (76%)	9 (31%)	13 (45%)
Employed in a Math or Science Related Position	Yes	7 (24%)	2 (7%)	5 (17%)
	No	22 (76%)	10 (34%)	12 (41%)
Major or Minor Related to K-12 Education	Yes	2 (7%)	1 (3%)	1 (3%)
	No	27 (93%)	11 (38%)	16 (55%)
Major or Minor Related to Math or Science	Yes	9 (31%)	2 (7%)	7 (24%)
	No	20 (69%)	10 (34%)	10 (34%)

All participants said their child brought home mathematics homework. While some said they helped their child everyday (n = 10 or 34%), the rest of the participants were split on all other options ranging from never to four times per week (refer to table 10). Three participants (10%) said they helped their child four times per week, four participants (14%) said they helped their child three times per week, four participants (14%) said they helped their child twice per week, three participants (10%) helped their child once per week, and five participants (17%) said they never helped their child.

Table 10

How often per week *do you help your child with homework? (Frequencies and Percentages)*

	Total	Treatment	Control
Everyday	10 (34%)	5 (17%)	5 (17%)
Four Times	3 (10%)	1(3%)	2 (7%)
Three Times	4 (14%)	2 (7%)	2 (7%)
Two Times	4 (14%)	1 (3%)	3 (10%)
One Time	3 (10%)	2 (7%)	1 (3%)
Never	5 (17%)	1 (3%)	4 (14%)

Frequencies and percentages for how participants responded to, “Helping with math is a positive experience” were reported (refer to table 11). The frequencies showed that the majority of participants, 69% (n = 20), either agreed or strongly agreed with this statement at pretest. Similarly, there were nineteen (66%) participants at posttest who agreed or strongly agreed with this statement. The number of responses for strongly disagreed for both the pretests and the posttests were the same 7% (n = 2). The number of responses for disagreed decreased from n = 5 (17%) at pretest to n = 4 (14%) at posttest, but the number of responses for undecided increased from n = 2 (7%) for the pretest to n = 4 (14%) at posttest.

Frequencies and percentages for how participants responded to, “I am confident with my math ability when my child asks for help on his or her math homework” were reported (refer to table 11). The frequencies showed that the majority of participants, n = 18 (62%) either agreed or strongly agreed with this statement on the pretest and 18 participants (62%) agreed or strongly agreed when this question was answered at posttest. However, the breakdown was different at pretest and posttest. While more participants strongly agreed at pretest (n= 11) than agreed at pretest (*n*=7), the same number of participants agreed and strongly agreed at posttest (*n*=9 for each category. The number of responses for strongly disagree, disagree, and undecided for both the pretest and the posttest were the same.

Frequencies and percentages for how participants responded to, "How satisfied are you with the implementation of the Common Core State Standards" were reported (refer to table 11). The frequencies showed that many participants, *n* = 13 (45%) were either very dissatisfied or dissatisfied with the implementation of the CCSSM on the pretest, and 14 participants (48%) were either very dissatisfied or dissatisfied with the implementation of the CCSSM on the posttest. Eight participants (28%) were neutral on the pretest and only five (17%) were neutral on the posttest, which means participants were more decisive with their response for the posttest. Seven participants (24%) were satisfied or very satisfied in the pretest and 10 (34%) were satisfied or very satisfied for the posttest. One participant (3%) did not answer this question for the pretest.

Table 11

Likert Items for the Demographic Information Separated by Pretest and Posttest and by Group (Frequencies and Percentages)

	Pre			Post		
	Total (*n*=29)	Treatment (*n*=12)	Control (*n*=17)	Total (*n*=29)	Treatment (*n*=12)	Control (*n*=17)
"Helping with math is a positive experience."						
Strongly Disagree	2 (7%)	1 (3%)	1 (3%)	2 (7%)	1 (3%)	1 (3%)
Disagree	5 (17%)	1 (3%)	4 (14%)	4 (14%)	0	4 (14%)
Undecided	2 (7%)	0	2 (7%)	4 (14%)	0	4 (14%)
Agree	8 (28%)	2 (7%)	6 (21%)	7 (24%)	2 (7%)	5 (17%)
Strongly Agree	12 (41%)	8 (28%)	4 (14%)	12 (41%)	9 (31%)	3 (10%)
"I am confident with my math ability when my child asks for help on his or her math homework."						
Strongly Disagree	1 (3%)	0	1 (3%)	1 (3%)	1 (3%)	0
Disagree	9 (31%)	2 (7%)	7 (24%)	9 (31%)	3 (10%)	6 (21%)
Undecided	1 (3%)	0	1 (3%)	1 (3%)	0	1 (3%)
Agree	7 (24%)	5 (17%)	2 (7%)	9 (31%)	2 (7%)	7 (24%)
Strongly Agree	11 (38%)	5 (17%)	6 (21%)	9 (31%)	6 (21%)	3 (10%)
"How satisfied are you with the implementation of the Common Core State Standards?"						
Very Unsatisfied	7 (24%)	1 (3%)	6 (21%)	6 (21%)	2 (7%)	4 (14%)
Unsatisfied	6 (21%)	3 (10%)	3 (10%)	8 (28%)	2 (7%)	6 (21%)
Neutral	8 (28%)	5 (17%)	3 (10%)	5 (17%)	1 (3%)	4 (14%)
Satisfied	6 (21%)	2 (7%)	4 (14%)	4 (14%)	3 (10%)	1 (3%)
Very Satisfied	1 (3%)	1 (3%)	0	6 (21%)	4 (14%)	2 (7%)
Missing	1 (3%)	0	1 (3%)	0	0	0

Table 12 includes means and standard deviations for each of the four research questions in addition to the three ancillary questions. Only 29 participants complete both the pretest and the posttest, which is why the total sample size went from 32 to 29. Three participants, two in the treatment and one in the control, did not take the posttest so were not included in the statistical analyses for the mean and standard deviations. First, the overall mean scores and standard deviations are reported for the pretest and posttest. Then, the mean scores and standard deviations are further broken into treatment and control group for the pretest and posttest. The first row shows the total sample size for each of the groups. The means are similar between treatment and control groups, with the exception of methods, where the treatment group had a significantly higher mean at the posttest (5.88) than the control group (.59).

Table 12

Mean and Standard Deviations for Pretest vs. Posttest Split by Group

	Pre			Post		
	Total	Treatment	Control	Total	Treatment	Control
N	29	12	17	29	12	17
Parent Content Knowledge (RQ1)						
Mean	9.59	9.67	9.53	9.86	9.67	10
Standard Deviation	1.32	.99	1.55	1.09	1.23	1
Beliefs (RQ2)						
Mean	52.72	50.33	54.41	54.48	56	53.41
Standard Deviation	8.92	6.40	10.19	9.21	7.60	10.28
Correct Student Responses (RQ3)						
Mean	9.48	9.67	9.35	10.17	9.83	10.41
Standard Deviation	1.75	1.37	2	1.28	1.27	1.28
Identify Student Errors (RQ4)						
Mean	1.31	1.17	1.41	2.14	2.59	1.88
Standard Deviation	1.82	.94	2.27	2.12	1.62	2.42
Tools (AQ1)						
Mean	18.97	19.25	18.76	19.83	22.92	17.65
Standard Deviation	3.98	3.67	4.28	4.40	1.24	4.54
Methods (AQ2)						
Mean	.28	.25	.29	2.66	5.88	.59
Standard Deviation	.70	.87	.59	3.38	3.34	1.18
Belief Factors (AQ3 – F1)						
Mean	14.52	13.33	15.25	15.34	15.33	15.35
Standard Deviation	4.41	2.93	5.14	4.59	5.11	4.36
Belief Factors (AQ3 – F2)						
Mean	17	16.5	17.35	17.52	17.42	17.59
Standard Deviation	3.57	3.15	3.89	3.75	3.32	4.12
Belief Factors (AQ3 – F3)						
Mean	21.51	20.5	21.71	21.62	23.25	20.47
Standard Deviation	3.76	3.12	4.18	4.07	3.33	4.24

Assumptions

A two-factor split-plot (one within-subjects factor and one between subjects factor) ANOVA was conducted. The within-subjects factor was time (pretest or posttest) and the between-subjects factor was group (treatment or control). Assumptions of baseline equivalency, homogeneity of variance, independence, normality, and sphericity were tested. Evidence of the extent to which the assumptions were met is presented next. This is followed by the results of the two-factor split-plot ANOVA results.

Baseline Equivalency

Baseline equivalency is met for each of the four research questions. The non-statistically significant *p* value for each of these research questions suggested baseline equivalency at pretest for the groups (refer to table 13). These results suggest any gains made at posttest should not be attributed to group differences at pretest.

Table 13

Tests for Assumption of Independence Between Groups

	Levene's Test for Equality of Variances		*t*-test for Equality of Means		
	F	*p*	*t*	*df*	*p*
Parent Content Knowledge (RQ1)	2.195	.149	-.183	30	.856
Beliefs (RQ2)	1.702	.202	1.329	30	.194
Correct Student Responses (RQ3)	2.245	.144	-.413	30	.683
Identify Student Errors (RQ4)	6.610	.015	.39	30	.699

Homogeneity of Variances

Table 14 displays Levene's test of equality of error variances to test for homogeneity of variances. Each of the four areas - content, beliefs, student responses, and errors, were separated into pre and post to report this information. Homogeneity of variances was violated for both the pretest, F (1, 27) = 7.424, p = .011 and posttest, F (1, 27) = 5.187, p = .031 for research question four, regarding the ability to identify student errors at the p < .05 level. It should be noted that the violations of homogeneity could increase likelihood of a Type II error so non-statistically significant results for research question four should be interpreted with caution.

Table 14

Levene's Test of Equality of Error Variances

	F	df_1	df_2	p
Research Question 1				
Pre Content	4.021	1	27	.055
Post Content	.801	1	27	.379
Research Question 2				
Pre Beliefs	1.509	1	27	.230
Post Beliefs	.545	1	27	.467
Research Question 3				
Pre Correct SR	3.057	1	27	.092
Post Correct SR	.064	1	27	.802
Research Question 4				
Pre Errors	7.424	1	27	.011
Post Errors	5.187	1	27	.031

Independence

To test for independence, residuals were plotted against groups to determine if there was any pattern in the data. Because the data randomly falls around the horizontal line of zero, there is some indication this assumption has been met. See figures 1, 2, 3, and 4.

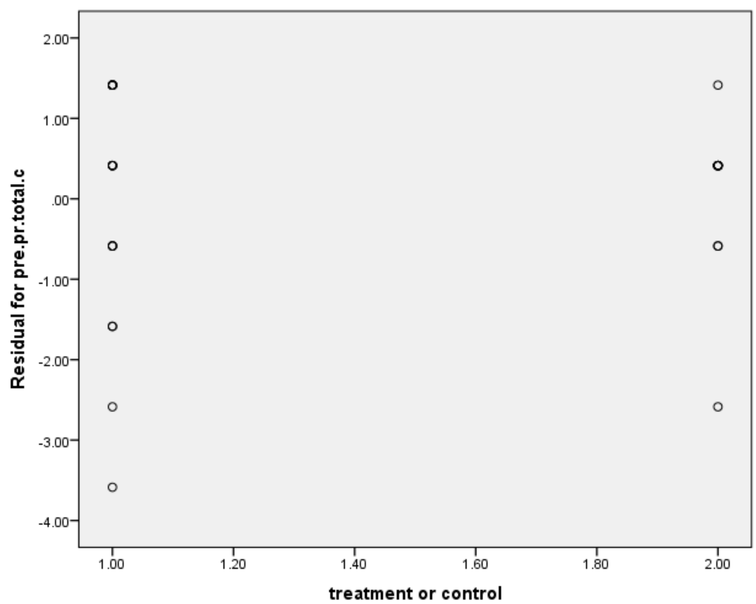


Figure 1: Scatterplot of Residual for Content Knowledge Pretest Against Group

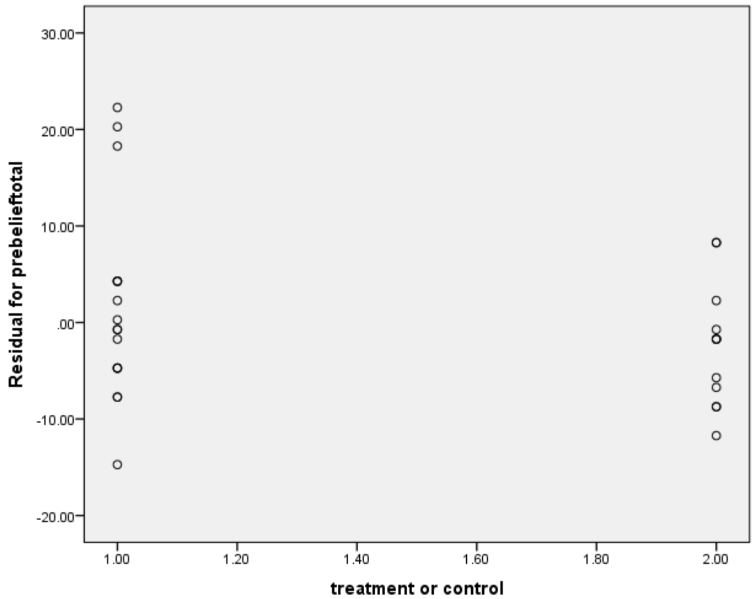


Figure 2: Scatterplot of Residual for Beliefs Pretest Against Group

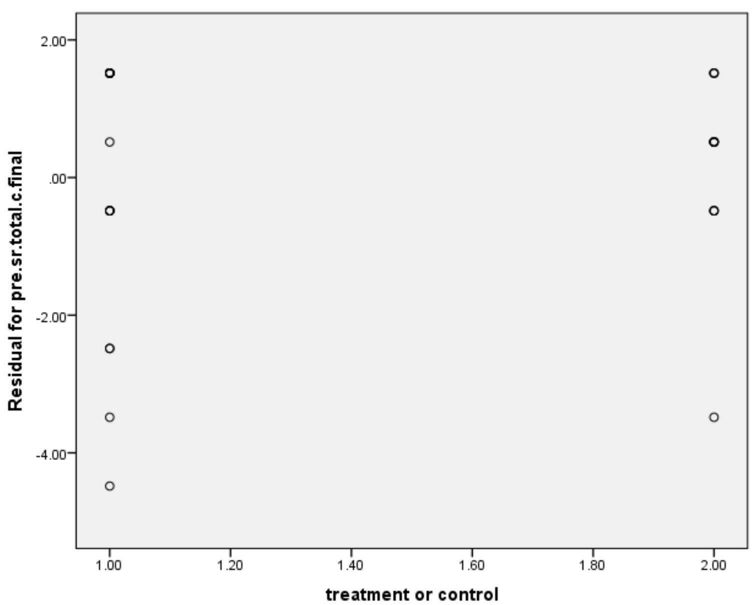


Figure 3: Scatterplot of Residual for Correct Responses Pretest Against Group

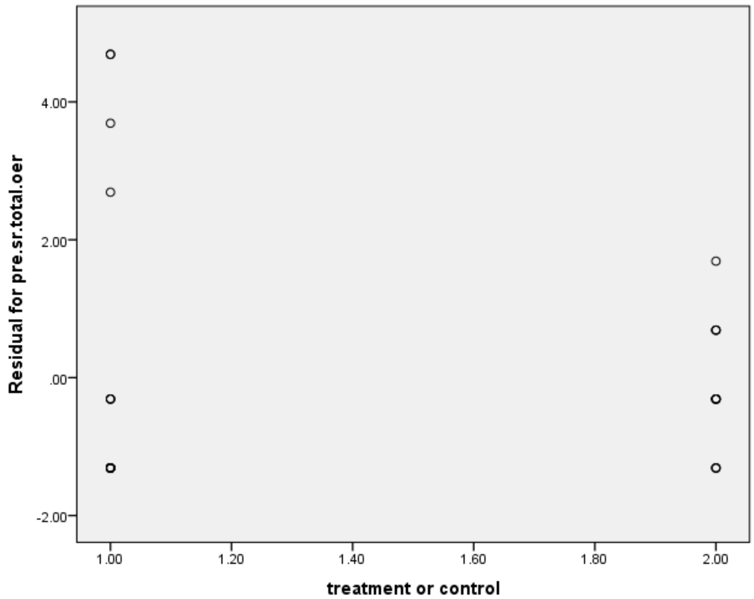


Figure 4: Scatterplot of Residual for Student Errors Pretest Against Group

Normality

Next, normality was tested. Skewness and kurtosis values for the posttest of correct student responses was negatively skewed and leptokurtic (refer to table 15). On the other hand, the other three research questions are within the ±2 guideline for some evidence of normality. However, according to the Shapiro-Wilk test, there is evidence of non-normality for parent content knowledge (pre, $SW = .869$, $df = 29$, $p = .002$; post, $SW = .169$, $df = 29$, $p = .011$), correct student responses (CSR) (pre, $SW = .846$, $df = 29$, $p = .001$; post, $SW = .743$, $df = 29$, $p < .001$), and identify student errors (ISE) (pre, $SW = .769$, $df = 29$, $p < .001$; post, $SW = .878$, $df = 29$, $p =$ .003.

