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A Mathematics Workshop for Parents:
Exploring Content Knowledge and Perceptions of Parental Involvement

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of
Philosophy at Virginia Commonwealth University.

by

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Dedication

For my boys, Lucas and Levi.

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Abstract

This qualitative study explored a mathematics workshop for parents and the impact on a parent's mathematical content knowledge in rational numbers, perceptions of current instructional practices, and parental beliefs in supporting their children in learning mathematics. A 6-week parent workshop on rational numbers was offered in a rural middle school. Data sources included interviews and workshop audio transcriptions. This study concluded that a mathematics workshop supports parents in developing a conceptual understanding of rational numbers and rational number operations. Furthermore, parents recognized the importance of discourse, representation, and justification for building conceptual understanding in mathematics. Parents, who participated in the workshops, were more open to the use of standards based instructional practices for developing conceptual understanding. Parental engagement in mathematics should include discourse at home to help students justify and explain their thinking. Questions related to the teaching of non-standard procedures without building a conceptual understanding hindered many parents from completely accepting new instructional practices.

Chapter 1: Introduction

Linda M. Gojak (2013), former President of the National Council of Teachers of Mathematics (NCTM), stated, “Too often when a student struggles with mathematics, a parent comments, ‘I was never very good at math either’.” Gojak’s statement was a call to action for mathematics educators and school administrators to enlist parental support in mathematics, but Gojak recognized the existence of challenges that schools face in getting and keeping parents involved in their children’s math education. Earlier foundational documents, such as the NCTM *Principals and Standards for School Mathematics* (2000), also acknowledged the importance of parental involvement:

When parents understand and support the schools’ mathematics program they can be invaluable in convincing their daughters and sons of the need to learn mathematics.

Families become advocates for education standards when they understand the importance of high quality mathematics education for their children (p. 378).

Parents are an important component of the school community and have a voice in their child’s education. Schools must work to incorporate parental experiences and perspectives into the educational setting (Neuman, Hagedorn, Celano, & Daly, 1995).

The main task of getting parents involved falls on the shoulders of school administrators and classroom teachers. Parental involvement literature recognizes the need for soliciting parental support, but there is no clear definition for successful parental involvement. The lack of clarity in a definition and in the expectations set forth by research and federal mandates can

make the task seem daunting. Ensinger and Fothergill (2012) found that building and strengthening parental involvement is a complex task due to the nature of the relationship between schools and parents. Parental involvement within mathematics education is often hindered by parents' lack of understanding of current instructional practices (DePlanty, Coulter-Kern, & Duchane, 2007; Sheldon & Epstein, 2005; Pritchard 2004).

The development of new models for parental involvement in mathematics have opened the door to exploring mathematics content with parents. For example, Math and Parent Partnerships of the Southwest (MAPPS) actively engages parents in mathematical exploration and discourse with other parents and teachers. Pritchard (2004) found that parents wanted support in helping their children understand mathematics concepts rather than just doing procedures. The development of parental involvement programs has also been shown to confidence in doing mathematics, as well as, to recognize that parents can be a mathematical resource in the school (Civil, 2001).

Background of the Study

For 25 years, The National Assessment of Educational Progress (NAEP) (2015) indicated either no change or an increase in mathematics scores in fourth and eighth grades, but the most recent test data reflect a decrease in mathematics scores. Since 2013, fourth and eighth grade math scores decreased by two and three points respectively (NAEP, 2015). In particular only, 40% of U.S. fourth graders and 33% of eighth graders scored at or above the proficient level in mathematics (NAEP, 2015). Internationally, fourth graders ranked below eight other countries and eighth graders ranked below twelve countries in mathematics (Trends in International Mathematics and Science Study, 2011). Similarly, a recent study found that only 50 percent of sixth and eighth graders could correctly solve a fraction problem with unequal denominators

(Siegler & Pyke, 2013). Other research has indicated that 66 percent of U.S. workers use rational numbers, fractions and decimals, at work (Handel, 2016). There exists a disconnect between the mathematical ability of children and the skills needed for the future workforce. Improving student achievement in mathematics has become a national goal.

Parental involvement is a key indicator of academic success. Research has concluded that parent-child interactions that are engaging and responsive to the child's educational needs are important components of a child's academic development (Christian, Morrison, & Bryant, 1998). Children who have higher levels of parental involvement, such as parents attending workshops on reading followed by parental encouragement to read at home, have shown greater literary growth compared to students whose parents are not actively involved (Leslie & Allen, 1999). Families, teachers, and administrators care about the academic success of children and want them to succeed, but there are hindrances to parental involvement. Research identifies the most common barriers to parental engagement as being time (Caplin, 2000; Kim 2009), communication (Caplin 2000; Lazar & Slostad, 1999), tension between parents and teachers (Baker & Soden, 2000), and limited family resources (Caplin, 2000; Daniel-White, 2002; Kim 2000). In mathematics, hindrances to parental involvement can be further complicated when parents do not understand the academic content (Pritchard, 2004) and, as a result, choose to not be involved. Content specific workshops in reading and mathematics have been successful in breaking down known barriers. With the success of parental involvement programs, there is a need for additional research on content focused programs that support parental engagement in mathematics.

Overview of the Literature

Defining Parent

Definitions of what constitutes a parent vary across literature. The U.S. Department of Education (2018) defines a parent as the legal guardian or other person standing in place of a parent for a child. The person could be a grandparent or stepparent with whom the child lives or a person who is legally responsible for the child (United States Department of Education, 2018). Similarly, Epstein (2001) defines parents as to include all family members who contribute to a child's education and development. The term parent is interchangeable with family (Epstein, 2001). For this project, a parent will be defined as the legal guardian or family member who contributes to a child's educational experience.

Defining Parental Involvement

The Every Student Succeeds Act (ESSA) of 2016 requires states to encourage parents to become involved in their child's education. Title I, Section 1116 of ESSA promotes parental involvement as the participation of parents in regular, two-way, and meaningful communication involving student academic learning and other activities including:

- that parents play an integral role in assisting their child's learning;
- that parents are encouraged to be actively involved in their child's education at school;
- that parents are full partners in their child's education and are included, as appropriate, in decision making and on advisory committees to assist in the education of their children; and
- that other activities are carried out, such as those described in section 1118 of the ESEA (Parental Involvement). (p. 6)

Although ESSA seeks the active engagement of parents within the school, the Act does not specifically tell states how to achieve this requirement.

The type and level of parental involvement can vary depending on the subject and the age of the student. Though the importance of parental involvement is not debatable, the kinds of involvement that are most effective are unclear. Traditionally, parental involvement has included what parents and families can do or provide for the school. This definition includes attending school activities, participating in school committees or being chaperones on field trips (Swap, 1993). Other definitions include parental involvement as talking to school employees and participating in the school decision-making processes (Epstein, 1995). Recent definitions of parental involvement have expanded to include what parents can do outside of the school to support instruction such as reading books or helping children with homework (Gonzalez-DeHass, Willems, & Doan Holbein, 2005).

Impacts of Parental Involvement

Research indicates that parental involvement improves many aspects of a child's education such as increases in academic achievement, (Henderson & Map, 2002; Jeynes, 2005; Starkey and Klein, 2000; Sheldon, 2005); increased motivation (Fan & Williams, 2010; Gonzalez-DeHass, Willems, & Doan Holbein, 2005); and a decrease in mathematical anxiety (Vukovi, Roberts, & Wright, 2013). Although parental involvement is usually associated with positive impacts on students, a lack of mathematical confidence and mathematical anxiety on the part of parents can have negative impacts on a child's success (Fan & Williams, 2010). Furthermore, Baker and Soden (2011) believe factors such as teacher effectiveness and instructional practices may have an impact on how much influence parental involvement has on a child's achievement results.

Hindrances to Parental Involvement

One goal of parental involvement in a child's education is to see positive changes in academic success, motivation, and anxiety. To achieve this goal, one must understand what hinders parental involvement. Research on the challenges that schools face in increasing parental engagement in mathematics includes a parent's mathematical ability (Jackson & Remillard, 2005), lack of understanding of current instructional practices (Jackson & Remillard, 2005, Pritchard, 2004), and family (parent's) culture (Civil, 2002). Based on their educational experiences, parents may question their understanding of mathematical ideas as well as their ability to support their child's mathematical learning (Garland, 2014). In turn, a lack of mathematical understanding causes parents to express extreme frustration when working with students and teachers on current mathematics teaching and learning practices (Jackson & Remillard, 2005, 2006). In particular, parents often could not understand how to help their children when they as learners did not understand the mathematical content or the current instructional practice methods. Instructional practices have moved beyond focusing on procedural skills in mathematics and instead focus on building a conceptual understanding in mathematics. In the last 15 years, the changes in mathematics instruction have focused on enhancing mathematical proficiency, building mathematical comprehension, and procedural flexibility instead of teaching mathematics without meaning (Kilpatrick, Swafford, & Findell, 2001). Parents have not been actively engaged in the changes from procedural to conceptual understanding and have been expected to support what they do not understand (Jackson & Remillard, 2006).

Math and Parent Programs

Recognizing the need for understanding the cultural differences and the mathematical abilities of parents led to the development of many new parental involvement models. One such

model, The Mathematics and Parent Partnership Research of the Southwest Project (MAPPS), has increased parental involvement in mathematics by building the parents' voice in schools with large Hispanic populations. The project consisted of three main components: professional development for parent, teacher, and administrator leaders; Mathematics Awareness Workshops (MAWS) for parents and children; and a Math for Parents (MFP) course. Each component of the program allowed parents to explore mathematics for a deeper conceptual understanding.

The program has helped parents and teachers to recognize the importance of mathematics partnerships. Teachers began the program believing they could teach parents some math, but by the end, they began to see the parents as mathematical thinkers (Civil, 2001). Parents began to recognize the practical uses for mathematics and that, as parents, they had mathematical ideas to share with their children at home and in school. Parents began to initiate their own involvement that focused on mathematical knowledge. Overall, Project MAPPS helped the schools and parents to recognize that parents were also educators and mathematical resources at home and at school (Civil, 2001). Similar research has found that parents are better prepared to support their children in mathematics when given the opportunity to construct mathematical knowledge (Eisenreich & Andreasen, 2016). The need to explore similar programs in different settings is important as school administrators look to design parental involvement programs in mathematics.

Statement of the Problem

Studies have shown that parental involvement increases student achievement (Henderson & Map, 2002; Jeynes, 2005; Starkey and Klein, 2000; Sheldon, 2005). However, many parents are not involved in the mathematical education of their children (Deplanty, Coulter-Kern, & Duchane, 2007). Parents may not feel comfortable helping children in mathematics when they

feel uninformed about mathematics and teaching methods (Pritchard 2004). With the overall goal of increasing student achievement, Sheldon, Epstein, and Galindo (2010) recognized the need to develop a parent's mathematical understanding. Federal and state mandates require schools to initiate parental involvement activities. If student success is the expected outcome, research must seek to understand and develop mathematics programs to actively engage parents in mathematics.

The success of parental involvement programs such as MAPPS has opened the door to study ways to promote parental involvement in mathematics across grade levels and school districts. Research must continue to understand how a mathematics workshop can influence a parents' mathematical content knowledge in all areas including rational numbers. Furthermore, research must understand how changes to parents' mathematical content knowledge can influence their perceptions about mathematics instructional practices and parental involvement in mathematics. These considerations are important if parents are to be informed about current mathematics teaching and learning practices (Pritchard, 2004). Standards-based or reform mathematics emphasizes skills that focus on concepts, problem solving, and a higher level of mathematical reasoning. This is a direct conflict to the grade-school level of mathematics education of many parents. Understanding the impact of a mathematics workshop on content knowledge and parental perceptions may lead to changes in the development of school based parental engagement activities.

Purpose of the Study

Since research has found that parental involvement impacts student achievement, it is necessary to determine how schools can structure programs that may affect the level and types of parental involvement. This qualitative study will explore a mathematics workshop for parents

and the impact on mathematical content knowledge in rational numbers, attitudes towards current instructional practices, and parental beliefs in supporting their children in learning mathematics.

A 6-week parent program on rational numbers was offered in a rural middle school. Results of this study added to the growing body of literature that has focused on parental involvement in mathematics. Findings provide a broader picture of parental involvement activities that schools may use to actively engage parents in mathematics. The study provides insight into the development of a mathematics workshop for school divisions as school administrators seek to increase student achievement. Furthermore, the findings support schools in understanding the role of a mathematics workshop on a parent's mathematical content knowledge and how these changes influence parental beliefs about supporting their children in mathematics.

Research Questions

The following research questions will be addressed by this qualitative study:

1. In what ways do parents' knowledge of rational numbers develop and change through their participation in a 6-session mathematics workshop?
2. In what ways do parents' understanding of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?
3. In what ways do parents' beliefs about their involvement in supporting their child's mathematical learning change through their participation in a 6-session mathematics workshop?

Significance of the Study

A child's first and most influential teacher is their parent. Parents who are involved in their child's education are more likely to have a child that succeeds academically (Henderson & Map, 2002; Jeynes, 2005; Starkey and Klein, 2000; Sheldon, 2005). Research varies on what defines parental involvement and what types of parental involvement activities are most beneficial. If increasing student achievement is a primary goal of education, then education must seek to understand different methods for supporting this goal. Parental involvement is a widely recognized method of increasing student achievement, so barriers to parental involvement such as lack of mathematical content knowledge must be understood to achieve student success.

Having a greater understanding of how a mathematics workshop can change parental perceptions of mathematics instruction and parental involvement in mathematics is important for an educational system. Parents are stakeholders in the education of their children and schools must actively encourage participation on the part of parents. School districts implement parental involvement programs every year, but if the goal is to increase student success one must explore the best methods for supporting parental involvement in all content areas including mathematics.

Mathematics workshops for parents have shown success in changing how parents perceive mathematics. Prior research has focused on specific school populations. This study seeks to address the use of a mathematics workshop on rational numbers in a rural school division. In order to understand the benefits of a mathematics workshop, research must look across grade levels, school settings, and mathematical content strands. Understanding the impact of a parent's mathematical content knowledge and perceptions towards working with children in mathematics is important if a mathematics workshop is to be a viable means for supporting parental involvement in mathematics.

Summary

An overview of the recent call for action from the National Council of Teachers of Mathematics and federal mandates associated with The Every Student Succeeds Act (ESSA) of 2016 have brought parental involvement to the forefront of education. Issues arise when one seeks to define parental involvement since there is no clear definition that fits the needs of all schools and subjects. Research on parental involvement recognizes the positive impacts on a student's academic success, but hindrances exist to parental involvement that must be accounted for when seeking to actively engage parents. Recent parental involvement programs have found that parents are mathematical resources at home and school. As schools seek to develop parental involvement programs, further research is needed to understand program development in middle schools. Specifically, how can mathematics workshops have an impact on a parent's content knowledge and perceptions of mathematics teaching and learning? Furthermore, what role does a mathematics workshop play in influencing parental involvement in mathematics?

Chapter 2: Review of Literature

Literature Search Method

This chapter presents an overview of parental involvement literature in mathematics education. The review will explore topics associated with parental involvement and mathematics, including:

- definitions of parental involvement across disciplines,
- positive impacts of parental involvement,
- hindrances that impact parental involvement, and
- emerging theories and programs that seek to explore the relationship between parental involvement and mathematics.

Reflecting on the key ideas associated with parental involvement, curriculum studies, professional development, and mathematics education as they related to my coursework helped me to initiate my review process. I searched the online resources Education Resources Information Center (ERIC) and the Virginia Commonwealth University (VCU) library database for articles that were written by key scholars in the identified areas as well as searched key terms relevant to parental involvement and mathematics. I also visited the VCU and Randolph Macon libraries to explore books and articles associated with parental involvement. These articles and books were read and used to determine additional sources of literature.

Due to the large amount of literature that exists on parental involvement, some literature had to be rejected. I excluded articles not related to parental involvement in mathematics education. Articles excluded from the literature review included:

- implications of parental involvement such as attendance that were not directly related to mathematics;
- forms of parental involvement in fields other than mathematics education;
- strategies for increasing parental involvement other than those directly associated with mathematics education; and
- the history of parental involvement.

Defining Parent

Typically, many define the term parent as someone one “who begets or brings forth offspring” (Merriam Webster, 2017). However, this definition does not take into account the varied family structures that exist today. Many federal and state court systems have weighed in on the term parent, but changes in what constitutes a family have created tension in how one can and should define the term (Elrod, 2011). Since this research will look at the term parent in an educational context, the U.S. Department of Education (2018) has defined a parent as the legal guardian or other person standing in place of the biological parent of a child. This definition broadens the term to include other individuals like a grandparent, aunt, uncle, sibling, or even a foster parent. Similarly, Epstein (2001), whose research has predominately focused on parental involvement, defines a parent as any family member who contributes to the child’s education and development. These definitions allow the word family or caregiver to be synonymous with parent. Throughout this project, the word parent will be the legal guardian or family member

who contributes to the child's educational experience. In this research study, the parent will be the person who attends the mathematics workshop.

Defining Parental Involvement

Parental involvement is defined as deliberate action by parents to engage in their child's education (Jeynes, 2009). Although research recognizes that parental involvement makes a difference in a child's education, issues arise when one looks at how to define parental involvement across schools and content areas. Lareau (1989) believed that schools must recognize there is not a one-size-fits-all model of parental involvement, but instead parental involvement must encompass the relationship between the school and the family as well as the structure of the family.

The most widely referenced definition of parental involvement (Epstein 1995, 2009) includes the following categories:

1. Parenting: Helping families establish home environments that support students.
2. Communicating: Developing bi-directional communication between home and school.
3. Volunteering: Recruiting parental support within the school.
4. Learning at Home: Providing information to support learning at home.
5. Decision Making: Including parents in school decisions as leaders and representatives.
6. Collaborating with the Community: Integrating community resources into the school.

These categories point to the importance of parents and schools initiating and creating programs that support home-school collaboration. The Epstein model recognizes that efforts to increase parental involvement should be designed to achieve a specific goal such as academic achievement. For example, helping parents to work with students at home could include sample mathematics problems that support parents in providing homework help.

Epstein (1995, 2009) defines parental involvement as being either parent-driven, school-driven, or a bi-directional endeavor on the part of home and school. Epstein's model encourages schools to create a place for parental ownership through shared decision-making. Studies have shown that schools that institute Epstein's model as a method of parental involvement have successfully increased student achievement (Bower & Griffin, 2011; Ingram, Wolfe, & Lieberman, 2007; Green & Walker, 2007). Epstein (1995, 2009) recognized that home-school collaboration could not be based on the assumption that any one type of parental involvement could produce student achievement across all grades and subject areas. Instead, researchers and educators must look at different types of activities in order to select and implement activities that will produce the desired goal.

Historically, efforts to improve mathematics education have predominantly focused on improved teacher education and curriculum (Ball, 1993) and very little effort has been given to developing connections between schools and parents in mathematics (Peressini, 1998). Changes in improved teacher education have been driven by standards-based mathematics reform, but as federal mandates have been put into place, there is a need to help parents understand instructional trends in mathematics. Current reforms have recognized the need to enlist many different forms of parental engagement as researchers, legislators and educators recognize that parental support can lead to positive student outcomes in all subject areas, including mathematics (Epstein & Dauber, 1991; Henderson & Berla, 1994).

Conceptual Framework for Parental Involvement

Hoover-Dempsey and Sandler Model of Parental Involvement.

Parents and schools share the responsibility in the education of children (Epstein, Sanders and Sheldon, 2009). Hoover-Dempsey and Sandler developed a framework for examining

parental involvement as a mechanism for increasing student achievement (Hoover-Dempsey & Sandler, 1995, 1997). The framework addresses: (a) why families become involved, (b) how parents choose which type of engagement, and (c) how parental involvement has a positive effect on a student's academic success (Hoover-Dempsey & Sandler, 1995, 1997). The framework focuses not on what parents need to do or should do, but instead on what parents choose to do to be involved in their child's education.

The Hoover-Dempsey and Sandler (1995, 1997) model recognizes the need for parents to construct their own definition of parental involvement. Individual definitions of parental involvement must focus on a parent's personal motivators for being involved, invitations received for parental involvement, and a parent's life contexts. Through the development of one's own parental involvement definition, parents develop a sense of self-efficacy for helping their children succeed. Hoover-Dempsey and Sandler (1995, 1997) identified the existence of two realities within parental involvement. First, not all parents need encouragement to be involved in their child's education. Second, parents must recognize developmentally appropriate parental involvement strategies.

The framework consists of five levels (see Figure 1) with student achievement being the top level or the overall outcome (Walker et al., 2005). The five levels of the model, starting with level one are as follows: parental perceptions of involvement, types of parental involvement, student perception of learning methods utilized by parents during involvement, student attributes conducive to achievement, and student achievement (Griffin & Galassi, 2010; Hoover-Dempsey & Sandler 1995, 1997).

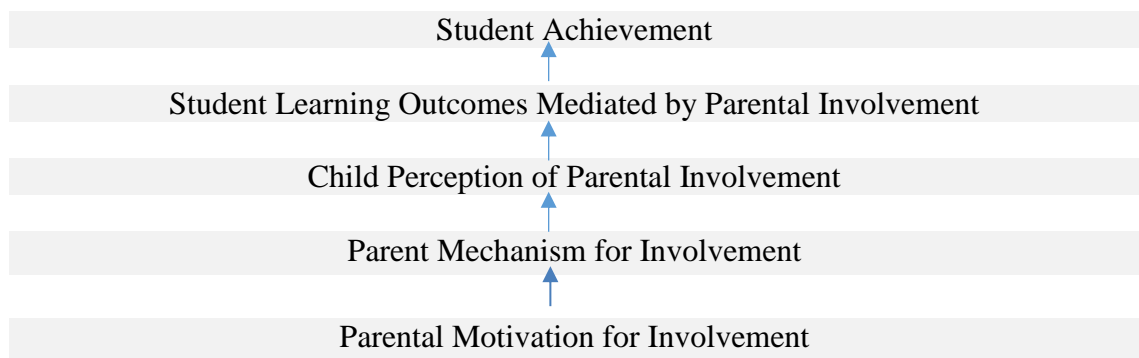


Figure 1. Hoover-Dempsey and Sandler Model, Levels of Parental Involvement.

Level one. Level one of the Hoover-Dempsey and Sandler framework includes the three major influences to the frequency and type of parental involvement. The three factors are (1) personal motivators, (2) perceptions of invitations to be involved, and (3) life context variables. Figure 2 show the influences for each factor of level 1 of the Hoover-Dempsey and Sandler Model.

<u>Personal Motivation</u>		<u>Invitation</u>			<u>Life Context</u>	
Personal Role Construction	Parental Efficacy	General School Inviations	Specific School Invitations	Specific Child Invitations	Knowledge & Skills	Time and Energy

Figure 2: Hoover-Dempsey and Sandler Model, Level 1

Personal motivation. The first level of parental involvement is what motivates parents to be involved. A parent’s personal motivation influences the construction of a parent’s role and their sense of self-efficacy. Role construction is based on a parent’s beliefs about what they are supposed to do as a parent in relation to what their child is learning. A parent’s role construction is identified as what a parent determines should be their role in the educational process. Research has revealed that there may be conflict in how parents construct their roles in mathematics education. Although parents believe in shared responsibility with teachers and schools, parents had doubts about their own mathematical content knowledge and their understanding of current mathematics instructional practices (Wilder, 2014, 2016; Pritchard, 2004).

Within a parent's personal motivation to be involved, their self-efficacy determines whether they believe that their involvement will make a difference for the student. Lack of self-efficacy in mathematical content knowledge can hinder a parent's involvement in mathematics (Bratton, Quintos, & Civil, 2005). Frustration in their inability to help their children and a disconnect between the way they learned mathematics in grade school versus the way their children are learning have kept many parents from being involved (Musty, 2015).

Invitation. Perceptions about invitations to be involved come in three forms. First, general invitations from the school are based on the school environment. Schools that welcome parental involvement exhibit the sense of an open invitation for parents in the school setting. The second form of invitation is a clear request from the teacher. This type of invitation can include requests to attend conferences or school functions. The third form of invitation comes from the child. These are opportunities that the child makes for the parents to be involved. For example, a child may ask a parent to attend lunch or even help with homework.

Life context variables. Life context variables take on many forms, including parental background and school experiences. A parent's content knowledge might influence the kinds of activities in which they will become involved. In mathematics, many parents feel unable to help their children due to their own lack of practice with basic skills (Civil, Bernier, & Quintos, 2003). Parents who identify themselves as having stronger abilities are more likely to be involved at home and at school.

Time and energy on the part of parents can also influence their involvement. Obligations at home and work often hinder parental involvement. Family culture can play a significant role in how parents feel about their levels of involvement. Many cultures believe that it is a teacher's role to educate, while others believe that the parents should be active participants in the

educational process. Furthermore, recent and prior experiences in the educational setting can influence the way in which parents envision their level of involvement.

Level two. Level two of the model describes the types of activities that parents choose to engage in and the skills needed for them to be involved. For many parents the mechanisms for involvement are encouragement, reinforcement, instruction or modeling (Griffin & Galassi, 2010, Hoover-Dempsey & Sandler 1995, 1997). These four mechanisms are important as one seeks to understand parental involvement in mathematics. Modeling refers to the behaviors and attitudes that parents present that are positive towards learning. In level two, parents can instruct their children indirectly by showing interest in what they are learning or directly by practicing or teaching content to their children. Reinforcement by parents is an appropriate consequence for children when learning behaviors and efforts. Lastly, encouragement is when parents support their children in activities related to what they are learning. The examples presented here merely scratch the surface of the types of engagement activities parents can do with their children.

Issues of time and academic knowledge become a key factor for parents at level two. Parents are invited to be involved and recognize the need for involvement, but may not know how to actively engage with their children in academic settings. Time and academic knowledge can hinder the amount of engagement parents have with children. Parents who do not understand the current instructional trends in mathematics or the content may not have a positive attitude or be able to instruct children in mathematics. Lack of time and academic ability may hinder involvement by influencing the parental mechanism for engagement.

The first two levels of the model are beneficial for schools when seeking to increase parental involvement. Schools must understand what factors play a role in how parents choose to be involved and how these factors affect the type of involvement. The initial decision to be

involved in a child's education is based on beliefs and is the most important level (Anderson & Minke, 2007). Personal motivation and expectations determine the level to which parents decide to become involved or not. Hoover-Dempsey, Walker, Jones, & Reed (2000) showed that role construction, self-efficacy, and perceptions of teacher invitations account for 35% of the variance in a parent's decision to become involved. If parental involvement is an expectation of the school, then invitations must be open and appealing for parents. Parental involvement activities must provide parents with the opportunity to explore their role and their self-efficacy in mathematics content. These are things teachers and administrators should consider when working to increase parental involvement.