Table 15

Normality Tests by Research Question

			Shapiro-Wilk		
	Skewness	Kurtosis	Statistic	*df*	*p*
Research Question 1					
Pre PCK	-1.083	.854	.869	29	.002
Post PCK	-.879	.169	.902	29	.011
Research Question 2					
Pre Beliefs	.815	.591	.929	29	.051
Post Beliefs	.066	.792	.964	29	.401
Research Question 3					
Pre CSR	-1.121	.517	.846	29	.001
Post CSR	-2.149	5.120	.743	29	.000
Research Question 4					
Pre ISE	1.496	1.408	.769	29	.000
Post ISE	.769	-.469	.878	29	.003

The assumption of normality was further explored. Each of the normal Q-Q plots showed some evidence of non-normality. Because sample sizes were unequal, this could have substantial effects to interpretations of these three research questions. See figures 5, 6, 7, and 8.

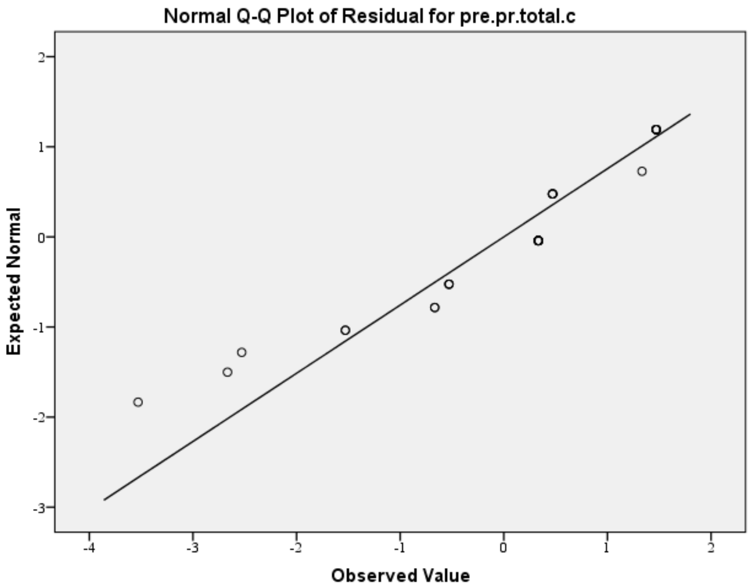


Figure 5: Normal Q-Q Plot for Parent Content Knowledge

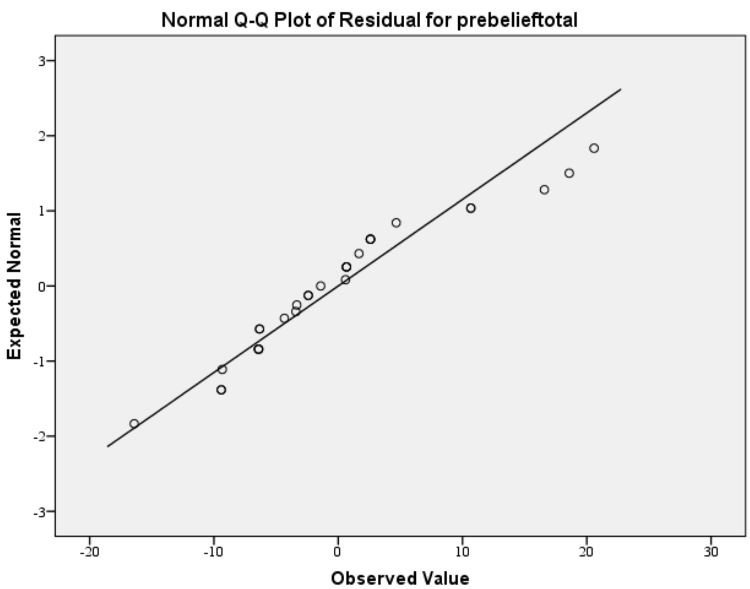


Figure 6: Normal Q-Q Plot for Beliefs

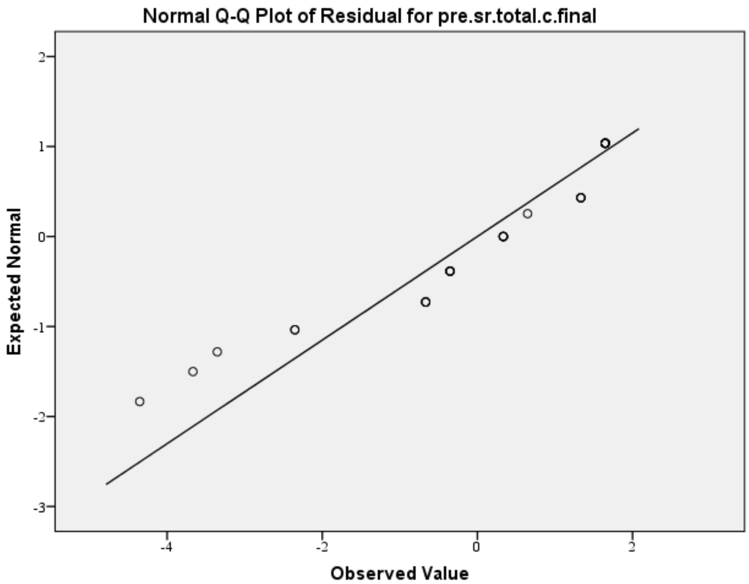


Figure 7: Normal Q-Q Plot for Correct Student Responses

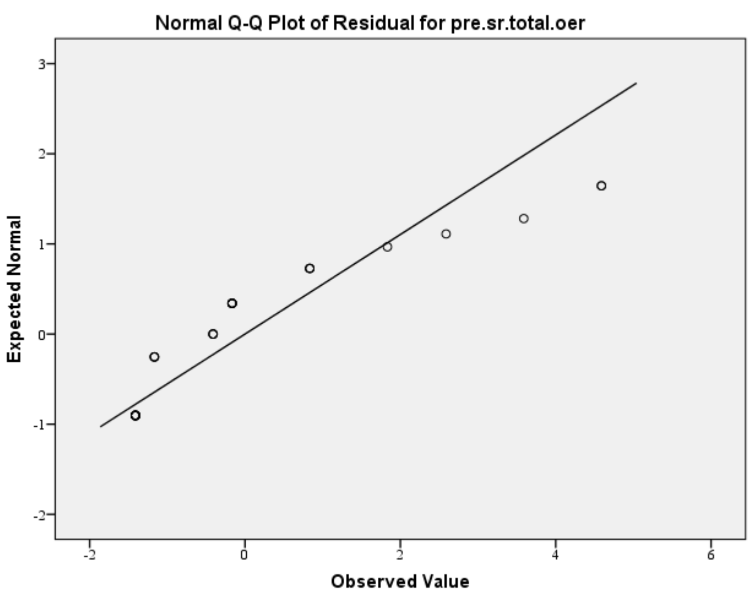


Figure 8: Normal Q-Q Plot for Identifying Student Errors

Sphericity

The assumption of sphericity was violated for each separate test so statistics from the Greenhouse-Geisser conservative *F* test were reported when analyzing statistical results (refer to table 16).

Table 16

Sphericity Tests by Research Question

	Mauchly's W	Appx. Chi^2	*df*	*p*
Parent Content Knowledge (RQ1)	1	0	0	<.01
Beliefs (RQ2)	1	0	0	<.01
Correct Student Responses (RQ3)	1	0	0	<.01
Identify Student Errors (RQ4)	1	0	0	<.01

Homogeneity of Covariance Matrices

Box's *M* was not significant for parent content knowledge, Box's $M = 5.871$, F (3, 36900) = 1.792, $p = .146$, which indicates that the assumption of homogeneity of covariance matrices was met (refer to table 17). Box's *M* was not significant for research question 2 (beliefs), Box's $M = 2.754$, F (3, 36900) = .841, $p = .471$, which indicates that the assumption of homogeneity of covariance matrices was met. Box's *M* was not significant for research question 3 (CSR), Box's $M = 4.105$, F (3, 36900) = 1.253, $p = .289$, which indicates that the assumption of homogeneity of covariance matrices was met. Box's *M* was not significant for research question 4 (ISE), Box's $M = 10.239$, F (3, 36900) = 3.126, $p = .025$, which indicates that the assumption of homogeneity of covariance matrices was met.

Table 17

Homogeneity of Covariance Matrices Tests by Research Question

	Box's *M*	*F*	df_1	df_2	*p*
Parent Content Knowledge (RQ1)	5.871	1.792	3	36899.706	.146
Beliefs (RQ2)	2.754	.841	3	36899.706	.471
Correct Student Responses (RQ3)	4.105	1.253	3	36899.706	.289
Identify Student Errors (RQ4)	10.239	3.126	3	36899.706	.025

ANOVA Test Results

The previous section regarding assumptions indicate the increased likelihood of a Type II error, due to the violation of the assumption of normality and homogeneity of variances, however the ANOVA is a robust test (Field, 2009). Additionally, effect sizes according to Cohen's values (1988), for small (.01), moderate (.06), and large (.14) effect sizes will be reported.

Research Question One

The first research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their mathematics content knowledge as compared to parents who do not attend?

There was a small effect size (.03) for main effects for the within subjects factor, a small effect size (.002) for main effects for the between-subjects factor, and a small effect size (.03) for the interaction of the between-within factor (refer to table 18). There was low observed power for the main effect for the between-subjects factor (.057), the within-subjects factor (.143), and the interaction of the between-within factor (.143). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for each of these interpretations of the statistical analyses.

There was a non-statistically significant within-subjects main effect for pretest and posttest (F = .837, df = 1, 27, p = .368) (pretest, M = 9.59, SD = 1.323; posttest, M = 9.86, SD = 1.093) (refer to table 18). The non-statistically significant result suggested that there were no mean differences between the pretest and posttest scores regarding content knowledge. In addition, there was a non-statistically significant within-between subjects interaction effect between group and time (F = .837, df = 1, 27, p = .368). ($M_{pre\ x\ control}$ = 9.53, SD = 1.546; $M_{pre\ x\ treatment}$ = 9.67, SD = .985; $M_{post\ x\ control}$ = 10, SD = 1; $M_{post\ x\ treatment}$ = 9.67, SD = 1.231). This non-statistically significant result suggested that there were no differences, on average, between treatment and control group over time regarding content knowledge. Finally, there was a non-statistically significant between-subjects main effect for treatment and control groups (F = .065, df = 1, 27, p = .801). This non-statistically significant result suggested that there were no mean differences between treatment and control groups regarding content knowledge.

Table 18

Greenhouse Geisser Results for Within and Between Subjects Effects for PCK

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	.837	.368	.030	.143
Within	Time * Group	1	27	.837	.368	.030	.143
Between	Group	1	27	.065	.801	.002	.057

Figure 9 shows the means for the pretest and posttest comparing the treatment and control groups for mathematics content knowledge. Although there is an interaction, the difference is very small. Note the difference of .5 from the pretest to posttest for the control group.

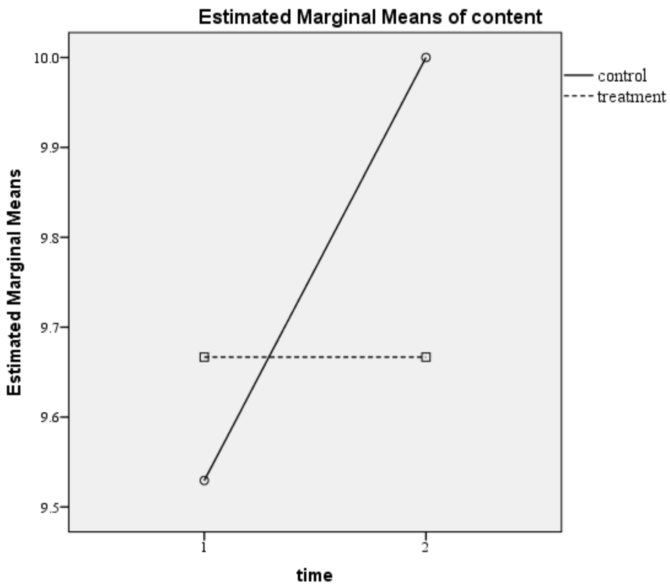


Figure 9: Profile Plot for Content Knowledge

Research Question Two

The second research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their beliefs about learning mathematics as compared to parents who do not attend?

There was a moderate to large effect size (.109) for main effects for the within subjects factor, a small effect size (.002) for main effects for the between-subjects factor, and a large effect size (.201) for the interaction of the between-within factor (refer to table 19). There was low observed power for the main effect for the between-subjects factor (.056) and the within-subjects factor (.420), but a slightly higher power for the interaction for the between-within factor (.708). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for the interpretations of the statistical analyses for the main effects, but is lower for the between-within interaction interpretations of the statistical analyses.

There was a non-statistically significant within-subjects main effect for pretest or posttest (F = 3.318, df = 1, 27, p = .080) (pretest, M = 52.72, SD = 8.92; posttest, M = 54.48, SD = 9.206) (refer to table 19). The non-statistically significant result suggested that there were no mean differences over time regarding beliefs. In addition, there was a non-statistically significant between-subjects main effect for treatment and control group (F = .055, df = 1, 27, p = .816). This non-statistically significant result suggested that there were no mean differences over time, from pretest to posttest regarding beliefs. On the other hand, there was a statistically significant within-between subjects interaction effect between group and time (F = 6.771, df = 1, 27, p = .015). ($M_{pre\ x\ control}$ = 54.41, SD = 10.186; $M_{pre\ x\ treatment}$ = 50.33, SD = 6.401; $M_{post\ x\ control}$ = 53.41, SD = 10.278; $M_{post\ x\ treatment}$ = 56, SD = 7.604). This statistically significant result suggested that there were differences, on average, between treatment and control group over time regarding beliefs.