Levels three, four and five. The last three levels focus on the student outcomes from parental involvement. The third level focuses on student perceptions of parental. This level is important because it determines the influence of the parental involvement interaction on the student. The attitudes, values, and behaviors exhibited by the parent and the experience influence the student learning (Grolnick & Slowiaczek, 1994).

The fourth level recognizes that there are student-learning attributes directly related to parental involvement. These learning attributes can be academic self-efficacy, motivation, and seeking help. Hoover-Dempsey and Sandler (1995, 1997) recognized that parental involvement could lead students to have strong beliefs about their academic abilities. In particular, the belief that seeking help from others is acceptable can be a positive experience. This framework for parental involvement states that parents must go through all of the levels in the model in order for student success to be the outcome.

Impacts of Parental Involvement

Research has indicated that parental involvement improves many aspects of a child's education including increased academic achievement (Henderson & Map, 2002; Jeynes, 2005; Sheldon, 2005; Starkey and Klein, 2000); increased motivation (Fan & Williams, 2010; Gonzalez-DeHass, Willems, & Doan Holbein, 2005); and decreased anxiety (Vukovi, Roberts, & Wright, 2010). When looking to understand the impacts of parental involvement, Baker and Soden (2011) argue that parental involvement research is highly susceptible to research flaws due to inconsistent definitions of parent involvement, the lack of ability to isolate parental involvement measures and the use of non-experimental design

Academic Achievement

Parental involvement has been linked to positive academic achievement. Widely referenced in parental involvement literature, Henderson and Mapp (2002), through a synthesis of 51 research studies, indicated there was a positive relationship between parental involvement and academic achievement.

The evidence is consistent, positive, and convincing: families have major influence on their children's achievement. When schools, families, and community groups work together to support learning, children tend to do better in school, stay in school longer, and like school more (p. 89).

Some research has suggested that parent involvement may be the most influential factor for improving student success (Jeynes, 2005; Sheldon, 2005; Starkey & Klein, 2000).

A study by Starkey and Klein (2000) looked at a long-term mathematics intervention program for low-income families. The program's intent was to increase mathematics ability and parental involvement for elementary students. The structured sessions required parents and children to attend each meeting. Sessions included discourse around content knowledge. Access to math materials for use at home were helpful to facilitate mathematical discussions about around developmentally appropriate mathematics curriculum. The children who had parents

involved in the study had significantly higher mathematics scores on a posttest ($F = 4.76, p < .05$) than students in the control group who did not have parents involved in the study.

In 2005, Sheldon used a structural equation model to test the relationship between the implementation of school and family partnerships on academic achievement. Survey data was collected from 565 schools. As part of the National Network for Partnership Schools, the schools that participated in the survey were working to improve partnerships between schools and parents. The study found that when schools involved parents in outreach opportunities for personal growth, parents were more likely to become involved in the learning opportunities. The researchers suggested that proficiency on children's math tests is associated with parental support.

Similarly, research has recognized the importance of dialogue between parents, students, and teachers around mathematics. Successful dialogue must explore mathematical thinking and lead to greater collaborative efforts among the three. Sheldon and Epstein (2005) found that having parents and students talk about mathematics during homework, and having schools that provided resources for parents may contribute to increased mathematics scores over schools that did not ($p\text{-value} = .60$). Parent and child discussions around homework have shown to increase parental involvement, increased homework completion, and student achievement (Epstein, Simon & Salinas, 1997; Epstein & Van Voorhis, 2001). Parents may be willing to help, but may not know how to help or why their involvement is important (Epstein & Van Voorhis, 2001).

Though prior studies have found that parental support increased mathematics proficiency, research is mixed on which types actually increase mathematics achievement. Some research suggests parental involvement must be through school-initiated programs (Fan & Chen, 2001); while other studies suggest that home motivation is successful in increasing mathematics ability

(Fantuzzo, Tighe, & Childs, 2000). To support children in mathematics, studies suggest providing families with opportunities to learn mathematics. Furthermore, engagement activities must focus on discourse around content specific material.

Motivation

Literature has indicated parental involvement influences a student's motivation towards learning. Gonzalez-DeHass, Willems, and Doan Holbein (2005) discovered that a child's intrinsic motivation to learn increases when children see constant communication and engagement on the part of parents in their education. Through a synthesis of literature, the authors found that students report more effort and focus on learning when their parents are involved. Furthermore, children of parents who are involved are more likely to take personal responsibility for their learning. The authors found that intrinsic motivation increased when parents provided encouragement and praise for learning. Jeynes (2010) supported these findings through a meta-analysis of 77 studies on parental involvement. Jeynes suggested that parents who communicated positive attitudes towards school were associated with students who had higher academic achievement. Subtle actions on the part of parents is important for motivating children to achieve (Jeynes, 2010).

Addressing limitations of previous studies on parental involvement and motivation, Fan and Williams (2010) used data from the Educational Longitudinal Study of 2002 (ELS, 2002) to determine whether specific types of parental involvement predicted a high school student's motivation. Motivation for learning was determined by a parent's engagement, self-efficacy and intrinsic motivation towards mathematics. Motivation directly relates to schools that initiated contact and involvement with parents.

Mathematical Anxiety

Vukovi, Roberts, and Wright (2013) conducted research on whether a child's mathematical anxiety related to parental involvement. Seventy-eight low income, ethnic minority parents completed a survey on parental involvement and mathematics anxiety in children. Mathematical anxiety was defined as a feeling that hindered mathematical performance in academics and ordinary life situations. The findings suggest that a parent can influence a child's mathematical achievement by reducing the child's mathematical anxiety. Furthermore, the researchers concluded that a mathematics program for parents should be developed that supports parents in creating appropriate mathematical learning environments in the home to decrease a child's mathematical anxiety. Similarly, Maloney, Ramirez, Gunderson, Levine, and Beilock (2015) demonstrated that when parents help children with homework, parents with math anxiety lead to a decrease in end of the year math achievement for students ($F(425) = 0.114, p = .736$) and increased math anxiety in children. Understanding methods for overcoming mathematical anxiety in parents is important as one seeks to increase student achievement in mathematics.

Evaluating Research on Parental Involvement.

Baker and Soden (1998) concluded that the lack of negative impacts in parental involvement research is due to the research methods used in published studies. Their fundamental argument is "the lack of scientific rigor in the research informing practice and policy" (p. 1). The authors suggest that early studies supporting parental involvement in a child's education specifically focused on the positive aspects. The researchers felt that the negative aspects of parental involvement were not being researched. Furthermore, the authors suggested that an inability to isolate parental involvement from all other factors may mean that drawbacks could be credited to parental involvement.

Similarly, Smith and Wohlstetter (2009) assert that most parental involvement researchers tend to focus on parental involvement using a middle class perspective. This view disregards other ways in which parents may be involved in their child's education such as the motivation to move beyond their parent's level of attainment in life. Researchers must focus on non-traditional forms of involvement when looking at the implications of parental support (Smith & Wohlstetter, 2009).

Challenges to Parental Involvement in Mathematics Education

Gal and Stoudt (1995) suggest several reasons why parents may not be involved in mathematics education. First, a disconnect may exist between the expectations of the schools and parents about the role of parents in the education of children. Second, changes in current mathematics instructional practices and standards may result in parental confusion in mathematics content knowledge. Lastly, recognizing the differences that exist between families is important in understanding the impact of parental involvement and its background. These factors present significant obstacles for some schools and may impact whether parents are able to be involved in their child's mathematical education.

Education's Role

Epstein (2001) found a strong connection between school climate and the extent to which parents were involved. Parental involvement has been recognized by many to end once teachers take over for parents as the primary givers of knowledge (Daniel-White, 2002). Daniel-White (2002) found that, in the eyes of the teachers, parental involvement could slowly become more about fixing the family to meet the needs of the school than fostering cooperation. This finding was true when the cultural background of the family did not match the cultural norm for the teacher. Teachers and school administrators fear that inviting parental support may result in a

lack of authority on the part of the school or may promote parental criticism within the classroom (Lareau, 2000a; Lareau, 2000b; Lazar & Slostad, 1999). Parents believe that teachers feel as if parents are “intruders rather than partners and give the impression they (parents) are interfering” (Gonzalez-DeHass & Willems, 2001, p. 85)

Lazar and Slostad (1999) assert that negative perceptions of parents persist because “schools do not adequately educate teachers to understand parents and to network with them” (p. 207). Administrators and teachers may not understand the importance of family involvement and the effects of parental involvement on student achievement (Flynn, 2007). Often, teachers believe that parents do not support the school. This perception is a problem when federal and state mandates require the involvement of parents in the educational system.

Research has shown that educators do not always recognize the skills that parents possess in subject matter, and teachers may lack awareness of the issues that families face when becoming involved in the education of their children (Civil, 2001; Civil, 2006; Daniel-White, 2002; Gonzalez-DeHass & Willems, 2001). Civil (2006), in her work with parents, teachers, and students, recognized a disconnect between classroom mathematics taught by teachers and the practical mathematics applications often developed within the family. The parents felt they were stuck between “two cultures” (p. 5) when working with their children in mathematics. Teachers may not view the parent as an equal asset in the education system, because teacher norms are not always the same as parent norms. This view of parents as non-sharers of knowledge widens the gap between parent and teacher instructional goals and practices (Dauber & Epstein, 1993). Parental involvement programs must look to bridge the divide between schools and parents to increase parental engagement in mathematics both in and out of the classroom.

Reform Mathematics

Parents have felt a lack of engagement in mathematics as instructional practices have shifted from teaching procedures to developing conceptual understanding. This shift in instructional practices have left many parents traversing unfamiliar territory (Jackson & Remillard, 2005; Peressini, 1998). The shift in mathematics teaching and learning is often referred to as reform mathematics. Wu (1997) referred to this reform as a “reaction to the traditional curriculum of the eighties” (p. 947), or a movement away from algorithm-driven and short explanations to a discovery of one’s own knowledge. Van de Walle, Karp, and Bay Williams (2016) described standards based mathematics as a way to challenge students to make sense of mathematical ideas through explorations and projects. This in turn, enables students to make sense of the mathematics. Opponents of standards based instruction believe children will not learn the standard methods of arithmetic (Wu, 1997). The NCTM Focal Points (2006) make it clear that such methods are still the ultimate goal, but that conceptual understanding should be developed first. The recent additions like the Common Core math standards have heightened the awareness of many around the use of reform mathematics. Common Core does not mandate certain mathematical methods, but focuses the learning process on understanding and explaining one’s solution (Garland, 2014).

Explaining a mathematical solution requires one to have mathematical understanding. Schoenfield (2007) defines knowing or understanding mathematics as not only having proficient procedural skills, but also the ability to understand mathematics for mathematical proficiency. Mathematical proficiency refers to the link between procedural knowledge, conceptual understanding, and problem solving (Senk & Thompson, 2003). Kilpatrick, Swafford, and Findell (2001) describe the five strands of mathematical proficiency needed to successfully develop mathematical skills. The five strands are as follows:

- conceptual understanding - comprehension and integration of mathematical concepts, operations, and relations;
- procedural fluency – skills in carrying out procedures flexibly, accurately, efficiently, and appropriately;
- strategic competence – ability to formula, represent, and solve mathematical problems (problem solving)
- adaptive reasoning – capacity for logical thought, reflection, explanation, and justification; and
- procedural disposition – habitual inclination to see mathematics as sensible, useful, and worthwhile (p. 4).

Mathematical proficiency is the interweaving of the five strands. Each strand supports each other.

Based on their grade-school mathematical experiences, parents question their understanding of mathematical ideas as well as their ability to support their child’s mathematical learning. In their qualitative study, Jackson and Remillard (2005) found that parents expressed extreme frustration when working with students and teachers on reform mathematics. Parents could not understand how to help their children when they (the parents) did not understand the mathematical content being taught. Parents expressed interest in spontaneous examples of teaching mathematics to their children, but this type teaching experience did not connect to what their children were learning, thus adding to parental discomfort.

Similar research findings have suggested that parents do not understand the ideas behind the current mathematics educational standards (Peressini, 1998). Parents were unsure about how their children were learning mathematics. This discomfort led to anxiety over not being able to

help their children with their work. Shelton and Epstein (2005) stated, “Efforts to change mathematics education have positioned parents on the sidelines, leaving educators, and other professionals to decide how mathematics learning should take place” (p. 196). The lack of involvement in mathematics results in a larger divide between school and home.

“School and family are the two most important institutions that affect the development of children” (Ma, 1999, p. 60), but what happens when the two do not connect? Civil, Bernier, and Quintos (2003) found that parents believe there is a lack of basic computational skills being developed in the current mathematics classroom. The lack of computational skills is directly related to the changes in current mathematics instructional practices. Lack of understanding can also be attributed to the parents’ own fear of learning new mathematical concepts and methods. These fears have contributed to a lack of involvement in mathematics (Peressini, 1997, 1998).

Understanding what hinders families in becoming involved is important if one wishes to increase parental involvement in mathematics. Building communities of learners means breaking down the walls that exist between schools and families around mathematical knowledge. Exploring different types of involvement activities in order to understand mathematics is important if schools wish to build a shared educational experience.

Rational numbers. Developing a deep understanding can be difficult in any area of mathematics, but rational number concepts are difficult for most students. Rational numbers are the “set of numbers that include the whole numbers and integers as well as numbers that can be written as the quotient of two integers $a \div b$, where b is not zero” (NCTM, 2010, p. 7).

Mathematics education tends to focus on fractions, decimals, ratios, and percents when using the term rational numbers. Mathematics curricula across the country devote time to exploring fractions in both fractional and decimal form. K-2 mathematics education focuses on whole

number operations. As student's move beyond grade 2, fractions and decimals are an extension of their previous work with whole numbers.

The focus of this research study is on the mathematical proficiency of middle school parents in the area of rational numbers. The extension from working with whole numbers in elementary school to rational numbers creates “a more powerful and complicated number system” (NCTM, 2010, p. 13). Fractions and decimals are difficult for students to learn (Behr, M. J., Harel, G., Post, T.R., & Lesh, R., 1992; Ni, 2001). Difficulties with fractions and decimals arise in many areas. Research has stated that when one assumes the properties of whole numbers apply to fractions and decimals (Zhou & Ni, 2014) or in understanding the magnitude of a fraction and decimal in relationship to other numbers (Siegler & Pyke, 2013) that mathematical misunderstandings occur for students. Concerns often arise that elementary and middle school instruction over-emphasize procedures instead of focusing on activities that help to build a foundation of mathematical understanding in working with rational numbers (Ni & Zhou, 2005).

A recent study of U.S. workers reported that 66% of the work force use rational numbers at work (Handel, 2016). On the other hand, NAEP (2004) results showed that only 50% of eighth graders could order three fractions from least to greatest. Creating a mathematical understanding of rational numbers is an important component of our children's future in the work force. Many researchers have suggested methods for improving rational numbers instruction (Steffe, 2002), but none have proven to be successful in increasing the mathematical proficiency with rational numbers.

Family Culture

Definitions and activities surrounding parental involvement tend to focus on behaviors of middle and upper-income Euro-American parents (Mapp, 2003). From this lens, parental involvement expectations do not recognize the values or the culture of low income and ethnic minority families. Research suggests the lack of parental involvement may be due to the lack of flexibility in schedules (Lareau & Shumar, 1996); the belief that a parent's role is to support the teacher and not to intervene in the educational process (Lareau & Shumar, 1996); and a lack of parental value in education compared to middle and upper class Euro-Americans (Ramirez, 2003). Other factors including time, distance, and daycare obligations can hinder parental involvement for families (Lareau, 2000; Smreker-Cohen & Vogel, 2001)

Kohl, Lengua, and McMahon (2000) looked at the types of parental involvement and the level of involvement for different cultures. They found that ethnicity influenced the level of parental involvement, not the type of involvement. Parents of different ethnicities talked to teachers and attended events, but the opportunities did not present themselves on a consistent basis with different ethnicities. Level of education and prior school experiences within different ethnic groups also played a role in involvement. Findings suggested that many minority parents have had prior negative school experiences or felt uncomfortable when working with teachers in certain settings thus making parents less likely to be involved. Kohl, Lengua, and McMahon's research focused on cultures, but a similar study by Cooper and Crosnoe (2007) found that economically disadvantaged parents were less likely to be involved in the education of their children due to similar factors.

Similarly, Lareau (2000) explained that communication between schools and parents of different social classes had a negative impact on parental involvement. Social class was a strong predictor in the expectations of parents in both formal and informal school programs. Parents of

poor and working-class children believed it was their duty to keep their children clothed, fed, and safe from harm, but they did not believe in actively participating within the school setting. School and home should be kept separate. As a result, parents were less proactive in their children's education. Parents of different socio-economic classes and ethnicities believed it was the school's role to educate children.

However, all parents shared the stress they felt with not being able to help their children learn mathematics (Civil, 2014). Parents have described their difficulties when trying to help their children do homework. Some parents had the knowledge of the content, but lacked the mathematical language to help. Language differences caused problems in the relationship between the parent and the child. Of note, Civil (2014) recognized that the language difficulties were not based on ethnic differences instead were between the language of mathematics and the language of daily activities at home. Understanding the language of mathematics is a challenge many parents face in supporting their children in studying mathematics.

Mapp (2003) found that differences in culture directly relate to how some parents believe schools can achieve parental participation. Parents feel more welcomed when their cultures and contributions are respected within the school setting. A lack of cultural recognition is directly related to a lack of parental involvement. It is not that parents are less involved in their children's academics, instead parental involvement is home-based and it is hard for schools to know about or to recognize. Educators were not aware of the educational experiences provided in the home, and the parents were not aware of the connections between home and school activities. Recognizing the barriers that exist in parental involvement such as family culture, the role of education, and parents' mathematical knowledge may help one to understand the personal

motivators that affect parental involvement and the types of programs to develop to increase involvement.

New Models of Parental Involvement in Mathematics

Efforts to redefine and increase parental involvement in mathematics have become more common as schools look to meet federal and state mandates. Recent efforts to support parents as mathematical learners and to study their perceptions and experiences in relation to current mathematics reforms have been developed (Civil, 2001). Mathematics and Parent Partnerships of the Southwest (MAPPS), developed with funding by the National Science Foundation, has become one of the leading programs in supporting parental content knowledge in mathematics. Program design is focused on schools with primarily Latino populations in grades K-4 and 5-8.

The program was developed and refined through three components. The first component offered professional development for parents, teachers and administrators to explore mathematical learning through structured activities. One purpose of this component was to establish a dialogue to guide the mathematical thinking that was taking place and to break down barriers that existed for parents within school structures. Parents became mathematical leaders within the schools and in doing so began to lead additional trainings for parents and teachers.

Next, MAPPS created Mathematics Awareness Workshops (MAWS) that were open to all parents and children in the school division. These workshops were opportunities for parents and children to work together on mathematics. At the end of the session, children would leave to allow parents to discuss and analyze the mathematical thinking gleaned from working with each other and with their children. Each MAWS session was led by a parent or a teacher trained during the first portion of the program. Participants in MAWS linked their everyday use of mathematics to classroom knowledge. The last component, Math for Parents (MFP), courses

were developed for members of the leadership teams and interested parents. MFP was an 8-week workshop that offered an in-depth professional development for parents and teachers. Each of the components was created to increase parental involvement in mathematics.

Members of each group had very different roles in generating parental involvement through this program. Teachers were both facilitators and participants in the program. Teachers worked with parents to facilitate mathematical learning and to understand the culture of the family. The initial MAPPS study showed that in working with parents the teachers changed some of their instructional strategies in the classroom to meet the needs of the students based on family knowledge (Civil, 2001). Bernier, Allexaht-Snyder and Civil (2003) found that teachers involved in MAPPS changed their thinking about parental involvement.

Arlene Summer, a middle school teacher said, ‘I have never had the chance to work with parents like this before. It’s always been like a parent on the other end of the phone...now it is somebody who you really felt like you worked with’ (p. 17).

Teachers participated in the program believing they could teach parents some math, but instead the teachers began to see parents as mathematical leaders and thinkers (Civil, 2001).

MAPPS parents recognized that mathematics can be used in real ways and that they had mathematical knowledge to share with children. Parents began to initiate their own mathematical involvement in the school that allowed them to use their mathematical knowledge. Moll, Amanti, Neff, and Gonzalez (2001) described how one mother and student sold Hispanic candy in their neighborhood. A teacher invited the mother into the classroom to share how making candy and mathematics were intertwined.

Mrs. Rodriguez arrived and she became the teacher. While the candy was cooking, she talked about how to make different kinds of candies as well as the differences in U.S. and Mexican candy consumption, production, nutritional value, candy, and more (p. 7).

Project MAPPS allowed teachers and parents to recognize that parents were mathematics educators (Civil, 2001).

Recent research by Knapp (2014) on parental involvement in mathematics has discovered that not only did children's mathematics scores improve, but also parent's attitude towards mathematics increased during participation in the program. Parents reported improved family interactions with their children by developing activities that they could implement at home. Parents and teachers found that parent-teacher interactions improved during the program. Knapp concluded that parental involvement should be academic in nature and at the same time should facilitate strong family interactions. Schools can do this by implementing programs that build mathematical knowledge for parents by providing learning situations for parents.

Eisenreich and Andreasen (2016) conducted a study where first, second, and third grade parents attended a two-day workshop on whole number operations. The workshop met for three hours over the two-day period. The qualitative study sought to understand if parents who attended the workshop changed their beliefs about mathematical learning. Eisenreich and Andreasen found that parents who participated in the workshop believed that student should construction their own knowledge in mathematics. Parents believed that mathematics should be taught using a student centered approach to learning.

Similarly, Mousoulides (2013) built a parental engagement program that focused on the development of an inquiry approach to mathematics. Mousoulides' model focused on high school students. Teachers focused more on discussion, group work and cooperative learning roles with peers and parents. Parents and teachers felt the joint activity around mathematical inquiry led to the construction of new partnerships between parents and teachers. The collaborative activities created better communication channels among parents, teachers, and

children. One parent stated, “Activities are one of the best ways to engage parents, because their children are also engaged” (p. 26). Engaging parents in mathematics dialogue is fundamental to increasing their involvement in mathematics.

Research findings suggest that parental involvement programs in mathematics are changing attitudes about how children best learn mathematics. It has helped to break down some of the barriers that exist within mathematics education. The literature focuses on elementary and high school students, but further research is needed to understand the impacts of a mathematics workshop for middle school parents. Mathematics workshops allow parents to be successful and to make a difference in their child’s education (Knapp, 2014), but holes exist in understanding their impact across grade levels and mathematical content strands.

Summary

During the past three decades, researchers have begun to understand the influence of parental involvement on student achievement. Jeynes (2005) examined 41 studies through a meta-analysis to determine the relationship between parental involvement and achievement. The results indicated that parent programs were associated with higher academic outcomes that were approximately .35-.40 of a grade point higher (effect size is .30 of a standard deviation). Parents who were active participants and sought support had the greatest impact on their child’s education. Parental engagement must be content specific and recognize the importance of mathematics discourse to have a positive impact. Jeynes (2005) suggested that future research be conducted in educational settings that supported parental knowledge acquisition to understand how one could affect parents. The Hoover-Dempsey and Sandler model recognizes that one must provide parents with opportunities invitations to be involved and that life contexts are important to be successful in achieving the first level of parental involvement.

Concerns have been and continue to be voiced by parents, but often these parental concerns are overlooked by teachers and administrators (Peressini, 1998). Parental engagement in mathematics is hindered by an understanding of current instructional practices (Sheldon & Epstein, 2005). Research projects on mathematics workshops have described changes in parents' perceptions of mathematics that lead to an increase in mathematical understanding. These projects have been successful in showing how parents can begin to understand how mathematics is used in everyday life and how mathematical ideas relate to their daily lives. Success has also been reflected through students' changes in attitudes about learning mathematics (Knapp, 2014). These projects have created communities of learners made up of members of the school community and family, but there is no research evident on if a parent's mathematical knowledge changes within these types of workshops. Changes in mathematical knowledge can increase a parent's self-efficacy and role construction. Research has shown that we need to help parents understand current instructional practices if the goal is to increase parental engagement. To do this we must understand the impact of participation in workshops on parents and students and the lasting impact on a parent's mathematical knowledge.

Chapter 3: Methodology

The purpose of this research study was to explore the impact of a mathematics workshop for parents. Specifically, this study sought to understand how parental participation in a mathematics workshop influenced a parent's mathematical content knowledge in rational numbers. Furthermore, this study examined parental perceptions of current mathematics instructional practices and parental perceptions of parental involvement in mathematics. By understanding how a mathematics workshop influenced parents, future parental involvement programs in mathematics can be developed to address the mathematical needs of parents and children.

This chapter discusses this study's research design and rationale, as well as the school and district demographics. It also presents the data collection procedures, methods of data analysis, and ethical considerations. This study was guided by the following research questions:

1. In what ways do parents' knowledge of rational numbers develop and change through their participation in a 6-session mathematics workshop?
2. In what ways do parents' understanding of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?
3. In what ways do parents' beliefs about their involvement in supporting their child's mathematical learning change through their participation in a 6-session mathematics workshop?

Research Design

This study employed a qualitative design. A qualitative study allows one to understand a particular context as to how an event has influenced participants (Maxwell, 2007). This study used descriptive case study methods. A descriptive case study as defined by Yin (2009) is an inquiry that investigates phenomenon within a real life context. A case study allows the researcher to understand a complex issue by actively engaging in the experience in order to answer the “how” and “why” questions (Ary, Jacobs, Razavieh, & Sorenson, 2006; Yin, 2009). In a qualitative approach to research, one explores “a real-life, contemporary system (a case), or multiple bounded cases over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audio visual material, and reports)” (Creswell, 2013, p.33). This single case study reflected on one 6-week mathematics workshop in a rural middle school setting, and the parents were sub-units within the case (Yin, 2003).

Interview data was collected before and after the 6-week mathematics workshop. The pre and post interview data included questions on perceptions of mathematics instruction and parental involvement in mathematics. Interviews also included the use of a think-aloud protocol to gather mathematical content data. Ericsson and Simon (1980) believe the think-aloud protocol gives the researcher a chance to understand the thought process of an individual through verbal explanations. Participants were asked to verbalize their procedures and strategies for solving mathematical problems. In looking at the mathematical content knowledge of participants, the use of a think-aloud during the interview process allowed for a complex picture to emerge from which to understand the development of a parent’s understanding of rational numbers.

For each session, workshop audio-recordings, researcher observations and workshop artifacts were collected. All whole group and small group discussions were audio recorded. Workshop observations were described each week by the researcher in her field notebook.

Whenever possible artifact collection included weekly mathematical activities, take-home assignments and session chart paper.

Setting and Participants

Setting

A single middle school in a rural community was selected as the study setting. The rural middle school (RMS) is the only middle school in the school division. The choice of setting was two-fold. First, the researcher is interested in small rural school divisions, specifically middle schools. Second, the researcher has prior experience working with RMS teachers. RMS enrolls sixth through eighth grade students. The county’s population is approximately 30,500 (U.S. Census, 2017). The median household income is \$61,000 and the percentage of households in poverty is approximately 10% (U.S. Census, 2017).