Table 19

Greenhouse-Geisser Results for Within and Between Subjects Effects for Beliefs

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	3.318	.08	.109	.420
Within	Time * Group	1	27	6.771	.015	.201	.708
Between	Group	1	27	.055	.816	.002	.056

Figure 10 shows the belief score means from the pretest and posttest, between the treatment and control groups. This provides a visual representation of the statistically significant interaction between time and group as reported from Table 18.

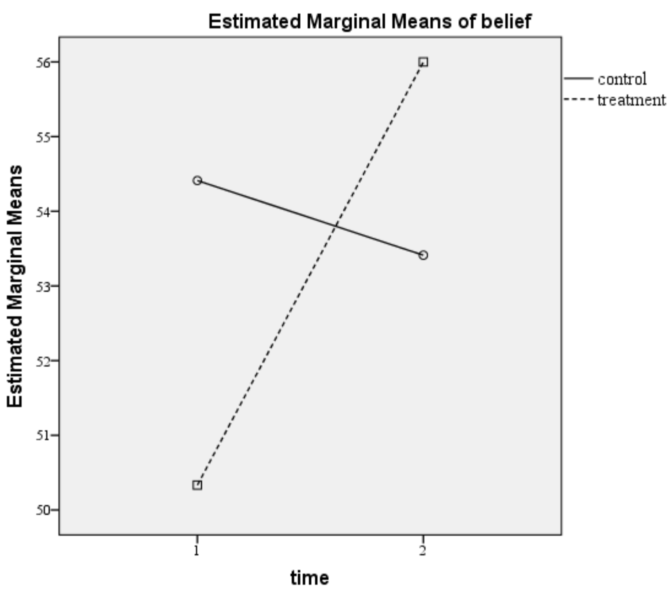


Figure 10: Profile Plot for Beliefs

Research Question Three

The third research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify whether student responses to 2nd, 3rd, and 4th grade mathematics content are correct as compared to parents who do not attend?

There was a large effect size (.141) for main effects for the within subjects factor, a small effect size (.003) for main effects for the between-subjects factor, and a moderate effect size (.08) for the interaction of the between-within factor (refer to table 20). There was low observed power for the main effect for the between-subjects factor (.057), the within-subjects factor (.526) and the interaction for the between-within factor (.314). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for each of these interpretations of the statistical analyses.

There was a statistically significant within-subjects main effect for pretest and posttest (F = 4.415, df = 1, 27, p = .045) (pretest, M = 9.48, SD = 1.74; posttest, M = 10.17, SD = 1.28) (refer to table 20). The statistically significant result suggested that there were mean differences from the pretest to posttest scores regarding identification of correct student responses. However, there was a non-statistically significant within-between subjects interaction effect between group and time (F = 2.340, df = 1, 27, p = .138). ($M_{pre\ x\ control}$ = 9.35, SD = 2; $M_{pre\ x\ treatment}$ = 9.67, SD = 1.37; $M_{post\ x\ control}$ = 10.41, SD = 1.28; $M_{post\ x\ treatment}$ = 9.83, SD = 1.27). This non-statistically significant result suggested that there were no mean differences between treatment and control group from pretest to posttest regarding identification of correct student responses. In addition, there was a non-statistically significant between-subjects main effect for treatment and control group (F = .069, df = 1, 27, p = .794). This non-statistically significant result suggested that there were no differences, on average, between treatment and control groups regarding identification of correct student responses (CSR).

Table 20

Greenhouse-Geisser Results for Within and Between Subject Effects for CSR

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	4.415	.045	.141	.526
Within	Time * Group	1	27	2.340	.138	.08	.314
Between	Group	1	27	.069	.794	.003	.057

Figure 11 shows the means for the pretest and posttest comparing the treatment and control groups for CSR. Although there is an interaction, the difference is insufficient to determine generalizability of the findings.

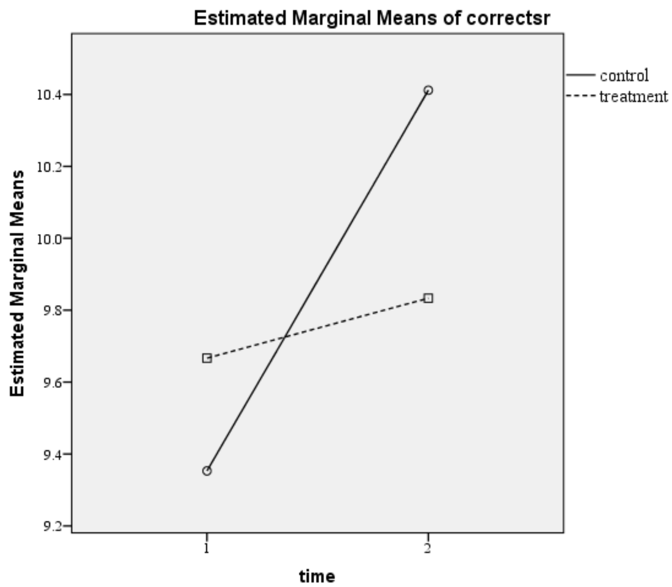


Figure 11: Profile Plot for Correct Student Solutions

Research Question Four

The fourth research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify student errors in incorrect solutions for 2^{nd}, 3^{rd}, and 4^{th} grade mathematics content as compared to parents who do not attend?

There was a large effect size (.273) for main effects for the within subjects factor, a small effect size (.003) for main effects for the between-subjects factor, and a moderate effect size (.079) for the interaction of the between-within factor (refer to table 21). There was low observed power for the main effects for the between-subjects factor (.058) and the interaction for the between-within factor (.312). However, there was sufficient observed power for the within-subjects factor (.867). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for the interpretations of the statistical analyses for the main effect for the between-subjects factor and the between-within interaction. The Type II error is lower for the main effects for the within-subjects factor as the power is higher.

There was a statistically significant within-subjects main effect from pretest to posttest (F = 10.148, df = 1, 27, p = .004) (pretest, M = 1.31, SD = 1.815; posttest, M = 2.14, SD = 2.117) (refer to table 21). The statistically significant result suggested that there were mean differences over time regarding identification of student errors. On the other hand, there was a non-statistically significant within-between subjects interaction effect between group and time (F = 2.321, df = 1, 27, p = .139). ($M_{pre\ x\ control}$ = 1.41, SD = 2.265; $M_{pre\ x\ treatment}$ = 1.17, SD = .937; $M_{post\ x\ control}$ = 1.88, SD = 2.421; $M_{post\ x\ treatment}$ = 2.59, SD = 1.624). This non-statistically significant result suggested that there were no differences, on average, between treatment and control group over time regarding identification of student errors. Additionally, there was a non-statistically significant between-subjects main effect for treatment and control groups (F = .072, df = 1, 27, p = .971). This non-statistically significant result suggested that there were no mean differences between groups regarding identification of student errors (ISE).

Table 21

Greenhouse-Geisser Results for Within and Between Subjects Effects for ISE

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	10.148	.004	.273	.867
Within	Time * Group	1	27	2.321	.139	.079	.312
Between	Group	1	27	.072	.791	.003	.058

Figure 12 shows the means for the pretest and posttest comparing the treatment and control groups for identifying student errors. Although there is an interaction, the difference is insufficient to determine generalizability of the findings.

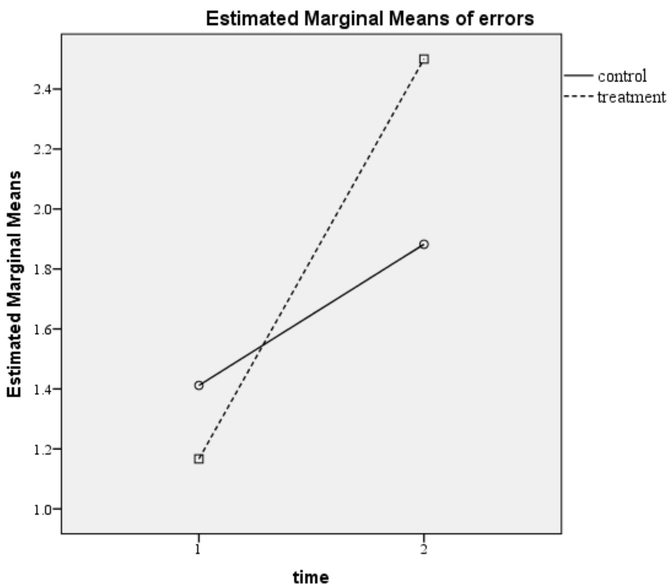


Figure 12: Profile Plot for Identification of Errors

Ancillary Tests

Additional data analyses were run for the following dependent variables – tools, methods used, and the three different factors for the Mathematics Beliefs Scales (MBS). The researcher-created instrument was designed to ask participants to rate their comfort level using different tools to solve problems. One of the original research questions included analyzing tests on the total MBS score. However, Capraro (2005) identified three factors through factor analysis. Due to the significance found in the total belief score from research question 2, the three factors of the MBS were analyzed separately.

Analyses on how comfortable participants were regarding tools used to solve problems were run. The workshops in the current study focused on helping participants be more comfortable using these tools. This was an original intent of the researcher, but upon reflection during data analysis this analysis was not captured in responding to the original research questions.

A two-factor split-plot ANOVA was run to differentiate between traditional (standard algorithm) or new (from the workshops) methods participants used to solve the problems. These results were analyzed because while participants in the treatment group were completing the posttest for the parent response instrument many participants used new strategies to solve the problems, whereas they used the standard algorithm to solve problems on the pretest. Additional analyses were generated on the MBS to determine which factors of the MBS had a statistically significant difference. The following ancillary questions were examined:

1. Ancillary Question 1: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in how comfortable they are with different manipulatives as compared to parents who do not attend?
2. Ancillary Question 2: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in using traditional or new methods to solve 2nd, 3rd, and 4th grade mathematics problems, as compared to parents who do not attend?
3. Ancillary Question 3: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their belief

factors (1, 2, and 3) about learning mathematics as compared to parents who do not attend?

Assumptions

As mentioned with previous research questions, a two-factor split-plot (one within-subjects factor and one between subjects factor) ANOVA was conducted. The within-subjects factor was time (pretest or posttest) and the between-subjects factor was group (treatment or control). Evidence of the extent to which the assumptions were met is presented next. This is followed by the results of the two-factor split-plot ANOVA results.

Baseline Equivalence

Baseline equivalence is met for each of the three ancillary questions (refer to table 22). The non-statistically significant *p* value for each of these research questions suggested baseline equivalency at pretest for the groups.

Table 22

Tests for Assumption of Independence Between Groups

	Levene's Test for Equality of Variances		*t*-test for Equality of Means		
	F	*p*	*t*	*df*	*p*
Tools (AQ1)	.106	.747	-.303	30	.764
Methods (AQ2)	.101	.752	-.032	30	.975
Beliefs – F1 (AQ3)	2.832	.103	1.226	30	.23
Beliefs – F2 (AQ3)	.443	.511	.734	30	.469
Beliefs – F3 (AQ3)	2.079	.160	.957	30	.346

Homogeneity of Variances

Table 23 displays Levene's test of equality of error variances to test for homogeneity of variances. Homogeneity of variances was violated for two variables at the $p < .05$ level: posttest tools, F (1, 27) = 23.472, p <.001, and posttest methods, F (1, 27) = 10.964, p = .003. It should be noted that the violations of homogeneity of variance could increase likelihood of a Type II error, so non-statistically significant results should be interpreted with caution.

Table 23

Levene's Test of Equality of Error Variances (Ancillary Tests)

	F	df_1	df_2	p
Ancillary Question 1				
Pre Tools	.186	1	27	.670
Post Tools	23.472	1	27	<.001
Ancillary Question 2				
Pre Methods	.002	1	27	.967
Post Methods	10.964	1	27	.003
Ancillary Question 3				
Pre Beliefs F1	3.481	1	27	.073
Post Beliefs F1	.699	1	27	.410
Pre Beliefs F2	.513	1	27	.480
Post Beliefs F2	1.174	1	27	.288
Pre Beliefs F3	2.235	1	27	.147
Post Beliefs F3	.366	1	27	.550

Belief F1 = student learning; Belief F2 = stages of learning; Belief F3 = teacher practices

Independence

The assumption of independence was tested by plotting residuals against groups to determine if there was any pattern in the data. Because the data randomly falls around the horizontal line of zero, there is some indication this assumption has been met. See figures 13, 14, 15, 16, and 17.