With respect to student demographics, according to the Virginia Department of Education (2016), there were approximately 4,300 students enrolled in the school division and 950 students in RMS in 2016. Table 1 contains demographic information for the rural school division.

Table 1.

Demographic Information for School Division

	American Indian	Asian	Hispanic	Black	2 or More Races	White	Other
School Division Demographics	0.2%	0.4%	7.9%	27.5%	8.9%	54.9%	0.2%

The school division student teacher ratio for grades K-7 is 15.6:1 and for grades 8-12 is 11.75:1 (VDOE, 2017). Site approval was obtained from the Assistant Superintendent of the school

district. The principal of RMS also provided approval for the research study to be conducted at RMS over the 6-week period.

Participants

Obtaining participants. To obtain study participants, a sign-up table was set up at the RMS Back to School Night. The event was held at the end of September. A flyer and consent form were distributed to interested parents that evening. The flyer provided the dates and times for the mathematics workshop as well as the contact information for the researcher. Parents who wished to participate in the study provided the researcher with their contact information. Parents who were interested, but were unsure of availability either left their contact information or took a flyer to contact the researcher later. The next day, a follow-up email was sent to all parents who provided contact information. The email thanked parents for their interest in the research project and also reiterated program information. The researcher's original intent was for eighteen to twenty-four parents to attend the mathematics workshop. Sixteen parents signed up to attend on Back to School night. The actual attendance for each workshop varied each week.

Workshop participants. The research study focused on two parents. Though other parents attended various workshop sessions, Laura and Alexis (pseudonyms) each attended all of the workshop sessions and participated in interviews. The study sought to overcome the known barriers to parental involvement. However, families that did not take part in all of the sessions pleaded that time constraints were the greatest hindrance to their attendance. One parent believed that the sessions would not directly benefit him/her in working with their child in Algebra I. Interactions among the research participants and other workshop attendees have been included in the findings only if they are likely to improve readers' understanding of the participants' experiences in the context of the research questions and the themes in this study.

Care has been taken so that nothing in this report will indicate the identities of the participants in the workshop. The two primary participants featured in the analysis are described below.

Alexis. Alexis is married and the mother of three children who range in age from four to fifteen. Her spouse did not attend the mathematics workshop. She has a college degree and works for a large corporation in the neighborhood. At the time of the workshop, one of her three children was attending RMS. Throughout the interviews and the workshop, it was clear that Alexis was involved in her children's studies. She shared her concerns about the mathematics grades of her middle-school attending child but also about other areas of the child's life. Prior to several of the sessions, the son interacted with the researcher about questions on his mathematics homework. After these interactions, Alexis would ask what areas of mathematics she could study at home to ensure her child's academic success. She shared her concern that, perhaps, her child was lazy in school and this was the cause for his struggle with mathematics instead of a lack of ability.

The researcher and Alexis met at the Back to School night. Alexis stopped at the sign-up table to talk with the researcher. At the sign-up table, Alexis expressed her joy that there were math leaning opportunities available for parents. Alexis signed up to attend the mathematics workshop that night after meeting with her child's mathematics teacher. Alexis felt that her child was struggling with math and felt frustrated because she wanted to help him at home but did not always understand what he was learning, and, therefore, was not able to provide help.

Throughout the sign-up meeting, interviews, and workshop sessions, Alexis shared that she did not like mathematics, but knew it was an important topic to understand. In her interview, she said that her child was the reason that she attended the sessions. "I want to help or, at least, know what they (her children) are doing." Alexis shared that at times it was difficult to help her

child with math. “Sometimes I have him solve a problem, and I solve it too. We do not get the same answer, but I look at his work and have no clue what he did, then I wonder whether he is right or am I. I try to show him my way, but he says we don’t do it that way.”

Laura. Laura is a married stay-at-home mother of five children spanning in ages four to fourteen. One of her children attended RMS, and she shared that her child did not necessarily need her help in math. The middle school child struggled at times, but in most cases, the older sibling could help. Laura also supported her children in their studies. She remembered her grade school and high school mathematics and did not mind working on the subject at home with her children. However, she became concerned when she did not always understand the methods her children were using to solve problems. But she was able to tell if they were getting the right or wrong answer.

Laura’s children were active in the workshop. Many of her children did not mind coming in and interacting with the parents as they explored mathematical ideas. This was not typical of the other children whose parents attended the workshop. It was obvious that Laura’s children helped each other with their homework. Laura would bring her questions to the sessions about the methods that her children were using to solve math problems. With these questions, she made meaningful contributions to the workshop sessions.

Laura’s husband attended every session with her. They discussed the mathematics concepts and solved the problems independently before sharing their ideas with the other participants. Interestingly, the couple often chose different approaches to solve the problems. Their personal learning experiences provided a context for their thinking. Laura tended to use her background knowledge of mathematics from her personal educational experiences. Her husband relied on the mathematics he used in work experiences to solve the problems. As the

workshop progressed, her husband's ideas affected Laura's thinking about mathematics. Laura was open to sharing her ideas with the group and to raising questions when she did not understand a procedure or a model for solving a problem. Many participant interactions during the sessions were initiated by questions or ideas that Laura shared.

Data Collection Procedures

Prior to workshop. The original intent of the study was to interview eight parents using the following protocol. Interview participants were to be selected using a computer's random number generator. Selected parents were to be phoned based on the random order and asked to participate in the interviews. The process was to be repeated until there were eight interview participants. The semi-structured interviews were to be conducted one-on-one between the participant and the researcher. The interviews were based on a set of common questions (Appendix B), but the researcher could modify the interview questions as needed to make the conversation natural. Due to the nature of the program and the possibility of participants withdrawing from the program, post-workshop interviews were to be held with original interviewees who participated in all workshop meetings.

Due to the low number of participants in the program, the protocol for obtaining interviewees had to be modified. Of the sixteen parents who signed up to attend the event, none expressed interest in meeting for an interview prior to the first session. Three interviews were held on the first night of the mathematics workshops.

The semi-structured interviews consisted of two components. The first portion of the interview focused on types of parental involvement activities; parental perceptions of mathematics teaching and learning, and a mathematical content think-aloud (Appendix B).

These interviews lasted approximately 15-20 minutes. The interviews were recorded using an

audio device to ensure an accurate transcription of the responses. The researcher transcribed the interviews. Parents' member checked the transcriptions of the pre-interview during the post-interview process.

Workshop design. The study implemented the use of Math for Parents Workshops Mini Courses developed by the Mathematics and Parent Partnerships of the Southwest (MAPPS). This curriculum was developed as part of a National Science Foundation grant awarded to the University of Arizona. The workshop consisted of 6 two-hour sessions. The original MAPPS project mini-courses were created to be an 8-week workshop. Due to concerns from the principal about an 8-week commitment on the part of the parents, the length was shortened to 6-weeks. While the scope of this study was limited to six sessions, the experience provided information to add to the growing body of literature on parental workshops in mathematics.

The 6-week workshop, Mathematics and Parents Partnerships, was held in RMS. Each session began with dinner for the participants and their children. Initially, dinner provided the participants with an opportunity to get to know each other as well as the workshop facilitator and the researcher. Spending time together also helped to dissolve the initial barriers to meaningful interaction. Later, participant interactions during the dinners were about community events, school events, as well as family events outside of the sessions. These experiences fostered a climate of mutual comfort and respect in the sessions.

Attendance was small for each session. While, sixteen parents signed up to attend the workshop, the largest session contained seven parents. Only two families attended all of the sessions. Other parents attended three of the six sessions, but different parents attended each of these weeks. Therefore, since the number of participants was small, the researcher engaged with the participants more actively than initially planned. This also changed the dynamics of the

interactions between the participants as well as between the participants and the researcher. As parents worked in small groups, the researcher could seek more detailed explanations from them about their thinking and also communicate with the facilitator more frequently throughout the workshops. As a result, the information gathered was beneficial to the research project.

The school space designated for the workshop was the teacher's lounge. While the space was not ideal because it lacked a projector and whiteboard, the facilitator used large sized post-it papers (25 in. x 30 in.) to share strategies and discuss problems. The parents interacted around large circular tables. This setting did not allow the facilitator to freely move about to interact with the parents. The size of the group permitted facilitator and researcher interaction with individual parents. Though the room was not ideal in many ways, the small group setting helped to raise the parents' comfort level within the workshop. Throughout the sessions, the parents could discuss what they did not understand, and more importantly from the researcher's perspective, they could freely share their strategies and answers regardless of whether they were right or wrong.

During the workshop, the children were with a volunteer chaperone in the adjoining cafeteria. The volunteer was a former student of the school and a pre-service teacher who was interested in developing her experience with working with children at different levels. She helped the children with their homework during the sessions. The manipulatives used during the sessions were also provided for the children to use during the sessions and at home. The purpose of the materials was to help facilitate the mathematical discourse between the parents and the children. As the children were not far from the parents during the sessions, they freely entered the sessions each evening. The parents seemed comfortable discussing mathematics with their children during the sessions. Though this was not the original intent of the workshop, it did offer

a chance for parents to experience their children’s mathematical thought processes in certain situations. These moments provided additional opportunities for discourse during the workshop sessions.

Often sessions ended with questions such as, “What did you learn tonight?” and “What is something that you wonder about?” (MAPPS, 2003). In response to these questions, the group talked about how one mathematical problem could be solved in several different ways. A participant said, “The blocks helped me to see where the numbers come from and why we do what we do when we solve a problem. I also saw why other ways worked.” Another person added that ideas related to decimals seemed easier to understand when using base ten blocks. Laura wondered, “Why do they all have to do it the same way or why can’t we all do it different?” Alexis added, “But how will we know all the different ways?” Many parents nodded in agreement. During several sessions, parents brought up questions related to things they wanted to learn or things in mathematics that they wondered about. These “I wonder why…” questions were often used as a springboard for initiating or reviewing content during the next session. Figure 3 shows a sample “Something I Wonder” chart from Session 5 (MAPPS, 2003). However, the topics listed on the sheet were not part of the planned workshop program and instead were discussed during the session 6 dinner.

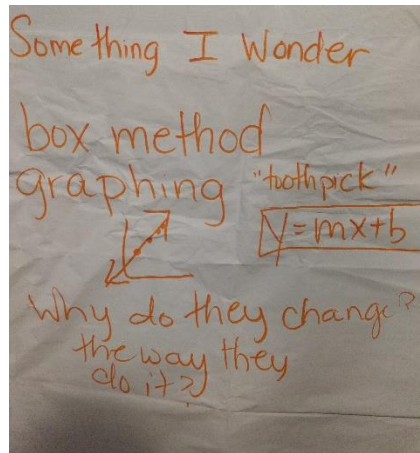


Figure 3. Something I Wonder Chart (Session 5)

Workshop design followed the MAPPS (2003) curriculum, *Thinking Rationally About Fractions, Decimals, and Percent*. However, the discussions were fluid and driven by the parents. Many times, the facilitator would begin to follow the curriculum, but parents would turn the conversation to mathematical areas of their interest. Several sessions began with questions posed by parents after discussing math homework with their child during the previous week or topics on the “I Wonder” charts. The facilitator and researcher both felt the fluid nature of the sessions was important to build a community of learners and therefore allowed parents to drive the conversation.

An educator with 15 years of experience led each of the sessions. The facilitator was a certified mathematics specialist in the state of Virginia. Her prior education experiences include being a fifth grade teacher, a mathematics specialist, and a post-secondary mathematics instructor working with pre-service teachers and in-service teachers. The facilitator and the researcher have been colleagues for ten years through their work in mathematics education. Based on prior work experiences, interactions between the facilitator and the researcher before, during and after the sessions was a natural part of the research process. Prior to the each session,

the facilitator received the materials and curriculum. Each week the facilitator and the researcher met to discuss the nightly plans for that week's session.

The sessions were audio recorded each evening. The researcher noted observations during each session in a field journal. According to Creswell (2013), observation is one of the central tools for gathering data in qualitative research. Journal entries allowed the researcher to note observations that may not have been easily understood when listening to the audio recording. The researcher's major role as an observer, was to observe using her five senses (Creswell, 2013), to fully understand the parents mathematical content knowledge and their changes in perceptions of mathematics instruction and parental involvement.

The morning after each session, the researcher held a post session discussion with the facilitator. During these unstructured discussions, the facilitator and the researcher discussed the mathematical knowledge acquisition of the parents during the session. The facilitator shared her perceptions of the mathematical content knowledge of the parents. These discussions allowed the researcher to reflect on her personal observations. The discussions centered on themes associated with the three research questions, but discussions predominantly focused on how the parents' mathematical content knowledge of rational numbers changed and developed throughout the workshop. This interaction served as peer review for the researcher. This process of peer review helped the researcher to mitigate against personal biases that might have arisen during the workshop observations (Lincoln & Guba, 1985).

Post Workshop Interviews

Post interviews further investigated the parents' experiences and feelings related to mathematics content and to the level of parental engagement after the completion of the workshop. Final interviews were held with two parents who completed all of the workshop

meetings. The semi-structured interviews were conducted at a location within the local community during times that were convenient for the parents. These interviews lasted between 45 and 60 minutes. Through their responses to post interview questions, the participants reflected on the impact of the mathematics workshops on their perceptions of mathematics teaching and learning (Appendix C). Additional relevant questions were used to probe deeper and to allow the conversation to take a natural path. Transcribed data gathered through the pre-workshop interview was used to enhance the conversation when needed. For example in the final interview, parents were asked if the prior transcribed descriptions of mathematics instruction or parental involvement were still valid after completing the workshop. This allowed the parents to reflect on changes to their own perceptions of mathematic content, instructional practices and parental involvement. Interviews were audio recorded and transcribed by the researcher. Table 2 shows the data collection summary within the research study.