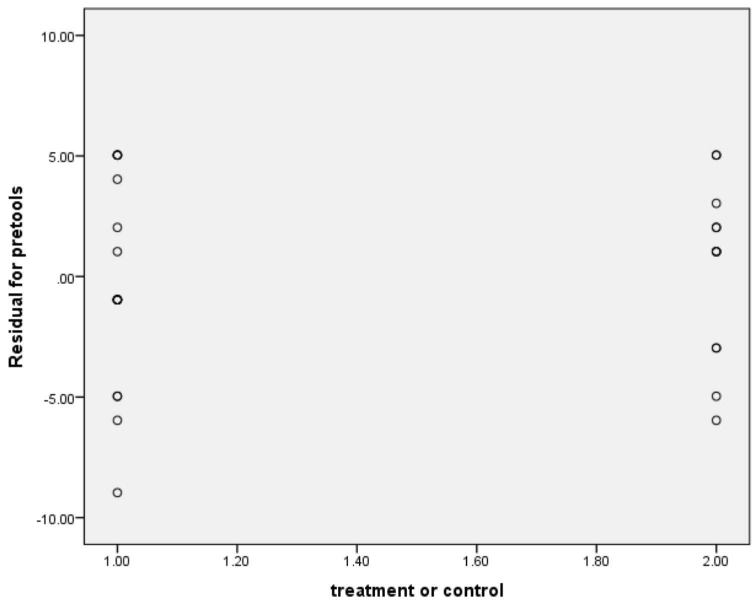


Figure 13: Scatterplot of Residual for Tools Pretest Against Group

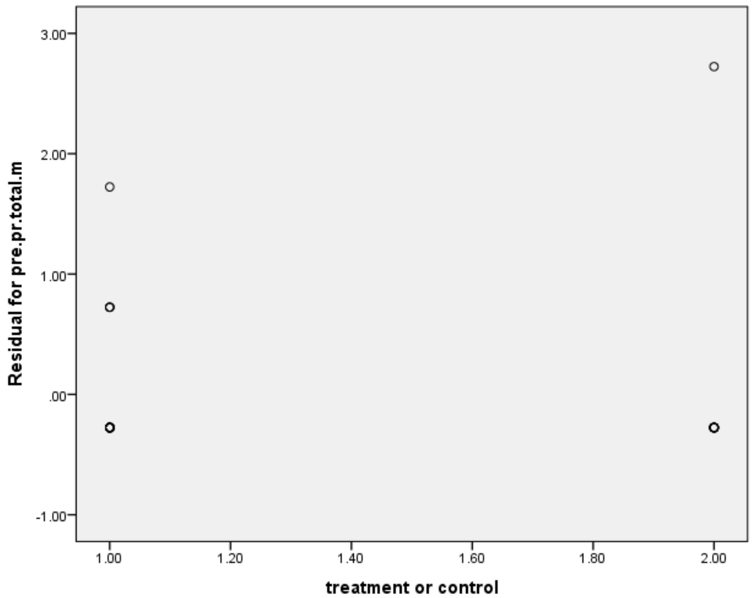


Figure 14: Scatterplot of Residual for Methods Pretest Against Group

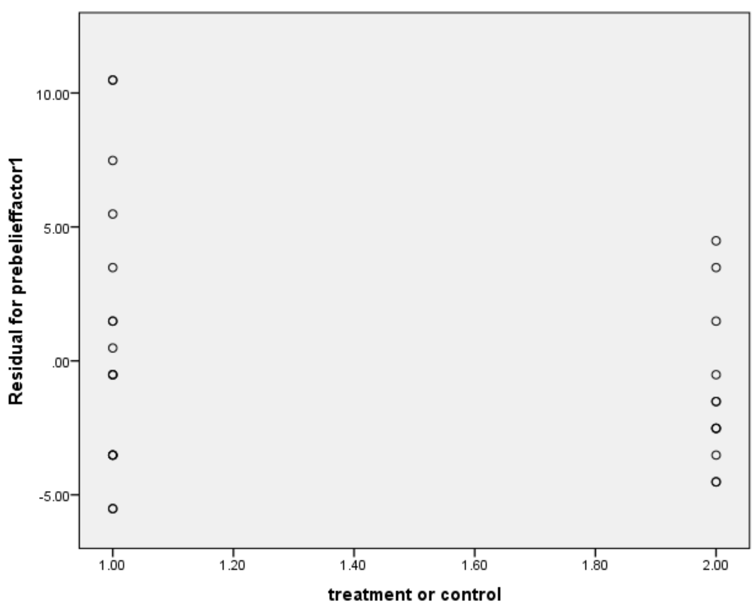


Figure 15: Scatterplot of Residual for Beliefs-Factor 1 Pretest Against Group

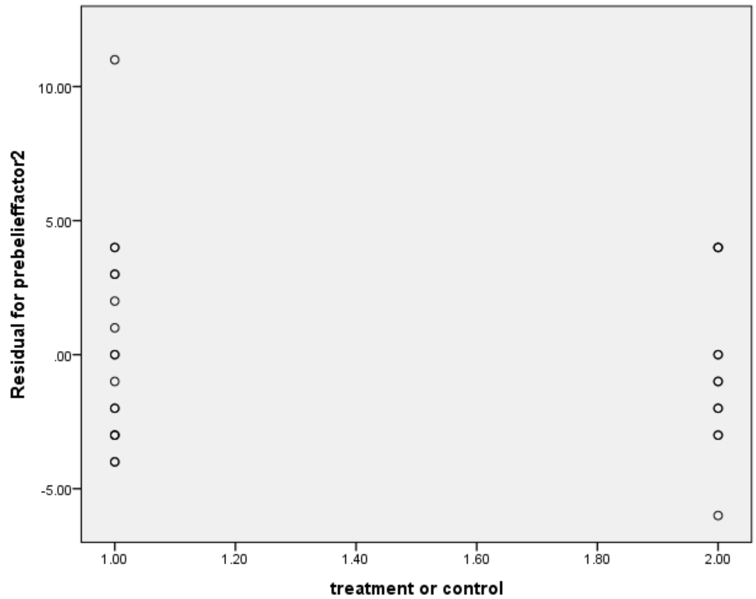


Figure 16: Scatterplot of Residual for Beliefs-Factor 2 Pretest Against Group

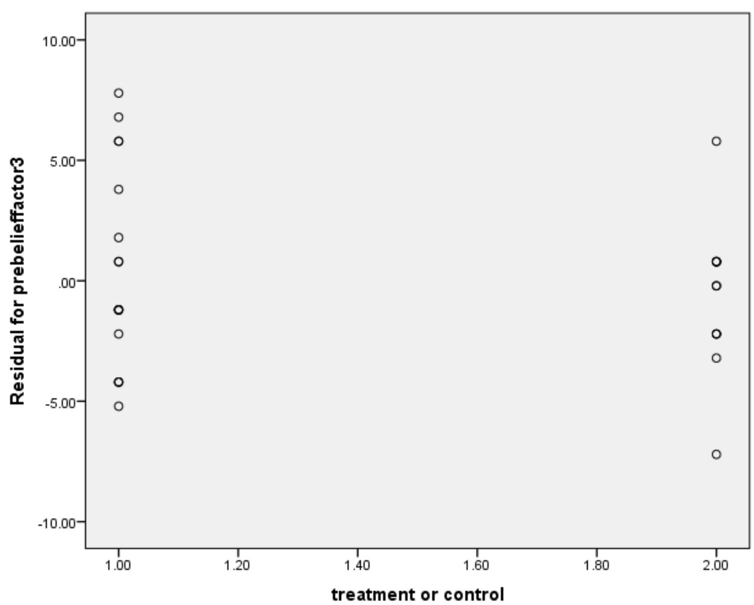


Figure 17: Scatterplot of Residual for Beliefs-Factor 3 Pretest Against Group

Normality

Next, normality was tested (refer to table 24). Skewness and kurtosis values for the pretest for methods was positively skewed and leptokurtic. On the other hand, the other two ancillary questions and the posttest for methods are within the ±2 guideline for some evidence of normality (Lomax & Hahs-Vaughn, 2012). However, according to the Shapiro-Wilk test, there is evidence of non-normality for methods (pre, $SW = .482$, $df = 29$, $p = .001$; post, $SW = .861$, $df = 29$, $p < .001$), and post beliefs – factor 1 ($SW = .928$, $df = 29$, $p = .048$).

Table 24

Additional Normality Statistics

			Shapiro-Wilk		
	Skewness	Kurtosis	Statistic	*df*	*p*
Ancillary Question 1					
Pre Tools	-.387	-.678	.940	29	.098
Post Tools	.152	-.173	.964	29	.417
Ancillary Question 2					
Pre Methods	2.924	8.811	.482	29	.000
Post Methods	.068	1.237	.861	29	.001
Ancillary Question 3					
Pre Beliefs F1	.759	.075	.931	29	.059
Post Beliefs F1	.290	-1.126	.928	29	.048
Pre Beliefs F2	.958	1.358	.935	29	.076
Post Beliefs F2	.037	.021	.983	29	.904
Pre Beliefs F3	.316	-.481	.955	29	.244
Post Beliefs F3	-.400	-.336	.975	29	.711

Each of the normal Q-Q plots (displayed in Figures 18, 19, 20, 21, and 22) show some evidence of non-normality, especially for ancillary question 2 regarding the methods participants used. Due to the unequal sample sizes between groups, this violation of the assumption of normality could have substantial effects so results should be interpreted with caution.

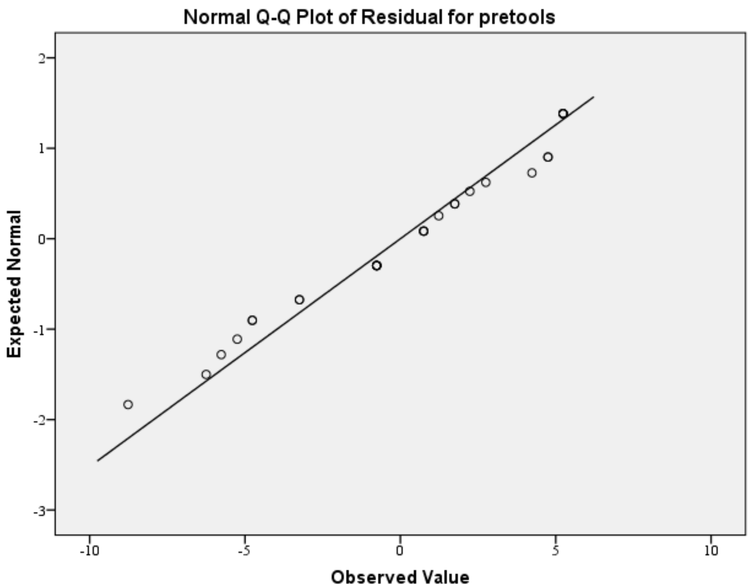


Figure 18: Normal Q-Q Plot for Tools

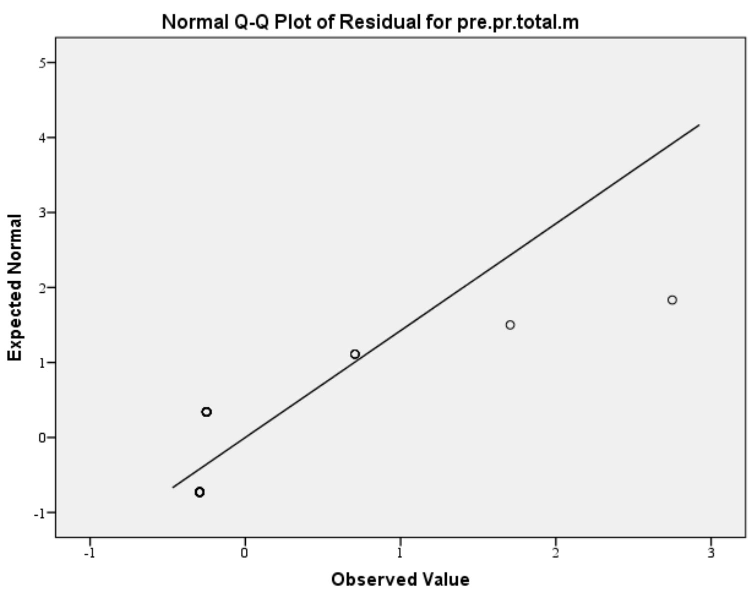


Figure 19: Normal Q-Q Plot for Methods

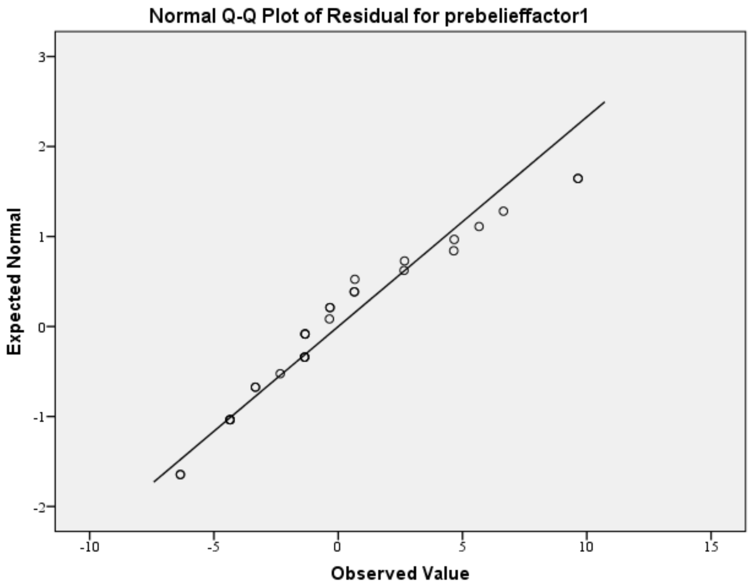


Figure 20: Normal Q-Q Plot for Belief Factor 1 (student learning)

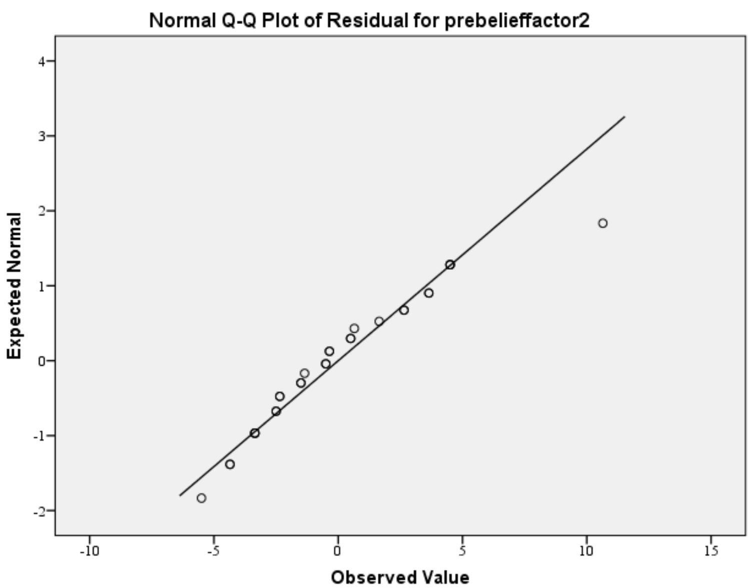


Figure 21: Normal Q-Q Plot for Belief Factor 2 (stages of learning)

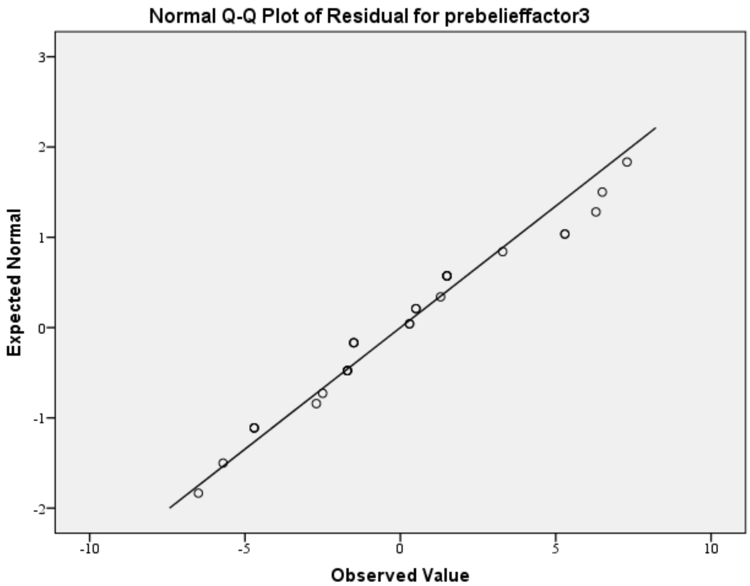


Figure 22: Normal Q-Q Plot for Beliefs Factor 3 (teacher practices)

Sphericity

The assumption of sphericity was violated for each separate test so statistics from the Greenhouse-Geisser conservative *F* test were reported when analyzing statistical results (refer to table 25).

Table 25

Sphericity Tests by Research Question

	Mauchly's W	*Appx Chi*^{2}	*df*	*p*
Tools (AQ1)	1	0	0	<.01
Methods (AQ2)	1	0	0	<.01
Beliefs – F1 (AQ3)	1	0	0	<.01
Beliefs – F2 (AQ3)	1	0	0	<.01
Beliefs – F3 (AQ3)	1	0	0	<.01

Homogeneity of Covariance Matrices

Box's *M* was significant for tools (AQ1), Box's $M = 20.022$, F (3, 36900) =6.113, $p < .001$ which indicates that the assumption of homogeneity of covariance matrices was violated (refer to table 26). However, because the control group had more participants and bigger variance, the test is more likely robust. Box's *M* was significant for methods (AQ2), Box's $M = 27.809$, F (3, 36900) = 8.49, $p < .001$, which indicates that the assumption of homogeneity of covariance matrices was violated. Additionally, the larger group (control) has a smaller variance so results should be interpreted with caution. For Beliefs Factor 1, Box's *M* was not significant, Box's $M = 5.871$, F (3, 36900) = 1.792, $p = .146$. For Beliefs Factor 2, Box's *M* was not significant, Box's $M = 1.416$, F (3, 36900) = .432, $p = .730$. For Beliefs Factor 3, Box's *M* was not significant, Box's $M = 1.827$, F (3, 36900) =.558, $p = .643$. Results for all three factors indicated that the assumption of homogeneity of covariance matrices was met for ancillary question 3.

Table 26

Homogeneity of Covariance Matrices Tests by Ancillary Question

	Box's *M*	*F*	df_1	df_2	*p*
Tools (AQ1)	20.022	6.113	3	36899.706	<.001
Methods (AQ2)	27.809	8.490	3	36899.706	<.001
Beliefs – F1 (AQ3)	5.871	1.792	3	36899.706	.146
Beliefs – F2 (AQ3)	1.416	.432	3	36899.706	.730
Beliefs – F3 (AQ3)	1.827	.558	3	36899.706	.643

Ancillary Test Results

The previous section regarding assumptions indicates the results of this test should be interpreted with caution due to the violation of the assumption of normality and homogeneity of variances. However, the ANOVA is a robust test (Field, 2009). Effect sizes according to Cohen's values (1988), for small (.01), moderate (.06), large (.14) effect sizes will be reported.

Ancillary Question One

The first ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in how comfortable they are with different manipulatives as compared to parents who do not attend?

There was a large effect size for main effects for the within subjects factor (.147), between-subjects factor (.151), and interaction for the between-within factor (.378) (refer to table 27). There was low observed power for the main effects for the between-subjects factor (.56) and the within-subjects factor (.549), but more than sufficient observed power for the interaction of the between-within factor (.974). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for the interpretations of the statistical analyses for the main effects for the between-subjects factor and within-subjects factor. However, the high power for the interaction for the between-within factor decreases the likelihood of making a Type II error.

There was a statistically significant within-subjects main effect for pretest and posttest (F = 4.667, df = 1, 27, p = .04) (pretest, M = 18.97, SD = 3.977; posttest, M = 19.83, SD = 4.40) (refer to table 27). This statistically significant result suggested that there were mean differences over time regarding comfort level with manipulatives. In addition, there was a statistically significant within-between subjects interaction effect between group and time (F = 16.441, df = 1, 27, p < .001). ($M_{pre\ x\ control}$ = 18.76, SD = 4.28; $M_{pre\ x\ treatment}$ = 19.25, SD = 3.671; $M_{post\ x\ control}$ = 17.65, SD = 4.541; $M_{post\ x\ treatment}$ = 22.92, SD = 1.24). This statistically significant result suggested that there were differences, on average, between groups over time regarding comfort level with manipulatives. Finally, there was a statistically significant between-subjects main effect for treatment and control group (F = 4.795, df = 1, 27, p = .037). The statistically significant result suggested that there were mean differences between groups regarding comfort level with manipulatives.

Table 27

Greenhouse-Geisser Results for Within and Between Subjects Effects for Tools

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	4.667	.04	.147	.549
Within	Time * Group	1	27	16.441	<.001	.378	.974
Between	Group	1	27	4.795	.037	.151	.56

Figure 23 shows the means for the pretest and posttest comparing the treatment and control groups for tools. This provides a visual representation of the statistically significant interaction between time and group as reported from Table 27.

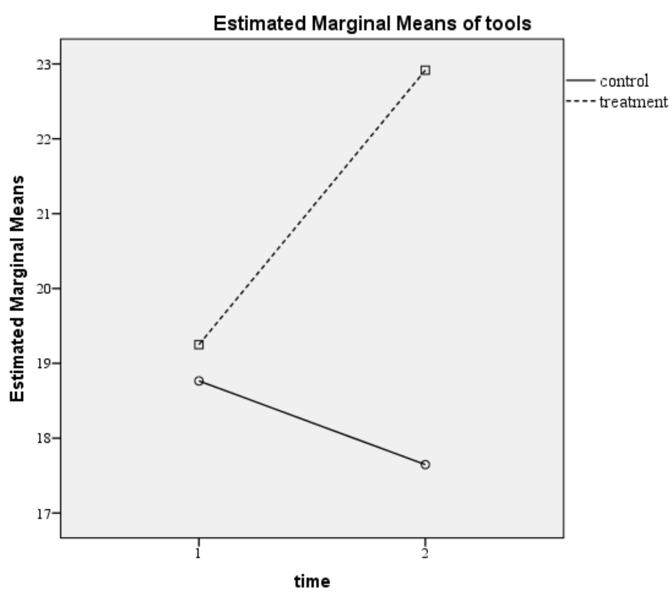


Figure 23: Profile Plot for Tools

Ancillary Question Two

The second ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in using traditional or new methods to solve 2nd, 3rd, and 4th grade mathematics problems, as compared to parents who do not attend?

There was a large effect size for main effects for the within subjects factor (.661), between-subjects factor (.459), and interaction for the between-within factor (.610) (refer to table 28). There was a more than sufficient observed power for the main effects for the between-subjects factor (.996), the within-subjects factor (1.0) and the interaction for the between-within factor (1.0). The high power suggests that the likelihood of obtaining a Type II error (false negative) is decreased for each of these interpretations of the statistical analyses.

There was a statistically significant within-subjects main effect for pretest or posttest (F = 52.67, df = 1, 27, $p < .001$) (pretest, M = .28, SD = .702; posttest, M = 2.66, SD = 3.384) (refer to table 28). The statistically significant result suggested that there were mean differences over time regarding methods participants used to solve problems. In addition, there was a statistically significant within-between subjects interaction effect between group and time (F = 42.235, df = 1, 27, $p < .001$). ($M_{pre\ x\ control}$ = .29, SD = .588; $M_{pre\ x\ treatment}$ = .25, SD = .866; $M_{post\ x\ control}$ = .59, SD = 1.176; $M_{post\ x\ treatment}$ = 5.88, SD = 3.343). This statistically significant result suggested that there were differences, on average, between groups over time regarding methods participants used to solve problems. Finally, there was a statistically significant between-subjects main effect for treatment and control groups (F = 22.886, df = 1, 27, $p < .001$). This statistically significant result suggested that there were mean differences between groups regarding methods participants used to solve problems.

Table 28

Greenhouse-Geisser Results for Within and Between Subjects Effects for Methods

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	52.671	<.001	.661	1.0
Within	Time * Group	1	27	42.235	<.001	.610	1.0
Between	Group	1	27	22.886	<.001	.459	.996

Figure 24 shows the means for the pretest and posttest comparing the treatment and control groups for methods, where "0" denoted more traditional methods, for example the standard algorithm, and "1" denoted new strategies such as regrouping or the use of tools to solve the problem. Participants' solution strategies were analyzed to identify any differences in solving problems using the traditional standard algorithm and new methods discussed in the workshops. This provides a visual representation of the statistically significant interaction between time and group as reported from table 28.

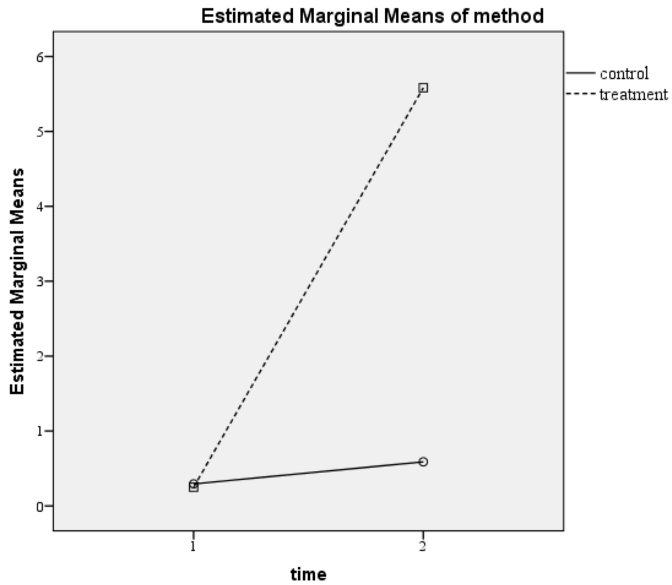


Figure 24: Profile Plot for Methods to Solve Problems

Ancillary Question Three

The third ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their belief factors (1, 2, and 3) about learning mathematics as compared to parents who do not attend? To answer this question each of the three factors were analyzed separately.

The MBS, which was used to analyze research question 2, was split into three factors identified by Capraro (2005). The three factors were student learning (factor 1), stages of learning (factor 2), and teacher practices (factor 3). Results for each of these three factors are reported separately.

Beliefs Factor 1

There was a moderate effect size for main effects for the within-subjects factor (.085) and the interaction for the between-within factor (.085), but a small effect size for main effect for the between-subjects factor (.015) (refer to table 29). There was low observed power for the main effects for the between-subjects factor (.095), the within-subjects factor (.332) and the interaction for the between-within factor (.332). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for each of these interpretations of the statistical analyses.

There was a non-statistically significant within-subjects main effect for pretest and posttest (F = 2.499, df = 1, 27, p = .126) (pretest, M = 14.52, SD = 4.413; posttest, M = 15.34, SD = 4.593) (refer to table 29). The non-statistically significant result suggested that there were no mean differences over time regarding beliefs about student learning. In addition, there was a non-statistically significant within-between subjects interaction effect between group and time (F = 2. 499, df = 1, 27, p = .126). ($M_{pre\ x\ control}$ = 15.35, SD = 5.135; $M_{pre\ x\ treatment}$ = 13.33, SD = 2.934; $M_{post\ x\ control}$ = 15.35, SD = 4.358; $M_{post\ x\ treatment}$ = 15.33, SD = 5.105). This non-statistically significant result suggested that there were no differences, on average, between groups over time regarding beliefs about student learning. Finally, there was a non-statistically significant between-subjects main effect for treatment and control group (F = .413, df = 1, 27, p = .526). This non-statistically significant result suggested that there were no mean differences between groups regarding beliefs about student learning.

Table 29

Greenhouse-Geisser Results for Within and Between Subjects Effects for Belief F1

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	2.499	.126	.085	.332
Within	Time * Group	1	27	2.499	.126	.085	.332
Between	Group	1	27	.413	.526	.015	.095

Figure 25 shows the means for the pretest and posttest comparing the treatment and control groups for beliefs factor 1 (student learning).

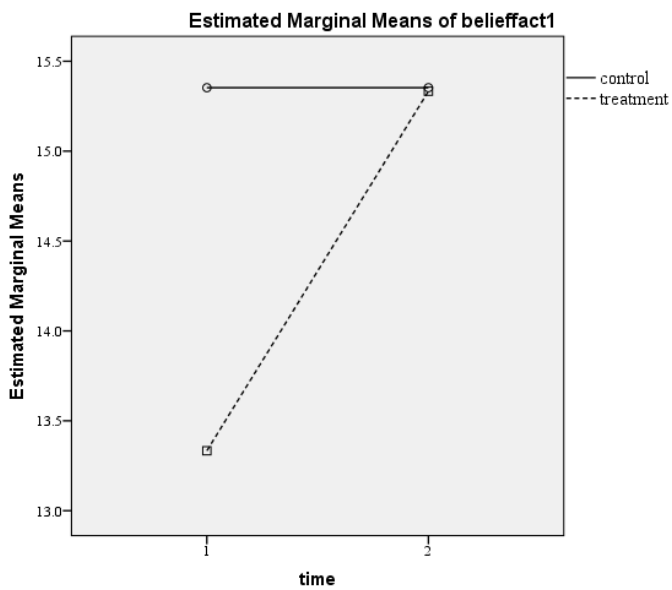


Figure 25: Profile Plot for Beliefs, Factor 1

Beliefs Factor 2

There was a small effect size for main effects for the within subjects factor (.026), between-subjects factor (.006), and the interaction for the between-within factor (.009) (refer to table 30). There was low observed power for the main effects for the between-subjects factor (.069), the within-subjects factor (.129) and the interaction for the between-within factor (.077). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for each of these interpretations of the statistical analyses.

There was a non-statistically significant within-subjects main effect for pretest and posttest (F = .712, df = 1, 27, p = .406) (pretest, M =17, SD = 3.57; posttest, M = 17.52, SD = 3.75) (refer to table 30). The non-statistically significant result suggested that there were no mean differences over time regarding beliefs about stages of learning. In addition, there was a non-statistically significant within-between subject interaction effect between group and time (F = .249, df = 1, 27, p = .622). ($M_{pre\ x\ control}$ = 17.35, SD = 3.89; $M_{pre\ x\ treatment}$ = 16.50, SD = 3.15; $M_{post\ x\ control}$ = 17.59, SD = 4.12; $M_{post\ x\ treatment}$ = 17.42, SD = 3.32). This non-statistically significant result suggested that there were no differences, on average, between groups over time regarding beliefs about stages of learning. Finally, there was a non-statistically significant between-subjects main effect for treatment and control groups (F = .176, df = 1, 27, p = .678). This non-statistically significant result suggested that there were no mean differences between groups regarding beliefs about stages of learning.

Table 30

Greenhouse-Geisser Results for Within and Between Subjects Effects for Belief F2

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	.712	.406	.026	.129
Within	Time * Group	1	27	.249	.622	.009	.077
Between	Group	1	27	.176	.678	.006	.069

Figure 26 shows the means for the pretest and posttest comparing the treatment and control groups for beliefs factor 2 (stages of learning).

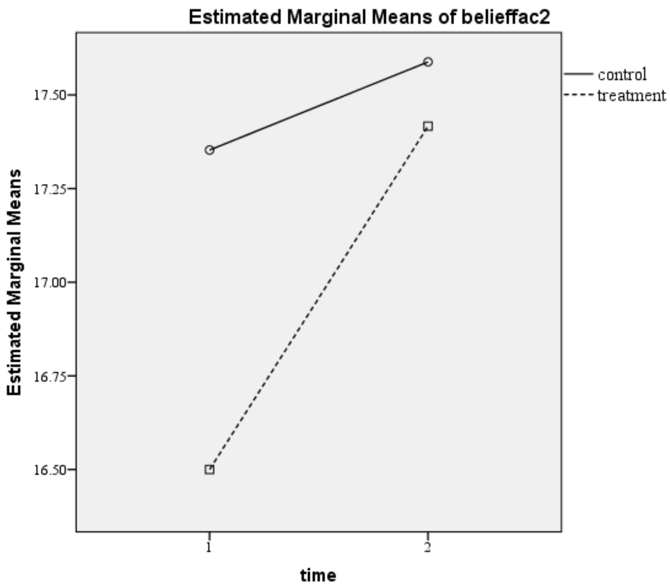


Figure 26: Profile Plot for Beliefs Factor 2

Beliefs Factor 3

There was a small to moderate effect size (.038) for main effects for the within subjects factor, a small effect size (.014) for main effects for the between-subjects factor, and a large effect size (.217) for the interaction for the between-within factor (refer to table 31). There was low observed power for the main effects for the between-subjects factor (.093) and the within-subjects factor (.171), but the observed power for the interaction for the between-within factor was sufficient (.751). The low power suggests that obtaining a Type II error (false negative) is a strong possibility for each of these interpretations of the statistical analyses for main effects. The observed power for the between-within interaction was higher, which would decrease the likelihood of obtaining a Type II error.