Table 2

Summary of Data Sources

Research Component	Data Sources
Pre-Workshop	Interviews Field Notes
Workshop Sessions	Observations Workshop Audio Recordings Workshop Chart Paper Session Work Samples Take It Home Activities Field Notes
Post-Workshop	Interviews Field Notes

Timeline

The research study began in the summer of 2017 and ended the spring of 2018. Table 3 below shows the timeline for the research process.

Table 3

Research Study Time Line

Research Project Component	Time Frame
IRB and District Approval	July 2017
Participant Sign-up	September 2017
Pre- Workshop Interviews	October 2017
Workshop Sessions	October & November 2017
Post-Workshop Interviews	December 2017 – January 2018

Role of the Researcher

I have worked in education for 20 years. During seven of those years, I was a seventh and eighth grade middle school teacher. Currently, I work as a full time post-secondary instructor teaching mathematics courses for pre-service teachers and teachers in the Richmond area. I am a parent of two elementary students. My interest in parental involvement and in developing methods for understanding parental involvement in mathematics have arisen from questions and concerns posed by parents in my community on current instructional practices.

As part of a qualitative study, I recognize that I was the learner within the interviews. Creswell (2013) recognized that in qualitative research, the researcher must be an active learner rather than a person who passes judgment on what is communicated. All participants were assured of confidentiality in the study. Participants were reminded that they could decline to answer any question that they were asked. I attempted to establish a level of trust so that participants felt comfortable sharing their thoughts and feelings. Furthermore, I member

checked during the interviews as well as through the transcripts of interviews. Lincoln and Guba (1985) believe the use of member checking is important for the credibility of the study due to the ability of the participant to review their comments for truthfulness.

My role within the study was the researcher. I collected, analyzed and interpreted data. I conducted all member checking and data analysis. There was researcher bias. I recognize that I am a parent and a mathematics educator. I believe that parents should be active participants in the mathematical teaching and learning experiences of their children. I also believe that parents, like children, have barriers that exist in learning mathematics and one must understand their perceptions in order to build programs for parents that will contribute to the academic success of children and adults in mathematics. To help recognize my bias, I used a reflective journal as well as peer review to help me reflect on topics from a larger frame of reference

Data Analysis

Interview and workshop sessions were transcribed throughout the process. Key ideas and common patterns in the data were identified and coded. The process of data collection and data analysis occurred simultaneously to test for emerging conclusions (Maxwell, 2007). The researcher used two decision methods for analyzing data. The two methods as defined by Maxwell (2007) were connecting strategies and coding. Connecting strategies attempts to understand the data in context. The researcher looks to find relationships to “connect statements and events within a particular context into a coherent whole” (Maxwell, 2007, p.238). In seeking connecting themes, the researcher broke the data into smaller pieces of information to facilitate making comparisons across and between categories. The categories were initially derived from pre-existing literature, but the researcher recognized that this could create “analytical blinders” (Maxwell, 2007) that may prevent the researcher from seeking alternative

ways to understand the data. To help the researcher seek alternative understandings, peer review and journaling were used during the research study.

Research question one sought to understand how parents' understanding of rational numbers changed and developed throughout the mathematics workshop. In order to understand how change occurred the use of mathematical think-aloud interview questions, workshop artifacts, workshop audio recordings, and workshop observations were analyzed. Initial coding categories were developed from prior literature on the five strands of mathematical proficiency. Significant indicators of each of the five levels of mathematical proficiency are:

- Conceptual understanding is representing mathematical situations in different ways, finding connections between the representations and connecting prior mathematical knowledge to new knowledge to solve problems.
- Procedural fluency is the ability to solve computational procedures efficiently and accurately.
- Strategic competence is the ability to solve a problem using several strategies, but also to recognize the best method for representing a problem.
- Adaptive reasoning is the capacity of justifying one's mathematical work.
- Productive disposition is to recognize that learning mathematics is important.

Kilpatrick, Swafford, and Findell (2001) advocate that when given a chance to reason, communicate, and build on mathematical thinking in collaborative environments an individuals' understanding of mathematical concepts will shift. Throughout the transcription process, data analysis identified the five interweaving strands of mathematical proficiency.

Research questions two and three, sought understand the influence of the mathematics workshop on parental perceptions of current mathematics instructional practices and parental involvement. The Hoover-Dempsey and Sandler Framework (1995, 1997) and literature on

parental perceptions of mathematics instruction and parental involvement, was used to code the transcripts and connect strategies. After multiple readings of the transcripts, some codes were eliminated or revised.

After the initial data analysis, the researcher returned to the raw data beginning with the final interview transcription. Auerbach and Silverstein (2003) suggest how to transition from raw text to theoretical context by narrowing data to relevant text, seeking similar words or phrases that suggest repeating ideas, looking for groups of repeating ideas to justify existing themes. The researcher color-coded statements within the final interviews and compared them to the previously identified themes developed throughout the data collection and data analysis process. Using the final interviews, the researcher identified words, phrases, or sentences to compare and categorize statements together for each participant to see if the themes that were identified reflected the guiding research questions. Lastly, the researcher followed the threads of change and development for each theme with each of the participants throughout the research study.

For example in her final interview, Laura described the use of pictures and blocks to help explain her reasoning. “The blocks helped me to think about and see what I was thinking. Moving them around and thinking about the operations really helped me.” The researcher looked for examples throughout the workshop transcriptions to find instances where Laura used blocks or representation to justify her thinking. In the session on adding decimals using base-ten blocks, Laura explained how the blocks helped her to understand the operations and to justify her own thinking. “It is about keeping the places together. Not just because someone told me to line them up, [but because] they have a value. The blocks made me think about each place based on the block.”

Similarly, the researcher sought to find threads of change in how Alexis developed a conceptual understanding of rational numbers. In her final interview, Alexis stated, “I can do the math. I don’t always remember the procedure at first, but it comes back to me. The meetings made me think about why we do what we do. There is a reason why the rule works.” During a session, Alexis was asked to order the decimal numbers, 0.03, 1.34, 1.4 using base-ten blocks. In describing how she determined that 1.4 was larger than 1.34, Alexis said, “Look at the three [1.34] and the four [1.4]. That four [1.4] is four rods and that three [1.34] is three rods. The four rods are bigger than the three.” Alexis explained that she had learned to add a zero to the end of 1.4 to make the numbers easier to compare, but had never thought about why the method worked. Base-ten blocks provided Alexis with the opportunity to develop a conceptual understanding of decimal place value.

The two examples provided were just two of the many cases where the researcher sought to understand how the participants developed and changed their mathematical understanding and parental perceptions during the workshop experience. By returning to the data, I sought to find alternative explanations to the themes that existed such as interactions or experiences that may have occurred outside of the sessions (Creswell, 2013). For example, if I read something within the final interview that led me to view changes in mathematical content knowledge differently than I had before; I searched for explanations within prior session transcripts. Alternatively, I might understand something a participant said during an interview in a different way due to a particular interaction that took place within the workshop sessions. Weaving the sources of data together, drawing on different pieces to support the emerging themes provided opportunities to re-examine the research questions. Table 4 represents data sources and analysis.

Table 4

Research Questions, Data Sources, and Analysis

<u>Research Question</u>	<u>Instruments</u>	<u>Analysis</u>
In what ways do parents' knowledge of rational numbers develop and change through the participation in a 6-session mathematics workshop?	Observation Artifacts Interview	Inductive & Deductive Coding
In what ways do parents' understandings of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?	Observation Interview Artifacts	Inductive & Deductive Coding
In what ways do parents' beliefs about their involvement in supporting their child's mathematical learning change through their participation in a 6-session mathematics workshop?	Observations Interview	Inductive & Deductive Coding

Validity/Trustworthiness Issues

Throughout the study, I sought to reduce the risks to trustworthiness by implementing a variety of strategies, such as reflecting on the biases or limitations of the study, utilizing triangulation, participating in peer review, and implementing member checking. I hoped to increase the credibility of the research study through prolonged engagement (Lincoln & Guba, 1985). Lengthy observations of the workshop sessions and detailed, descriptive field notes as well as solicited feedback on data and conclusions from the participants and peer reviewer aided in producing valid findings.

In order to ensure validity in this qualitative research study, participants took part in member checking and thus provided credibility to the study (Lincoln & Guba, 1985). The researcher invited the workshop facilitator to serve as the peer reviewer for the study. The facilitator helped to provide guidance on emerging themes. The researcher used a reflective and observation journal to write thoughts and ideas that emerged during the research process. To

account for dependability, an extensive audit trail was kept, which described the process by which data collection and analysis were recorded (Lincoln & Guba, 1985). This audit trail included interview transcriptions, workshop transcriptions, the researcher's reflective journal, field (observation) journal, and workshop artifacts. The audit trail allowed the researcher to build and support a thick description of the program. Although this research is not generalizable to a larger audience, it is possible that the information is transferable to other settings and adds to the growing body of literature on mathematics workshops for parents.

Summary

The purpose of this study was to examine the role mathematics workshops for parents on parents' mathematical content knowledge, perceptions of current instructional practices, and parental involvement in mathematics. It was expected that a total of 18-24 parents from RMS in Virginia would participate in the study; of those eight parents would be interviewed. Due to the low number of participants, two parents were interviewed for the study. Though the researcher sought to overcome known barriers to parental involvement, the barriers still existed. Parents listed time as the main hindrance to attendance. In order to answer the research questions, a qualitative study was used. Data collection included interviews, workshop audio recordings, workshop observations, and workshop artifacts. Data was analyzed using inductive and deductive methods to search for themes that related to each of the research questions.

Chapter 4: Findings

This chapter presents the findings from qualitative research. The study explored mathematics workshops for parents and the impact of the workshops on parents' mathematical content knowledge, perceptions of current instructional practices, and parental beliefs in supporting their children in mathematics. The three research questions that guided the study were as follows:

1. In what ways do parents' knowledge of rational numbers develop and change through their participation in a 6-session mathematics workshop?
2. In what ways do parents' understanding of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?
3. In what ways do parents' beliefs about their involvement in supporting their child's mathematical learning change through their participation in a 6-session mathematics workshop?

This chapter presents the findings from the investigation into these three research questions. Analysis of all three research questions included data from face-to-face interviews with parents, workshop observations, document analysis, and the researcher's field notes.

Research Question 1

In what ways do parent's knowledge of rational numbers develop and change through their participation in a 6-session mathematics workshop?

Reflecting on how parents' knowledge develops and changes overtime is important in order to find ways to increase parental involvement. Parents need an understanding of mathematics as well as the appropriate knowledge and skills to feel comfortable helping their child study mathematics (Vukovic, Roberts, & Wright, 2013). Mathematical understanding in the area of rational numbers predominately focuses on working with fractions, decimals, ratios, and percents. However, the formal definition of the set of rational number includes whole numbers. While not the original intent of this workshop, specific questions about whole numbers from parents were addressed during the workshop.

As described in Chapter 2, the development of mathematical understanding consists of the interweaving of five strands of mathematical proficiency, namely, conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and procedural disposition (Kilpatrick, Swafford, & Findell, 2001). Throughout the workshop, the participants engaged in activities that focused on these five strands. By attending, parents changed some of their prior understandings of mathematics and developed new understandings of rational number concepts.

Parents Connect New Mathematical Ideas to Old: Building Conceptual Knowledge

Kilpatrick, Swafford, and Findell (2001) state that conceptual understanding supports the connection of ideas, which in turn supports the retention and reconstruction of mathematical facts. Learning for conceptual understanding is rooted in the developmental learning theory of Piaget (1970) and describes how learners generate knowledge and understanding through their experiences. The workshop provided an opportunity for participants to explore new mathematical learning experiences. They interpreted these experiences through their prior mathematical experiences. A parent's ability to find connections between ideas and recognize relationships among various mathematical representations is evidence of the development of

conceptual understanding (NCTM, 2014). Building this type of conceptual knowledge was important as the parents began to develop connections between new mathematical understandings and their prior mathematical skills in rational numbers.

Conceptualizing the relationships between numbers. Transitioning from working with whole numbers to rational numbers requires one to move beyond expressing a number as a fixed quantity (Moss, 2005). Parents began to develop a deeper conceptual understanding of rational numbers. In particular that rational numbers are expressed in relationship to other numbers. Rational numbers have multiple interpretations, but, in each case, one must understand the unit of comparison.

Parents conceptualize together. One session explored fractions and decimals using tangrams, an ancient Chinese puzzle consisting of seven pieces that form a square (Figure 4). The parents began by exploring tangrams by fitting the pieces into puzzles presented by the facilitator. As the parents manipulated the pieces, they used informal (e.g. turn, flip, and slide) and formal (e.g. rotation, reflection, and translation) mathematical language describe the movements. Many expressed frustration in trying to form pictures from the pieces. The facilitator shared with the parents that one use for these manipulatives is the development of spatial skills.



Figure 4. Tangram Puzzle

To explore fractions and decimals, the parents were asked to imagine that a person could buy the whole set of tangrams for eight dollars. They were tasked with finding the value of each piece. Working in groups of two, parents began by discussing possible values. Alexis's group decided that the large triangle was worth one-fourth of the original square. When she was asked to explain Alexis replied, "I can see that two of these triangles make half of the square, so each (large triangle) must be one-fourth. Half of a half is a fourth." Another parent in the same small group continued the conversation by saying, "If this (pointing to the large triangle) is one-fourth of it then it is two dollars." When asked to explain how they knew the value was two dollars, a parent replied, "Eight divided by four is two." When prompted to explain how one-fourth and dividing by four were the same, the group could not answer the question. They were unable to provide a justification for that part of the solution or to concretely represent the situation using the manipulatives.

Participants continued to work individually and in small groups to investigate the value of the tangram pieces. The tangram piece that raised the most questions among the parents was the parallelogram. Parents could not instantly see the value with respect to the other pieces. Both groups laid the parallelogram on the large triangle to find the value. The groups concluded that it was one-third of the large triangle, but after further discussion, they determined that could not be true. Laura's group then decided that the small triangle could be used to determine the value of the parallelogram. When asked to explain the reasoning to the whole group of participants, Laura explained that parallelogram was the same as two of the small triangles so one would need to figure out the value of one of the smallest triangles before figuring out the value of the parallelogram.

Laura's group continued to explain the value of each piece. The group referenced the large triangle when determining the value of all of the other pieces. The researcher noted that this seemed odd since the large triangle was worth one-fourth and the entire square was worth one. A parent asked Laura's group to explain their method for determining that the small triangle was worth one-sixteenth of the whole or 50 cents. Laura said, "We know this is the two dollar triangle [large triangle] and then lay the smaller pieces on top of it to see the other values in relationship to the two." The reasoning was not clear so a parent asked Laura to explain again how the value of the small triangle was one-sixteenth. Laura said, "If this, the largest triangle, is one-fourth then it takes four of them to make the square. It takes four little triangles to make the largest triangle, so 16 to make the square. So, I would need sixteen of the littlest triangles to make a whole, so this one is one-sixteenth."

After each group shared their findings and solution methods, the parents were asked what they thought about as they completed the activity. Alexis said,

I always thought about fractions as cutting shapes or circles. We didn't cut them but instead used them to think about how they made a square. It was also odd that these pieces [square and parallelogram] were the same. They don't look like they should be the same. Since the pieces were different, I had to think about how they fit with the little triangle.

Adding to the thought, Laura said, "This made me think about how the piece doesn't have to be the same shape but can be the same size like the square and this shape [parallelogram]." Laura recognized that to be equivalent fractions did not mean the same shape, but instead meant the same size. The size is relative to the whole.

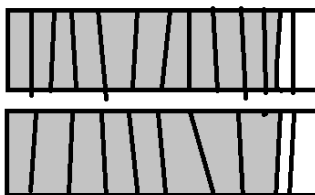
Alexis. After modeling whole numbers and operations of whole numbers with base-ten blocks, the facilitator instructed participants to order the decimal numbers, 0.03, 1.34, and 1.4, using base-ten block representations. Prior to beginning the exploration, participants had assigned a numerical value to each of the base-ten blocks. Alexis responded, "Wouldn't the flat

be one?” Using Alexis’s suggestion, another parent explained that if the flat were one then a rod would be one tenth. Continuing the explanation, the parent determined it would take ten rods to make a flat. Alexis added, “The little cube would be a hundredth since it would take 100 of them to make a flat.” Using context, Alexis responded, “Like money, this [unit] is like a penny and this [rod] is like a dime. It takes ten to make it [a flat].” Alexis determined that 1.4 was the largest number in the set. In describing how she determined that 1.4 was larger than 1.34, Alexis said, “Look at the three [1.34] and the four [1.4]. That four [1.4] is four rods and that three [1.34] is three rods. The four rods are bigger than the three.” Alexis explained that she had learned to add a zero to the end of 1.4 to make the numbers easier to compare, but had never thought about why the method worked. Base-ten blocks provided Alexis the opportunity to develop a conceptual understanding of decimal place value.

Similarly, during the final interview, Alexis did not try to solve any mathematics problems but instead described several ways in which she could now think about solving each of the questions. Alex was posed the following interview question (Figure 5) during the post interview (see Appendix C, Question E).

Your child is asked to compare $\frac{8}{10}$ and $\frac{11}{13}$.

Based on his/her drawing your child believes the two fractions are the same.



Do you agree that his/her drawing shows the two fractions are equal?

Why? How would you compare the two fractions? Clearly, explain your method.

Figure 5. Post Interview Question E

Alexis shared:

I cannot compare these pictures as easily as the numbers. It is hard to keep the sizes the same when drawing. The two pictures make me think they are the same, but I know they are not. Thinking about the size of the piece helps me. Eleven-thirteenths is larger. It has smaller pieces, but I have more of them.

Continuing with the conversation, Alexis described how when comparing fractions she must think about the object or the whole. When asked to elaborate on what she meant by the whole, Alexis responded, “I have one pizza. You can cut it into eight slices or four slices. The eight slices means you have more slices, so they are smaller than the fourths.” Referring to a conversation with the facilitator, Alexis added, “[Facilitator’s name] talked about how one half was not the same as one-half. Half a medium pizza is not the same as half a large pizza.”

During the final interview, Alexis described how her thinking had changed when thinking about fraction equivalence. Alexis stated,

[Before the workshop] I would have done common denominators, but I think now I would think about the pictures and visually try to see them. I also know what common denominators are. Before the workshop, I just knew how to find them, and never thought about what they really meant. They [common denominators] are about having the same size pieces.

Alexis correctly described how to do the problem by finding common denominators, but in sharing her ideas, she described the shift in her thinking. “I can do the math. I don’t always remember the procedure at first, but it comes back to me. The meetings made me think about why we do what we do. There is a reason why the rule works.” Alexis developed a conceptual understanding of the relationship between the numerator and the denominator as well as an understanding of the equivalence of fractions.

Laura. Each week, Laura was open to sharing her thinking, whether her methods were right or wrong. In one session, parents were asked to think about why $2\frac{1}{2}$ is equivalent to $\frac{5}{2}$. Laura said, “I know you multiply and you add.” The facilitator asked her which numbers should

be added and which should be multiplied. She paused and said, “Two times two plus one is five so five-halves.” The facilitator asked the group to explain how the rule worked. The parents worked on drawing illustrations to show that two and a half was equal to five halves.

Laura developed a drawing that showed three whole circles. She completely colored in the first two circles. The last circle, Laura cut in half and colored in one of the halves. After a minute, she cut the two whole circles into halves (Figure 6). Laura said, “I started with two and a half. I then realized that if I cut each whole in half, I still have a one.” Another parent asked her to explain. Laura said, “Just look at the halves. I have one, two here; three, four here; and five there.” As she spoke, she pointed to each of the halves. Laura’s explanation was followed by a discussion among the participants of the rule for converting from mixed numbers to improper fractions. Laura added, “It is two wholes divided into halves. Two times two gives me four halves and then the one more to add the numerator. I like how the picture makes me see why I multiply and add.”

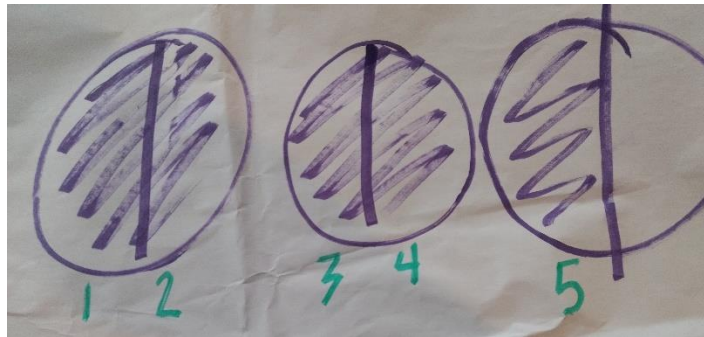


Figure 6. Laura’s Representation of Mixed Number to Improper Fraction

Laura continued the discussion by recognizing how one could convert an improper fraction to a mixed number by using the same representation. “Is that why it works the other way? Two goes into five twice because there are two circles and then the one left over is the one half?”

Laura's mathematical ability was high. She was able to articulate clearly how to solve problems. In her final interview, she talked about the gains in her mathematical understanding. "I get so many of the ideas differently than I did before. I can look at this problem and think about it in different ways." Recognizing the mathematical connections between concepts was important for Laura. During her post-session interview, Laura compared $\frac{8}{10}$ and $\frac{11}{13}$ based on a picture (Figure 5). After looking at the picture, she responded,

In just looking, I would agree that they are equal, but I know that the denominator says they are not the same. In the past, I know I could have changed the fraction to decimal or found common denominators, but I understand that it is about the relationship of the denominator and the numerator.

Laura correctly identified the larger fraction as being $\frac{11}{13}$. "It is larger, closer to 1. That picture doesn't show it, but if you think about it in your head it is closer to one." Focusing on the relationship of the numerator and denominator provided Laura the opportunity to think about the value of each of the fractions to determine which was greater.

Parents move beyond one strategy: Conceptualizing operations. Knowledge of different procedures coupled with the ability to perform them flexibly, accurately, and efficiently constitutes procedural fluency (Kilpatrick, Swafford, & Findell, 2001). Changes in a participant's conceptual understanding led to many conversations on the variety of procedures that children brought home, or that parents found through social media. Parents began to explore procedures by developing a conceptual understanding of the operations for rational numbers.

Alexis. During the workshop, Alexis expressed her own perceived lack of mathematical understanding and skill. When presented with a question, Alexis was not always able to use a mathematical procedure. "I don't remember how to do that," was often her response. Alexis would remember the procedure if another participant shared a standard algorithm. For example, when working with a problem involving dividing two fractions, Alexis remembered that she

needed to flip one fraction, but did not remember which fraction she should use to take the reciprocal. Before the workshop, Alexis perceived her inability to remember the rules of mathematics was not based on a lack of education but instead was a product of relying on a calculator or computer to complete mathematical calculations.

The plan for the fourth session was to focus on decimal numbers, but after responding to several questions from parents, a decision was made to begin with whole number operations before moving to decimal numbers. The facilitator asked the participants to add the numbers 33 and 17 using base-ten blocks. After laying base-ten block representations of both numbers on the table, Alexis responded, “I got forty and fifteen.” On the table in front of her were four rods and 15 units. When asked if she could simplify her answer, Alexis said, “Ten units would give a rod which would give us 55.” The facilitator wrote the $40 + 15$ on the chart paper and then below it wrote $40+10+5$ equals 55 (Figure 7).

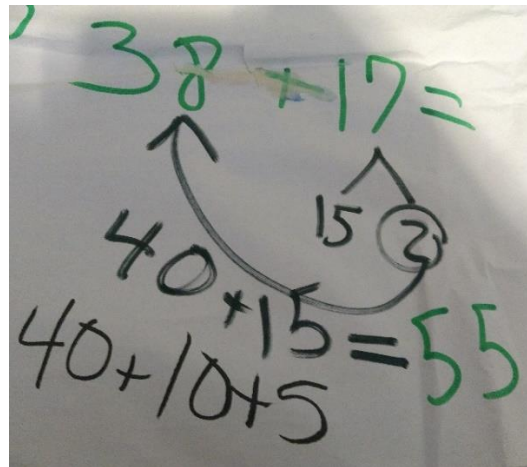
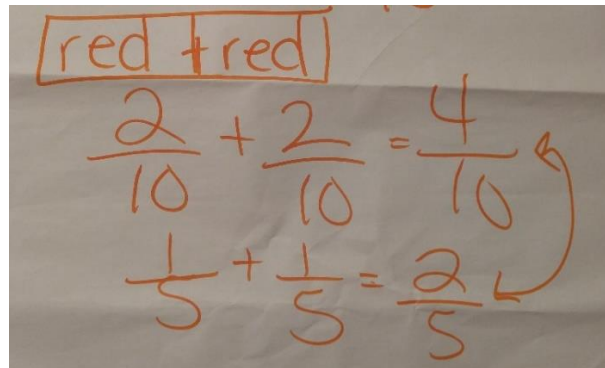


Figure 7. Alexis’s Addition Strategy

Participants shared several other strategies before the facilitator wrote the standard algorithm and showed the regrouping of the ten “ones” into one “ten”. When asked to think about the relationship between the blocks and the algorithm, a parent attending the session commented that the blocks showed where the one in the tens place comes from in the standard

algorithm. Alexis added, “I think I knew that is where the one came from, but I have never thought about it until now. I see why it is a one there. It is saying one ‘ten’.” Alexis was making connections between what she remembered about standard algorithms and the conceptual ideas behind them.

Moving beyond whole numbers to working with fractions operations, Cuisenaire rods helped participants to explore fraction operations. In one session, participants were asked to determine the sum of two red rods if the orange rod was worth one. Alexis laid the two red rods above the orange rod and then placed a purple rod above them. When asked for the answer, Alexis responded, “Purple.” The facilitator prompted Alexis’s group to use fractions to determine a numerical value. The group had used the white block as one-tenth in a prior activity. As a result, Alexis said, “Four-tenths.” When asked to explain, Alexis responded, “A red is two whites or two tenths, so I have four-tenths.” The number sentence was written on the chart paper, and then the facilitator asked the group if there was another way to think about the problem. After several minutes, Alexis responded “Two-fifths. It takes five red rods to make an orange, so a red is one-fifth.” The number sentence was added to the chart paper. Alexis added, “The rods let me to see that two-tenths are the same as one-fifth. Either way, I get the same answer since they would simplify to get the same answer (Figure 8).”



The image shows a piece of white chart paper with handwritten mathematical equations in orange ink. At the top, the words "red + red" are written and enclosed in a rectangular box. Below this, two equations are written. The first equation is $\frac{2}{10} + \frac{2}{10} = \frac{4}{10}$. The second equation is $\frac{1}{5} + \frac{1}{5} = \frac{2}{5}$. A curved arrow on the right side of the equations points from the $\frac{4}{10}$ result of the first equation down to the $\frac{2}{5}$ result of the second equation, indicating that these two fractions are equivalent.