There was a non-statistically significant within-subjects main effect for pretest and posttest (F = 1.08, df = 1, 27, p = .308) (pretest, M = 21.51, SD = 3.76; posttest, M = 21.62, SD = 4.07) (refer to table 31). The non-statistically significant result suggested that there were no mean differences over time regarding beliefs about teacher practices. Additionally, there was a non-statistically significant between-subjects main effect for treatment and control group (F = .395, df = 1, 27, p = .535). This non-statistically significant result suggested that there were no mean differences between groups regarding beliefs about teacher practices. On the other hand, there was a statistically significant within-between subject interaction between group and time (F = 7.48, df = 1, 27, p = .011). ($M_{pre\ x\ control}$ = 21.71, SD = 4.18; $M_{pre\ x\ treatment}$ = 20.50, SD = 3.12; $M_{post\ x\ control}$ = 20.47, SD = 4.24; $M_{post\ x\ treatment}$ = 23.25, SD = 3.33). This statistically significant result suggested that there were mean differences, on average between groups over time regarding beliefs about teacher practices.

Table 31

Greenhouse Geisser Results for Within and Between Subjects Effects for Belief F3

Between/ Within	Source	df_1	df_2	F	p	Partial η^2	Power
Within	Time	1	27	1.08	.308	.038	.171
Within	Time * Group	1	27	7.48	.011	.217	.751
Between	Group	1	27	.395	.535	.014	.093

Figure 27 shows the means for the pretest and posttest comparing the treatment and control groups for beliefs, factor 3 (teacher practices). This provides a visual representation of the statistically significant interaction between time and group as reported from Table 31.

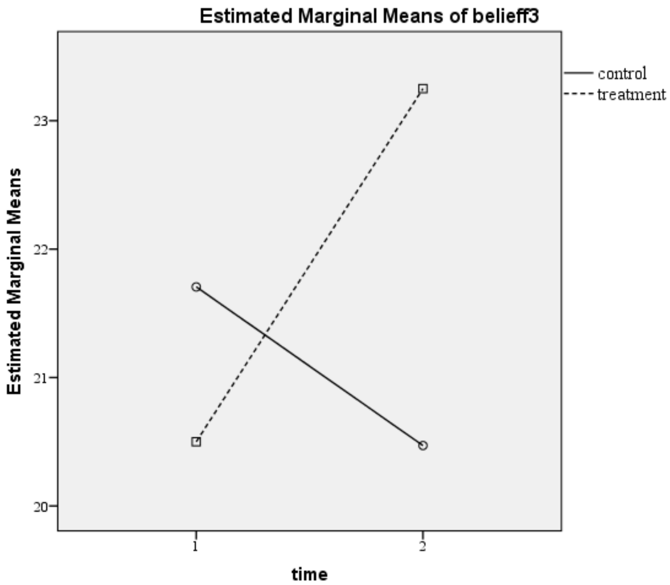


Figure 27: Profile Plot for Beliefs, Factor 3

Summary

Research questions were analyzed in this section and statistical significance indicating the benefits of the workshops for parents were found for beliefs. The following research questions had a large effect size when looking at the statistically significant between-within interaction for beliefs (.201). Additional tests were run to analyze participants' level of comfort with tools, methods they used to solve the problems, and the three different factors for the MBS. Statistical significance indicated that the workshops were beneficial for participants' comfort level with tools, using non-traditional solution strategies to solve problems, and beliefs about teacher practices. Additionally, the following ancillary questions had a large effect size when looking at the statistically significant between-within interaction: tools (.378), methods (.610), and beliefs-factor 3 (.217).

CHAPTER FIVE: SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Introduction

This chapter contains a summary and discussion of the findings, organized by research question. Implications for educational policy and practice are discussed. Finally, the limitations of this study are identified and the potential contributions and recommendations for future research are presented.

Research Question One

The first research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their mathematics content knowledge as compared to parents who do not attend?

There was no statistically significant change in parent content knowledge between groups over time. Participants in the treatment group attempted to use the new strategies and methods from the workshops but did not use the strategies and methods properly. This discrepancy could explain the lack of change of content knowledge mean score in the treatment group, from pretest to posttest. The results indicate that two days of learning about addition, subtraction, multiplication, and division is insufficient for parents to increase their content knowledge as measured by the researcher-created instrument. This finding backs previous research findings where researchers posit nine hours of professional development (PD) may not be enough time to attribute any changes to participation in workshops (Frechtling, 2001; Quint, 2011; Vendlinski et al., 2009). Even though research indicated ongoing PD is better (Frechtling, 2001; Quint, 2011), it was difficult for some parents to commit to two days. Two participants out of the 14 who participated in the workshops did not attend the second session and one participant out of the 18 who participated in the control group did not complete the posttest. Had more sessions been included in the series rather than the two days in the current study, attrition may have been a bigger limitation. Other research findings indicate some PSTs graduate from education programs without the conceptual knowledge about mathematics they need to teach (Ball et al., 2001; Hill et al., 2004; Hill et al., 2008). These PSTs complete programs with at least one semester of a mathematics content or mathematics method course or both, which is considerably more time than the two-day workshops scheduled for parents. This implies that more time is needed to make an impact on increasing mathematics content knowledge parents need to help their children.

Research Question Two

The second research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their beliefs about learning mathematics as compared to parents who do not attend?

Results regarding beliefs were statistically significant between groups and over time with a large effect size (*partial* $\eta^2 = .201$) with the treatment group changing their beliefs to ones that were more focused on students constructing their own knowledge. Participants in the control group did not shift their beliefs from the pretest to posttest. The findings indicate that the workshops had a positive effect on parents' beliefs regarding learning about mathematics. To wit, parents who attended the workshops had beliefs more aligned with the idea that students should learn in a learner-centered environment, compared to parents who did not attend the workshops.

Through participation in the workshops, which were learner focused, parents may have understood the importance of allowing their child to learn mathematics in a student-centered environment instead of one focused on the parent guiding their child to the answer. Previous research indicates beliefs are influenced by a person's experiences (Op't Eynde, DeCorte, & Verschaffel, 2002), one of which could be in an instructional situation (Richardson, 2003). Additionally, the findings in the current study are similar to the study by Civil et al. (2002) who indicated that parents were better prepared to work with their children when they were given opportunities to construct their own knowledge.

Research Question Three

The third research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify whether student responses to 2nd, 3rd, and 4th grade mathematics content are correct as compared to parents who do not attend?

There was no statistically significant change between groups over time. However, there was statistically significant change from pretest to posttest with a large effect size (*partial* η^2 = .141). Parents in both the treatment and control increased their ability to identify correct student responses. Because this instrument was similar to the parent response instrument, it was not surprising these results were comparable to results from research question 1 regarding content knowledge. Questions asked in each instrument were the same. However, the student response instrument included a possible student solution that parents read and decided whether the *student* *response* was correct or incorrect, whereas in the parent response instrument, parents needed to solve the problem using a method with which *they* were familiar. Due to the argument made in previous chapters for the similarity between parents and preservice teachers, and research that posits preservice teachers (PSTs) and inservice teachers (ISTs) have difficulty finding student errors (da Ponte & Chapman, 2006; Simon, 1993), parents might also have difficulty finding errors. Parent solutions in this instrument could have been affected by their responses on the previous instrument. Research indicates that increasing the amount of PD in schools will have a positive impact on the way mathematics is taught (Hawley & Valli, 1999), so the short duration of the workshop may have affected these results. However, parent attrition was taken into consideration when the number of workshop sessions was chosen for the series and the duration of each session.

Research Question Four

The fourth research question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their ability to identify student errors in incorrect solutions for 2^{nd}, 3^{rd}, and 4^{th} grade mathematics content as compared to parents who do not attend?

There was no statistically significant change between groups over time. However, there was statistically significant change from pretest to posttest with a large effect size (*partial* η^2 = .273). This change could be attributed to time between the pretest and posttest and the fact that parents may have learned about the specific errors while helping their children with homework or talking about the questions on the instrument with friends. Even though parents in both groups were able to identify more student errors at posttest, the results indicated that after participating in the workshops parents in the treatment group were able to identify more student errors, the difference was just not statistically significant. During the workshop, possible student errors were identified and discussed, which could have contributed to workshop parents being able to identify more student errors. This is important because previous research indicated teachers have a deeper understanding of mathematics if they understand student solutions (Knapp & Peterson, 1995), which is why the researcher included possible student errors in the workshop curriculum.

The ability to identify the student error was difficult for parents, as some mentioned during the group discussion that they had never done anything like that before. During administration of the "student response instrument," parents were expected to identify where the student made their error in the response. Even preservice teachers (PSTs) and inservice teachers (ISTs) have difficulty finding student errors, and this is an important part of teaching (da Ponte & Chapman, 2006; Simon, 1993). The current study indicates that similar to PSTs and ISTs, parents have difficulty finding student errors. However, after participating in the workshops parents were able to identify more student errors than before the workshops.

Ancillary Question One

The first ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in how comfortable they are with different manipulatives as compared to parents who do not attend?

There was a statistically significant change between groups over time with a large effect size (*partial* η^2 = .378). Parents completed a one-page questionnaire regarding how comfortable they were with different tools; specifically base ten blocks, part-part-whole mats, open number lines, ten frames, hundred charts, and arrays. Self-reported comfort levels for parents in the treatment group were higher at posttest, which indicated these parents were more comfortable using manipulatives after the workshops. The results indicate that these workshops may have helped to increase parent's comfort level with using these manipulatives, even with the short amount of time they participated in the workshops. Previous research on teachers indicated that many feel like they did not have opportunities to learn how to use manipulatives (McIntosh, 2012; Swan & Marshall, 2010), which is why parents were given manipulatives to make sense of the mathematics in this research.

The increase in comfort level could be attributed to parents in the workshop being able to engage in using those tools because they participated in the workshops, whereas the control group did not participate in the workshops. Both the treatment and control groups received the math kit after taking the posttests. The results align with research by Knapp et al. (2013) who claimed that when parents explored mathematics using manipulatives during a workshop series for 8 weeks, two hours each week, the parents were more comfortable with them and used them more often. The workshops in the current study indicate even a short duration, specifically two days, may have some benefits.

Ancillary Question Two

The second ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in using traditional or new methods to solve 2nd, 3rd, and 4th grade mathematics problems, as compared to parents who do not attend?

There was a statistically significant change between groups over time with a large effect size (*partial* η^2 = .610). Even though both treatment and control groups solved more problems using new strategies on the posttest than pretest, the change from pretest to posttest for the treatment group was bigger than the control group on the posttest. In other words, parents who attended the workshops chose to solve more problems using new methods for the posttest than parents who did not attend the workshops. These statistically significant results indicate that participation in the workshops may have influenced the choice parents made when they chose which method to use to solve problems. Instead of the traditional algorithm used to solve problems on the pretest, more parents used new strategies that were discussed in the workshops on the posttest. Both the treatment and control groups used traditional methods to solve problems on the pretest for the parent response instrument, specifically the standard algorithm. However, many parents in the treatment group used methods that were discussed in the workshop as strategies their child might use to solve the problems at the posttest, whereas not as many in the control group did. Teachers have a deeper understanding of mathematics if they understand student solutions (Knapp & Peterson, 1995). This research could lead to similar results if the sample were parents, due to the argument made previously about their similarities in this situation.

The drawback for this was that some parents who used new strategies made errors in their solution strategies, which affected their content knowledge score. The errors participants made were typically conceptual, for example using “compensating” but instead of adding “1” they subtracted. For example, one parent subtracted 237 – 169 by rounding 169 up to 170 with a result of 67. Instead of realizing their new difference was too small by “1” and they should add it back to 67, the parent subtracted 67 – 1 and got 66 as an answer (see figure 19). This error might indicate that the parent either did not have a deep understanding of this method, or made a careless mistake because they were trying to complete the assessments quickly.

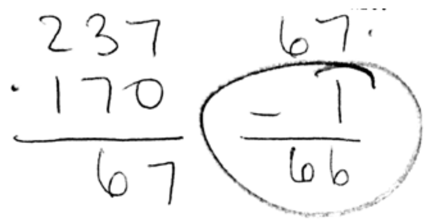


Figure 28: Parent solution strategy for problem # 6 (compensating)

Additionally, when solving 19 x 14 using repeated addition, one parent repeated 14 an incorrect number of times. The parent added 18 groups of 14 when the parent should have added 19 groups of 14. These mistakes still resulted in no credit for those problems being correct, so affected the content knowledge score. More time with these strategies, a larger sample size, or a different instrument might have had a different outcome on the measure of parents' content knowledge. However, even with the short duration of the workshops, there was a statistically significant change in the methods parents chose to use to solve the problems. On the other hand, careless mistakes may have affected whether or not the parent arrived at the correct answer. Furthermore, a larger sample size would have made these errors less influential. Finally, if the instrument would have been multiple choice instead of open-ended, parents might have found their error by looking at possible answers before moving onto the next problem.

Ancillary Question Three

The third ancillary question was: To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their belief factors (1, 2, and 3) about learning mathematics as compared to parents who do not attend?

There was no statistically significant change between groups over time for factor 1 (student learning) and factor 2 (stages of learning), but there was a statistically significant change between groups over time for factor 3 (teacher practices) with a large effect size (*partial* η^2 = .217). Parents in the treatment group had beliefs that leaned more towards students learning about mathematics in a learner-centered environment after completing the workshops. Parents in the control group did not shift their beliefs from the pretest to the posttest. This indicates that the workshops may have shifted parents' beliefs about student learning to beliefs that students should learn in a learner-centered environment.

These statistically significant results indicate that parents may have shifted beliefs about student learning through participation in workshops. This supports previous findings that belief change could occur through participation in an instructional situations (Richardson, 2003). This significance could be explained due to the fact that parents were participating as learners in a student-centered environment, which was different from the direct instruction they may have experienced as young learners (Garland, 2014; Richards, 2014). Furthermore, each factor of the MBS was analyzed using a two-factor split-plot ANOVA. Through participation in the workshops, which were learner focused, parents may have understood the importance of allowing their child to learn mathematics in a student-centered environment instead of one focused on the parent guiding their child to the answer. This aligns with previous findings that beliefs are influenced by a person's experiences (Op't Eynde, DeCorte, & Verschaffel, 2002). Additionally, the findings in the current study are similar to the study by Civil et al. (2002) who indicated that parents were better prepared to work with their children when they were given opportunities to construct their own knowledge. Even though the duration of the workshops were short, findings in the current study are similar to the study by Civil et al. (2002) who indicated that parents were better prepared to work with their children when they were given opportunities to construct their own knowledge.

This research study demonstrated the benefit of programs focused on helping parents understand mathematics strategies their child may use. As discussed in chapter four, there was no statistically significant difference between the treatment and control group from pretest to posttest regarding parents' change in content knowledge, ability to identify correct student responses, and their ability to identify the student error following the intervention. However, there was statistical significance between groups and over time regarding beliefs, comfort level with tools, and methods used to solve problems. These results are consistent with those of Civil et al. (2002) regarding teacher beliefs, Knapp et al. (2013) regarding tools, and (Vendlinski et al., 2009) regarding solving problems.

Implications

Social media outlets indicate parents are frustrated with the way their child is learning mathematics, such as the multiple solution strategies students need to understand how to use and the strategies that seem to include unnecessary steps (Cleveland, 2014; Decarr, 2014; Garland, 2014; Richards, 2014). This is important because when a child is at home, his or her parents may take on the role of teacher. Parents want to help their child with homework, but only have their personal experiences, which are often very procedural, upon which to base the support they provide (Garland, 2014; Richards, 2014). The results of this study suggest that parents could benefit from workshops regarding a shift in beliefs towards students constructing their own knowledge, using strategies similar to the ones their child uses, and feeling more comfortable with different manipulatives.

Therefore, parent workshops that include parents engaging in the mathematics their child is learning by using similar strategies are warranted. These workshops should include using multiple strategies and becoming more familiar with the manipulatives (Knapp et al., 2013; Syropoulos, 1982). By helping parents through workshops focused on parents as learners in a learner-focused environment where there is an expectation that learners make sense of each other's solutions, parents are experiencing mathematics in ways consistent with how their child is learning (Mistretta, 2013; Whiteford, 1998). This will help the parents understand what their child experiences in the classroom so that parents can make sense of their child's solution strategies instead of encouraging their child to use the strategy that makes the most sense to the parents.

It is recommended that mathematics be taught in ways that may be different from when parents were in elementary school, and these workshops may help parents understand how and why mathematics should be taught in these ways (Knapp et al., 2013). Preservice teachers may have opportunities to learn these strategies while they are enrolled in a university program. Inservice teachers have professional development and other resources in the school that may help (FCTM, 2015; NCTM, 2015; WMC, 2015), but parents who want to help their child with homework may not have the same accessibility to resources (Associated Press, 2014). While there are websites parents can peruse and pamphlets they can read, parents may not have been taught mathematics by engaging in it using manipulatives and multiple strategies, unlike current preservice and inservice teachers going through educational programs or in PD settings.

Additionally, this research could be implemented in undergraduate and graduate programs. If PSTs and ISTs are involved in this type of research, they might have a better understanding of why it is important to get parents involved in this manner. This could in turn help teachers determine common errors students might bring to whole class discussions, and why those errors arise by allowing parents to share solution strategies. An additional study could be conducted to determine how participation in the workshops affected student achievement. Parents may be the biggest supporter for a teacher when working with their child on homework, but parents need the tools that will be most helpful.

The goal of this workshop series was to offer support to parents so they can better assist their children, similar to previous research studies (Civil et al., 2002; Cotton, 2014; Knapp et al., 2013; Kreinberg, 1989; Marshall & Swan, 2010; Ochoa & Mardirosian, 1996; Whiteford, 1998). However, this research is different from previous studies as parents' content knowledge was measured through administration of an instrument, which included questions similar to what their children may see on homework. This research could be extended by offering different workshops to parents of elementary students in different grades as well as in other locations (this study was situated in central Florida) in addition to implementing a longer PD, to determine if similar results are reported.

These workshops were implemented at another school and due to the larger sample size, more time was spent on sharing solution strategies. There were 23 participants and the entire first two-hour session and some of the second session was spent working on addition and subtraction problems. Because the researcher did not want to rush though the material, additional days were offered. Currently there have been three two-hour sessions and division has not been discussed at this time. If others are attempting to replicate this study, the sample size should be taken into account to anticipate the amount of time that might be spent on sharing strategies, or fewer strategies should be shared. Due to the focus on depth of strategies, and the flexibility to continue to offer more sessions, the researcher maintained the depth of content to be the focus for the workshops.

Limitations

One limitation of this research was that participants completed a pre and post belief instrument, where their beliefs were self-reported. Researchers have found that teachers need to be observed multiple times to determine their underlying beliefs, which can be different from their self-reported beliefs (Charalambous, Philippou, & Kyriakides, 2008, Cross 2009; Cross & Hong, 2012; Leatham, 2006). Due to the similarities of teachers and parents regarding helping a student with a mathematical task, this may be true for parents as well. Because the parents were asked to fill out the instrument using self-report, their underlying beliefs may not have been apparent.

Various threats to internal validity are present in the current study. More specifically, instrumentation validity may be a threat because while there was some evidence supporting the reliability and validity of the abbreviated MBS (Capraro, 2005), this instrument was not tested on parents. Further, the researcher-created parent and student response instruments were not explicitly evaluated for validity and reliability. To address the researcher-created instruments' limitation, experienced education and research faculty, with extensive knowledge in research instrumentation, reviewed the instruments, which supports some form of validity. Additionally, the small sample size in the current study did not support testing statistical validity and reliability evidence for the scores from the instruments.

The parents in the study did not represent a random sample because they were selected based on convenience and self-selection, which may have introduced self-selection bias. Additionally, subject attrition was an issue because of the 32 participants who completed pretest instruments three (9%) did not complete the posttest. To help reduce attrition, participants were provided with light refreshments at each session, and parents who attended both sessions and completed the instruments were provided a math kit after the posttest. This math kit included a small set of base ten blocks, a handout that included pictures of the different tools discussed in the workshops, and a few mathematics games to play that could help increase procedural fluency for their child.

The lack of random selection from the population limits the generalizability of the study findings. Because the sample was small and non-random, results from the current study may be limited in generalizability to similar contexts and populations. Additional workshops will need to be conducted and data will need to be collected and analyzed in different parts of the country to be able to generalize these findings.

Recommendations for Future Research

This research study had some findings that indicated that workshops for parents could help parents to: (a) shift beliefs to those that are more focused on a learner-centered environment when working on mathematics; (b) increase their awareness of and comfort level with different tools; and (c) change the way they solve problems towards strategies that students may be learning about in the classroom instead of only using the standard algorithm. However, the short amount of time parents participated in the workshops should be taken into consideration when analyzing results. Research posits prolonged workshops are more beneficial (Frechtling, 2001; Quint, 2011), and to make these findings more meaningful a longer workshop series should be provided for parents.

Parent responses, including solution strategies used and identification of student errors, could be analyzed to add a qualitative component. Parent strategies could be analyzed in depth to determine if parents used similar strategies when solving each question, if parents used similar strategies on all questions on the instrument, and which strategies were used if they wrote an incorrect answer. For the second part of the researcher-created instrument, parents' responses to the student error could be analyzed because the instrument prompted parents to identify the student error through explanation.

These workshops addressed whole number concepts and operations, with a focus on 2^{nd}, 3^{rd}, and 4^{th} grade standards (CCSS, 2015), but other topics could be included. Sessions could also address topics such as counting and cardinality, fractions, measurement, statistics, geometry or any other topic taught to students in ways different from how parents learned. Parents need the opportunity to engage in the mathematics as their child does, so they are better prepared when their child asks for help (Mistretta, 2013; Whiteford, 1998).

Only three schools were invited to participate to maintain commonalities in school demographics, but in order to gain a bigger population more schools could be included. Determining evidence of score reliability and validity is also suggested. Finding a central location may be key to offering more workshops to a bigger population. Parent response to the flyer indicated the two most convenient times for participants in the current research were the night sessions (6 - 8) and the morning sessions (9 - 11).

Additional research could be conducted by including students in a future version of the workshop, which is similar to the structure of previous workshops (Ginsburg et al., 2008; Kreinberg, 1989; Mistretta, 2013). However, more time for each session may be needed so there is sufficient time to observe and interact with each parent and child. Observing how the parent interacts with his or her child as they work through mathematics problems together could help to gain insight into the collaboration between parent and child, similar to previous research (Mistretta, 2013). If students are not invited to participate in the workshops, a recording of these interactions could be included in future versions of the workshop to make workshops more meaningful. This is similar to the component of CGI workshops where teachers interview students to gain a better understanding of the child's thinking process (Franke et al., 2009).

The schools that participated in the current study were not Title 1 schools, but future research could be conducted at a Title 1 school. Previous research studies on parent workshops that focused on low-income schools (Ochoa & Mardirosian, 1996) indicated that parents found workshops beneficial when helping their child with homework. The workshops in this study could be offered at schools serving a low-income population to determine if the content would affect parents in a way similar to the way parents in the current study were affected.

Furthermore, this research could be extended to preservice teachers by administering the student response instrument and the parent response instrument to obtain a larger sample size, one that would be sufficient to run reliability and validity tests. Even though participants in this sample may not be parents, reliability and validity tests could be run on the researcher-created instruments and connections could be made to the reliability and validity of the instruments in the current study due to the similarities between preservice teachers and parents.

Summary

This section discussed results from the study, implications, limitations, potential contributions, and recommendations for future research. This research implies the need for more parent workshops to help parents understand the new mathematics strategies their child is using to solve problems. Although the duration of the workshops was short, a total of three hours, parents who participated in the workshops showed shifts in beliefs, comfort with tools, and methods used. Parents are frustrated with the new strategies their children are using to solve problems (Cleveland, 2014; Decarr, 2014; Garland, 2014; Richards, 2014). Many parents in the workshops used the strategies they learned in the workshop sessions to solve problems on the posttest. This demonstrates that parents attempted to make sense of different strategies their child may be using to solve mathematics problems, which makes a case for continued research in this area.

APPENDIX A: OPEN ENDED RESPONSES

I hope to continue providing workshops like these to parents, but due to this being the first group of sessions your feedback is important. Please answer the following questions:

What did you like most? What did you like least?

Would you attend a workshop like this again? YES NO

What suggestions do you have that would make this better for parents in the future?

APPENDIX B: INSTITUTIONAL REVIEW BOARD APPROVAL

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Heidi A. Eisenreich**

Date: **April 29, 2015**

Dear Researcher:

On 04/29/2015, the IRB approved the following minor modifications to human participant research until 04/09/2016 inclusive:

Type of Review:	IRB Addendum and Modification Request Form
Modification Type:	The study will not consist of two parent workshops. A revised protocol and other documents have been uploaded to the study in iRIS. A revised Informed Consent document has been approved for use.
Project Title:	Math Workshops for Parents of 1st, 2nd, and 3rd Grade Students
Investigator:	Heidi A Eisenreich
IRB Number:	SBE-15-11215
Funding Agency:	
Grant Title:	
Research ID:	na

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 04/09/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Joanne Muratori

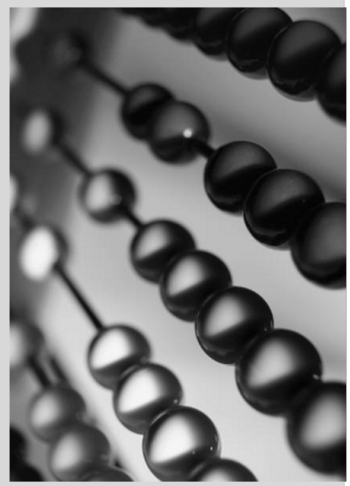
Signature applied by Joanne Muratori on 04/29/2015 03:42:25 PM EDT

IRB manager

APPENDIX C: FLYER

Parent Workshop:

A fun and engaging way to learn about different addition, subtraction, multiplication, and division strategies



Are you a parent of a 1st, 2nd, or 3rd grader?

Do the math strategies your child comes home with confuse you?

Do you want a math kit (valued at $10) to take with you?

Parents of 1st, 2nd, and 3rd graders are invited to attend a workshop series at no cost to you entitled:

"Addition, Subtraction, Multiplication, and Division Strategies: A Guide for Parents"

In this interactive workshop series you will learn about and practice different addition, subtraction, multiplication, and division strategies that you can use to help your child with their homework. Snacks will be provided. Workshop participants who attend both sessions and complete the pre and post assessments will be given a math kit (valued at $10) to take home during the final session. For greater convenience, participants can elect to attend one of the following series (held at [redacted]).

Series 1: Tuesday May 26 and Tuesday June 2: 3:30-5:30pm
Series 2: Tuesday May 26 and Tuesday June 2: 6-8pm
Series 3: Tuesday May 26 and Thursday May 28: 9-11am
Series 4: Wednesday May 27 and Thursday May 28: 9-11am

If you cannot attend the workshops but would still like a math kit to take home, you can participate in the *non-workshop group* by completing pre and post assessments during the dates and times listed below (please allow 45 minutes each of the two times you come). Non-workshop group participants who complete both the pre and posttests will be given a math kit (valued at $10) after the posttest is completed.

Non-workshop Parent Information: Please choose one pre and one post date		
Assessment	**Dates**	**Time**
Pre	May 1, 4, 11, 12, 13, 14, 15	8am-6pm
	May 14 (STEM night)	5-9pm
Post	About 1-2 weeks after your pretest	TBD

All workshop series and non-workshop group participation will be offered at [redacted]

Please RSVP to participate in the workshop series or the non-workshop group, or ask any questions via email to heisenreich@knights.ucf.edu.

APPENDIX D: INFORMED CONSENT

Math Workshops for Parents of 1st, 2nd, and 3rd Grade Students

Informed Consent

Principal Investigator: Heidi Eisenreich, Doctoral Candidate

Faculty Advisor: Juli Dixon, PhD

Investigational Site(s): [redacted]

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 150 people at [redacted] You have been asked to take part in this research study because you are the parent of a 1st, 2nd, or 3rd grade student at [redacted]. You must be 18 years of age or older to be included in the study.

The person doing this research is Heidi Eisenreich of UCF. Because the researcher is a doctoral student, she is being guided by Dr. Juli Dixon, a UCF faculty advisor in Mathematics Education.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of these two workshops is to help parents of 1st, 2nd, and 3rd grade students understand different math strategies.

What you will be asked to do in the study:
<u>For the treatment group</u>: During the first workshop, which will deal with addition and subtraction strategies, parents will complete surveys about their background and knowledge and beliefs in regards to learning about mathematics. During the second workshop, which will deal with multiplication and division strategies, parents will complete surveys about their knowledge and beliefs in regard to learning about mathematics, and a follow up survey related to the workshops. Each workshop will last no more than two hours, which will include the amount of time needed to complete the surveys.

For the control group: Participants will be asked to complete a pretest and posttest about their background and knowledge and beliefs in regard to learning about mathematics before the first treatment group's first workshop, and then around the last treatment group's second workshop.

Location: [redacted]

Time required: You will be in this research study for 2 days, (May 12 and 19) OR (May 26 and June 2) for 2 hours each of the two sessions, so a total of 4 hours. If you are part of the non-research group you will need to come two different times to complete pre and posttests, for no more than 45 minutes each time.

Risks: There are no foreseeable risks involved with this study, but one possible risk could be frustration, due to the fact that adults were not taught the same way students are being taught. These workshops attempt to lessen that frustration.

Benefits: We cannot promise any benefits to you or others from your taking part in this research, but possible benefits could include an increased knowledge and less frustration with the different strategies your child is using as well as gaining a deeper understanding of the math your child is learning.

Compensation or payment: Refreshments will be provided and a math kit will be distributed to parents in the workshop group who attend both session and complete the pre and post. Parents in the non-workshop group will receive the math kit if they complete the pre and the post test.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints contact Heidi Eisenreich, Doctoral Candidate, University of Central Florida at [redacted] or [redacted] or Dr. Juli Dixon, Faculty Supervisor, University of Central Florida at [redacted]

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study If you decide to leave the study, contact the investigator so that the investigator can remove your information from the study. You can email or call using the information above, or speak to her during one of the workshops.

APPENDIX E: MATHEMATICS BELIEF SCALES

Mathematics Beliefs Scales   Name____________________

For the statements below, indicate your agreement or disagreement by checking the box that best expresses what you think about the statement. Your replies to these statements can range from **strongly agree to strongly disagree.**		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1.	**Teachers should encourage children to find their own solutions to math problems even if they are inefficient.**					
2.	Teachers should teach exact procedures for solving word problems.					
3.	**Mathematics should be presented to children in such a way that they can discover relationships for themselves.**					
4.	Most young children have to be shown how to solve simple word problems.					
5.	**Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).**					
6.	Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.					
7.	**Children should understand computational procedures before they master them.**					
8.	Children learn math best by attending to the teacher's explanations.					
9.	**Time should be spent practicing computational procedures before children are expected to understand the procedures.**					
10.	The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.					
11.	**Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution.**					
12.	Most young children can figure out a way to solve many mathematics problems without any adult help.					
13.	**Teachers should allow children to figure out their own ways to solve simple word problems.**					
14.	Children should not solve simple word problems until they have mastered some number facts.					
15.	**Time should be spent practicing computational procedures before children spend much time solving problems.**					
16.	To be successful in mathematics, a child must be a good listener.					
17.	**Children need explicit instruction on how to solve word problems.**					
18.	Children should master computational procedures before they are expected to understand how those procedures work.					

APPENDIX F: DEMOGRAPHIC INSTRUMENT

Demographic Questions   School______________________________

1. What is your gender?

☐ **Male**
☐ **Female**

2. Please answer BOTH part (a) about Hispanic origin and part (b) about race. For this survey, Hispanic origins are not races.

a. Are you of Hispanic, Latino, or Spanish, origin?
☐ No, not of Hispanic, Latino, or Spanish origin
☐ Yes, Mexican, Mexican American, Chicano
☐ Yes, Puerto Rican
☐ Yes, Cuban
☐ Yes, another Hispanic, Latino, or Spanish origin (identify)_________________

b. What is your race? (Check all that apply)

☐ **White**
☐ **Black, African American, or Negro**
☐ **American Indian or Alaska Native**
☐ **Asian Indian**
☐ **Chinese**
☐ **Filipino**
☐ **Japanese**
☐ **Korean**
☐ **Vietnamese**
☐ **Other Asian (please identify)**_________________
☐ **Native Hawaiian**
☐ **Guamanian or Chamorro**
☐ **Samoan**
☐ **Other Pacific Islander (please identify)**_________________
☐ **Other Race (Please identify)**_______________

3. What is your age?

☐ Under 18
☐ 18-25
☐ 26-35
☐ 36-45
☐ 46-55
☐ 56-65
☐ 65 or over

4. What is your marital status?

☐ **Separated**
☐ **Divorced**
☐ **Widowed**
☐ **Single or never been married**
☐ **Married or domestic partnership**
☐ **Other (please identify)**______________

Please&continue&on&the&next&page.&

II

5. Including yourself, how many people live in your household?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ More than 6 (please identify)___________

6. In which grades do you have children? (Select all that apply)

- ☐ **Not in school yet**
- ☐ **Pre-K**
- ☐ **Kindergarten**
- ☐ **First**
- ☐ **Second**
- ☐ **Third**
- ☐ **Fourth**
- ☐ **Fifth**
- ☐ **Sixth**
- ☐ **Seventh**
- ☐ **Eighth**
- ☐ **High School (Identify which grade (s)**___________
- ☐ **College (Identify which year (s)**_______________

7. What is the highest degree or level of school you have ***completed***?

- ☐ Some high school
- ☐ High school diploma or GED
- ☐ Some college
- ☐ Trade/ technical/ vocational degree
- ☐ Associate degree
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Professional or specialist degree
- ☐ Doctorate degree
- ☐ Other (please identify)__________________

8. What is your current employment status?

- ☐ **Employed full-time**
- ☐ **Employed part-time**
- ☐ **Not employed and *not* seeking work**
- ☐ **Not employed but seeking work**
- ☐ **Retired**
- ☐ **Other (please identify)**_________

9. Does your child bring home math homework?

- ☐ Yes
- ☐ No

If yes, how often do you help him or her?

- ☐ Never
- ☐ Once a week
- ☐ 2 times each week
- ☐ 3 times each week
- ☐ 4 times each week
- ☐ Every day

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
10.	**For the following two statements, indicate your agreement or disagreement by checking the box that best expresses what you think about the statement. Your replies to these statements can range from strongly agree to strongly disagree.**					
	a. Helping my child with math homework is a positive experience.					
	b. I am confident with my math ability when my child asks for help on his or her math homework.					

11. Are you currently, or have you ever been, employed in a teaching-related position?

- ☐ Yes (Please specify__________________)
- ☐ No

12. Was/ Is your major or minor related to K-12 education?

- ☐ **Yes (Please specify__________________)**
- ☐ **No**
- ☐ **I have never attended college**

13. Are you currently, or have you ever been, employed in a math or science related position?

- ☐ Yes (Please specify   )
- ☐ No

14. Was/ Is your major or minor related to math or science?

- ☐ **Yes (Please specify__________________)**
- ☐ **No**
- ☐ **I have never attended college**

15. How satisfied are you with the implementation of the Common Core State Standards?

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Very Dissatisfied

16. If a parent workshop for elementary math were offered, would you attend?

- ☐ **Yes (if so, what specifically would you like to learn about? Please respond below)**
- ☐ **No**

Thank you for completing this questionnaire.

APPENDIX G: COGNITIVE INTERVIEW PROTOCOL

Cognitive Interview Protocol

Notes from observing them reading through the test and solving the problems.

Is it clear they are evaluating the student solution?

Is it clear they should explain the mistake if they understand it? Not a paragraph but just circle in the problem or one quick statement

What do you think about the layout?

Are the strategies that students use different in each problem?

Do the directions make sense?

Do the questions make sense?

Do the solutions make sense? Do they need to have more explanation/justification?

Are there any words that need to be better explained? For example a word that you don't know the definition of?

Which option for parents to respond?

Why?

Changes:

APPENDIX H: PARENT RESPONSES CONTENT TEST

Name______________________________

Math for Parents Survey: Content Test

Please answer these questions to the best of your ability. In addition to your solutions, show all work on this page. Please do not use a calculator at any time.

1. Luke counted 243 using his base ten blocks and counted 2 hundreds, 4 tens, and 3 ones. What would be different way to represent 243?

Answer____________________

2. Jessi made 74 bracelets over summer break and then sold some. Now she has 45 bracelets left. How many bracelets did she sell?

Answer____________________

3. Isabel had 186 pieces of candy. She divided the pieces of candy equally among the 6 students in the class. How many pieces of candy will each person get?

Answer____________________

4. Andy is helping his dad plant pumpkins. They want to plant 8 rows of 23 pumpkins. How many pumpkins will they plant?

Answer___________________

5. Justin had 58 toy cars. He bought some more toy cars. Now he has 184 toy cars. How many toy cars did Justin buy?

Answer___________________

6. Lexi had some marbles. She bought 169 more marbles. Now she has 237 marbles. How many marbles did Lexi have to start?

Answer___________________

7. Sam completed 67 math problems last week. Jamie completed 2 more than Sam. How many math problems did they complete altogether?

Answer___________________

8. There are 14 bowls on the table. Each bowl has 19 blueberries in it. How many blueberries are there in all?

Answer___________________

9. 483 students are going to Sea World for a field trip. 249 are girls and the rest are boys. How many boys are going to Sea World?

Answer___________________

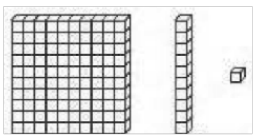
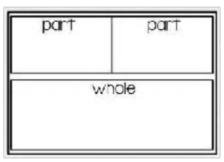
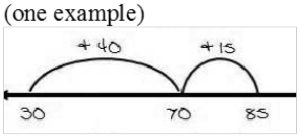
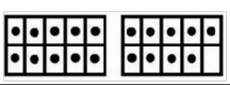
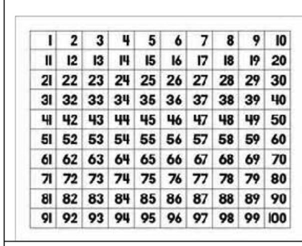
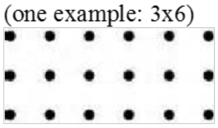
10. A honeybee is an insect. It has 6 legs. How many more legs do 13 honeybees have than 9 honeybees?

Answer___________________

11. A pet store has 56 kittens and plans to put 4 kittens in each cage. If the pet store has 6 cages, how many more cages will the pet store need?

Answer___________________

12. Look at each concrete tool (manipulative) illustrated in the left column, and place a checkmark for the response that indicates your comfort level with the tool.

	I've heard of this tool and can solve problems using it	I've heard of this tool and somewhat understand how to use it	I've heard of this tool but don't know how to use it	I've never heard of this tool
Base 10 blocks 				
Part-part-whole mat 				
Open number line (one example)  Ten frames 				
Hundreds Chart 				
Array (one example: 3x6) 				

Thank you for completing this survey.

APPENDIX I: STUDENT RESPONSES CONTENT TEST

Name___________________

Math for Parents: Student Responses

The purpose of this survey is to determine how parents make sense of student responses when helping them with homework. These questions are *two part questions*. Each question begins with a math problem that could be posed to students and each problem is then followed by one possible student solution. *Please respond to both parts (a)* ***and*** *(b) even if you do not know how to solve the problem.* It is important to know how you think about these mathematics problems. If you circle INCORRECT and YES, in the space provided, describe the mistake that you saw in the student's solution. An example of an INCORRECT and YES response is below. You may do calculations on the side of the paper, but please do not use a calculator at any time.

Example

Problem posed to students:

Using the clock below, what time is it?

Student Solution
"The time on the clock is 1:50."

a. The student's answer is: (circle one)

CORRECT **INCORRECT** **NOT SURE**

b. Do you understand how the student solved it? (circle one)

YES **NO**

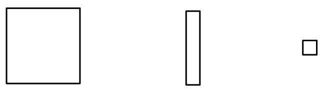
If the student made a mistake and you understand what it is, please identify:

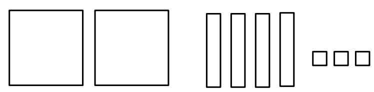
The student mixed up the long and short hand on the clock.

Please&continue&on&the&next&page.&

1. Problem posed to students:

Luke counted 243 using his base ten blocks and counted 2 hundreds, 4 tens, and 3 ones. What would be different way to represent 243?





ES **NO**

If the student made a mistake and you understand what it is, please describe the error.

Please continue on the next page.

2. Problem posed to students:

Jessi made 74 bracelets over summer break and then sold some. Now she has 45 bracelets left. How many bracelets did she sell?

Student Solution

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

"I can use the hundreds chart and start at 74. I can move up 3 spaces and one to the right to get to 45.

She sold 31 bracelets."

a. The student's answer is: (circle one)

CORRECT **INCORRECT** **NOT SURE**

b. Do you understand how the student solved it? (circle one)

YES **NO**

If the student made a mistake and you understand what it is, please describe the error.

Please&continue&on&the&next&page.&

3. Problem posed to students:

Isabel had 186 pieces of candy. She divided the pieces of candy equally among the 6 students in the class. How many pieces of candy will each person get?

Student Solution

dent made a mistake and you understand what it is, please describe the error.

Please continue on the next page.

4. Problem posed to students:

Andy is helping his dad plant pumpkins. They want to plant 8 rows of 23 pumpkins. How many pumpkins will they plant?

Student Solution

at it is, please describe the error.

Please continue on the next page.

5. Problem posed to students:

Justin had 58 toy cars. He bought some more toy cars. Now he has 184 toy cars. How many toy cars did Justin buy?

Student Solution

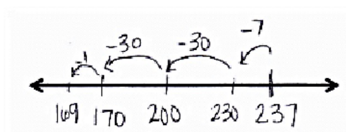
student made a mistake and you understand what it is, please describe the error.

Please continue on the next page.

6. Problem posed to students:

Lexi had some marbles. She bought 169 more marbles. Now she has 237 marbles. How many marbles did Lexi have to start?

Student Solution



"I can use an open number line by counting back from 237.

I can subtract 7 to get to 230, then I can subtract 30 more to get to 200.

Then I can take 30 more away to get 170. I still need to take 1 more away so I can subtract 1 from 170 to get 169.

Lexi started with 169 marbles."

a. The student's answer is: (circle one)

CORRECT **INCORRECT** **NOT SURE**

b. Do you understand how the student solved it? (circle one)

YES **NO**

If the student made a mistake and you understand what it is, please describe the error.

Please&continue&on&the&next&page.&

7. Problem posed to students:

Sam completed 67 math problems last week. Jamie completed 2 more than Sam. How many math problems did they complete altogether?

Student Solution

ror.

Please continue on the next page.

8. Problem posed to students:

There are 14 bowls on the table. Each bowl has 19 blueberries in it. How many blueberries are there in all?

Student Solution

and what it is, please describe the error.

Please continue on the next page.

9. Problem posed to students:

Some boys and girls are going to Sea World on a field trip. If there are 483 students, and 249 are girls, how many boys are going to Sea World?

Student Solution

Part	**Part**
249	
Whole	
483	

"I used a part-part-whole mat to determine that I need to find 249 + ? = 483.

To make this problem easier I can write it as 250 + ? = 483.

If I take 250 and add 200 I get 450. 450+30=480. 480+3=483 so I added 233.

Because I originally added 1 to 249, I need to subtract 1 from 233.

There are 232 boys."

a. The student's answer is: (circle one)

CORRECT **INCORRECT** **NOT SURE**

b. Do you understand how the student solved it? (circle one)

YES **NO**

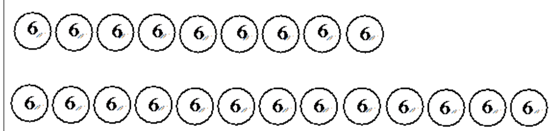
If the student made a mistake and you understand what it is, please describe the error.

Please&continue&on&the&next&page.&

10. Problem posed to students:

A honeybee is an insect. It has 6 legs. How many more legs do 13 honeybees have than 9 honeybees?

Student Solution



"Each honeybee has 6 legs, so each circle represents 6.

In my model I can cross out 9 circles from both because one circle is one honeybee.

I am left with 4 honeybees so I need to find how many legs 4 honeybees have so I can multiply 6 by 4 to get 24."

a. The student's answer is: (circle one)

CORRECT **INCORRECT** **NOT SURE**

b. Do you understand how the student solved it? (circle one)

YES **NO**

If the student made a mistake and you understand what it is, please describe the error.

Please&continue&on&the&next&page.&

11. Problem posed to students:

A pet store has 56 kittens and plans to put 4 kittens in each cage. If the pet store has 6 cages, how many more cages will the pet store need?

Student Solution

e a mistake and you understand what it is, please describe the error.

Thank you for completing this survey.

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