Figure 8. Cuisenaire Rods

As the conversation progressed, the group solved for the sum of a yellow rod and a green rod when the orange rod was worth one. Another group determined that the number sentence was five-tenths plus three-tenths is equal to eight tenths. Alexis said,

I was looking at the yellow at first and thinking one-half, and then realized that I have to put it in terms of tenths to find the answer. I was having a hard time thinking of one-half and three-tenths...Instead, I needed them to be in the same size to add them; it is easier to add five-tenths instead of one-half.

Alexis was justifying her thinking about how to add fractions without finding a common denominator or using the formal algorithm.

Laura. During conversation one night at dinner, Laura brought up the lattice method for multiplication. She did not state the method by name but mentioned “a weird way of multiplying that had lines and boxes”. The lattice method is based on a grid in which numbers being multiplied are written across the top and right of the grid. Each cell is filled with a product of the row and column. The values are summed along the diagonals (Figure 9).

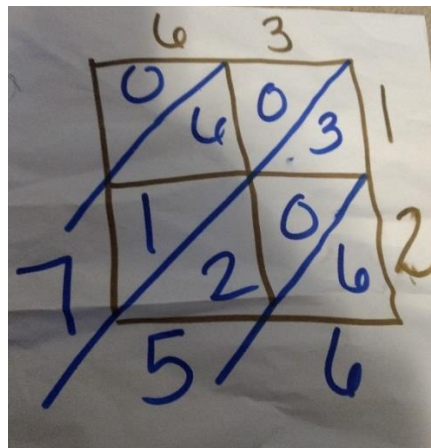


Figure 9. Lattice Multiplication

The researcher and facilitator decided to use Laura’s comment as the springboard for the discussion that night. The problem posed for the night was 63 times 12. The group first solved the problem by using the standard algorithm. The method of partial products (Figure 10) was

written on chart paper and the group was asked to explain the procedure. Laura responded rather quickly. “The six is from two times three, the 120 from two times 60, the 30 from ten times three, and the 600 from ten times 60.” When prompted to explain how she recognized it so quickly, Laura responded,

It is the same [as standard algorithm], but you write what you get with each set of numbers. So, in the normal way you do two times two first, which is the same over there. Then you do two times six and write the twelve beside the six, which is 126. The difference is that you write 120 over here instead of 12. It is like when we said 12 rods was 120.

$$\begin{array}{r}
 63 \\
 \times 12 \\
 \hline
 6 \quad (2 \cdot 3) \\
 120 \quad (2 \cdot 60) \\
 30 \quad 10 \cdot 3 \\
 + 600 \quad 10 \cdot 60 \\
 \hline
 756
 \end{array}$$

Figure 10. Partial Products

As the group moved to the lattice method (Figure 9), Laura identified where the numbers came from, but she was unsure about why the method arrived at the correct solution by adding. “I don’t see it. Why does it need the diagonals?” The facilitator explained that the diagonals correspond to hundreds, tens, and one’s place value positions. The process of multiplying the numerals along with the place value position results in the value of the product from the sums along the diagonals. Laura could see the method but had some doubts as to the effectiveness of the strategy. “I like the other methods, and I can see the similarities between them, but the lattice

does not make sense. I don't know if I could figure it out. There is a lot going on that a kid could mess up. Well, I could mess it up!"

Transitioning to a discussion about multiplication of fractions, the facilitator asked participants what two times three meant. A participant responded by saying three plus three. Building on this response, the facilitator instructed the group to think of this example of multiplication as two sets of three. Participants were posed the problem, $1/2$ times $1/3$. Laura said, "Can I think of this as half a set of one-third?" The facilitator asked Laura to explain her thinking in a drawing. Laura said, "I guess you have a third." The facilitator drew one-third of a rectangle on chart paper. Laura responded, "One-sixth. If you cut that one third in half, it is one-sixth." In justifying her answer, Laura continued said, "I thought of cooking like I have a third a cup of sugar and I only need half of it to make the recipe." In explaining how her picture justified her thinking, Laura, said,

If you cut the one-third in half, you can see the one-sixth. I know how to solve it by multiplying the top and the bottom, but it makes more sense to think about it as half a set of a third. You [facilitator] said we do not have to always write it down. You can solve these [fraction multiplication] in your head if you think about it.

In her post-session interview, Laura expressed the importance of having a conceptual understanding when developing procedural fluency. "The different ways we looked at problems really helped me to think about how different ways to solve it [a problem] are the same. They all work for the same reasons, but look different." Similar to Alexis, Laura recognized the importance of having non-standard procedures for solving problems. Laura stated, "We don't need paper and pencil, but [for] many of the problems I can just reason out in my head. Many of the ways we thought about are easier than what we actually do." Instead of being able to able to perform a mathematical algorithm, one can think about the underlying mathematical concepts to find a solution. The development of conceptual understandings behind rational number

procedures allowed parents to begin thinking about using different strategies to solve problems both fluently and efficiently.

Parents Justify Their Mathematical Thinking

Representing, discussing and making connections among mathematical ideas deepens one's understanding of mathematics concepts (NCTM, 2014). Justifying solutions requires the use of prior knowledge along with reasoning to connect different mathematical ideas. The solution must not only provide the correct answer, but justify requires an explanation about why the strategy worked for the given mathematical situation. Representing the problem situations, solving the problem, and offering mathematically sound reasons for the work are important for developing a full mathematical understanding (Kilpatrick, Swafford, & Findell, 2001). In the workshop, evidence of justification through discourse and representation was not apparent in the first couple of sessions, but as the parents began to further explore mathematical ideas, changes occurred in the ways they explained their mathematical thinking. Parents began to represent mathematical ideas using diagrams and manipulatives as well as to verbally explain their thinking to each other.

Alexis. Alexis asked questions throughout the workshop. Throughout the sessions, she focused on looking at the strategies of others and making connections to what she knew. Alexis asked other parents to explain their methods with regularity. Listening to others helped Alexis to develop justifications for her own thinking. For example, a conversation about subtraction strategies led Alexis to provide a real-world explanation. The group was provided with an open number line showing the difference between 49 and 76. To find the solution, the facilitator added up from 49 to get to 76. The facilitator started at 49 and added one to get to 50, then jumped by 20 to get to 70. Lastly, she made a jump of six to get to 76. The result of the jumps

$(1 + 20 + 6)$ represented the difference between 49 and 76 (Figure 11). In discussing the method, Alexis provided a context for the situation. “I have seen that before when someone returns money at a store. They count from what I owe.” A real-world context or other methods for finding meaning when looking at the problem situation was important to help Alexis find answers to her questions and justify her understanding. Similarly, when Alexis described an answer or questioned a solution, she often based her response on a representation. Alexis understood the concepts when she could represent them in a visual context.

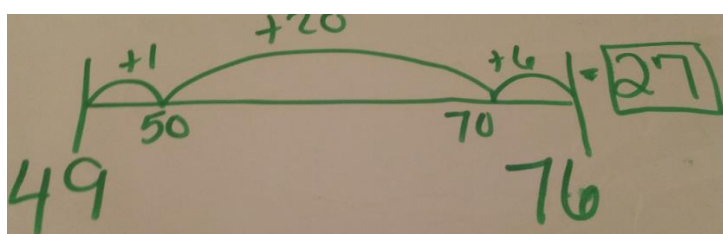


Figure 11. Subtracting on an Empty Number Line

One evening the facilitator posed a subtraction problem to the participants, $1002 - 998$. One participant said, “I can’t do that in my head.” The facilitator agreed that the problem was difficult to do in your head when using a standard algorithm. “For me, I would look at this one and start at 998 then 999, 1000, 1001, and 1002 which would give me four,” shared the facilitator. Alexis said, “I would add two and two.” When asked to describe why, Alexis shared, “If you look, 998 is two from 1000 and 1002 is two above it, so both are two away. That gives me four.” Figure 12 below is the mathematical representation that Alexis and the facilitator shared during the session.

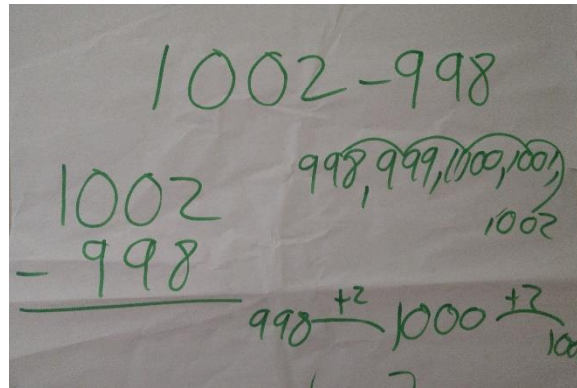


Figure 12. Discussion of 1002 - 998

In addition, Alexis noted again that although she knew how to use the algorithm for subtraction, she had never really thought about where the one came from in the borrowing process. Discussing the procedures helped Alexis to recognize that there were multiple ways to solve a problem. Strategies were not just steps to follow. There was a mathematical idea associated with each part of the non-standard procedure. After this, Alexis began to unpack other procedures and to develop solution strategies on her own.

In explaining her mathematical thinking, Alexis would use the manipulatives or ideas from her personal experiences to justify her answers. During her post-workshop interview, she looked at the second mathematical content problem (see Appendix C – question E -b) that required her to order fractions and decimals from the least to the greatest (Figure 13).

A test question asks your child to put the numerical representations below on the number line in least to greatest order. Place each number on the number line and explain your reasoning for the placement.

a) 0.452 b) $\frac{1}{3}$ c) $\frac{8}{7}$ d) 0.55 e)

Figure 13. Interview Question E (b)

Her first strategy was to think of the numbers in relationship to 50%. When asked why she thought of this strategy, she said, “When I shop, I think of how things are on sale. I use percents.” Alexis described how she could change all the numbers to decimals but recognized that it did not make sense if she did not have a calculator. “Some fractions are easy to think of as a percent or decimal. I just know what they are, but some of these I don’t [know what they are]. I could use my phone or estimate.” When asked if she could solve the problem using fractions, Alexis said,

Yes. I know that one-third is less than a half and that picture is two-fifth, which is also less than one-half. I know this because I can think about what one-half means. Two isn’t half of five. It is less than it [half of five], so two-fifths is less than one-half.

Alexis used fractional reasoning to explain where to place the numbers on the number line.

Notably, she did not use her calculator. During the discussion about this problem, the researcher noted that in several instances Alexis would refer to a number as a percent and other times as a fraction.

Laura. The context was important for Laura in building her mathematical understanding. Context helped her to create visual representations for sharing her mathematical ideas. When revisiting the idea of division of fractions, participants were asked to solve the problem two divided by one-third. Laura’s group was unable to find an answer. The following context for the problem was provided on chart paper.

If I have two cups of sugar, and it takes 1/3 cup to make a batch of brownies, how many brownies can I make?

Laura responded, “Six.” When prompted to explain, Laura replied, “I know that there are three thirds in a cup.” The facilitator added the six to the original problem ($2 \div 1/3$) written on the board and asked Laura to explain her reasoning. Laura asked the facilitator to draw two cups on the chart paper and then described her thinking. Laura said, “If we cut each cup into thirds, we

know there are three one-thirds in a cup. I have to do it to both cups, which means you would have six one-thirds.”

Throughout the workshop, Laura identified many of her own mistakes by explaining and justifying her answers to others. During one session, the facilitator asked the group to solve $0.67 + 0.45$. Laura’s group laid base ten block representations of the two numbers on the table. One participant said she was confused since the numbers were decimals. The facilitator prompted the group to use a strategy similar to the previous work with base-ten blocks. Laura said the answer was 1.02. She described how she combined the ten rods each representing one-tenth and got a flat, representing a whole, with twelve units left. As the facilitator started to draw her representation on the chart paper, and Laura realized that she had made a mistake. “It should be 1.12 because 10 rods make one flat, and then the 12 ones give you one rod and two units.” The group discussed how the base-ten blocks provide a visible representation for decimal numbers and the rules for working with them. The idea behind lining up the decimal is to provide a structure to ensure numbers of the same place value are being added. Laura described how using the blocks helped her to make this connection and also to understand her own mistakes. “It is about keeping the places together. Not just because someone told me to line them up, [but because] they have a value. The blocks made me think about each place based on the block.” Reasoning with the blocks and sharing her ideas helped Laura to recognize and fix her mistakes.

In the post-session interview, Laura shared how the workshop helped her to solve problems by drawing pictures. “I never thought about drawing a picture before to think about my answer. It helps me to think about the steps [algorithm]. It really makes it easier to see where they [algorithms] come from.” Similarly, Laura understood the value of using manipulatives to explore her ideas and to explain her thinking. “The blocks helped me to think

about and see what I was thinking. Moving them around and thinking about the operations really helped me.” Similarly, justifying her answers helped her to develop her mathematical understanding. Laura also recognized her own mistakes by sharing her ideas and explaining her reasoning. Laura said,

I liked that we talked in the workshops. I remember math being just doing what the teacher showed, but that isn't how we learned in these workshops. We talked with each other, and it really helped me learn and think about what we were doing. I found my own mistakes, but I also had to share my thinking with others. Sometimes it was hard to think about how to get others to see my ideas.

Opportunities to represent and explain her ideas provided Laura with a rich mathematical learning experience.

Parents Develop Mathematical Curiosity

“Math also deserves to be enjoyed for its own sake, without being constantly subjected to the question, ‘When will I use this?’” (Suri, 2013, p. A23). Active engagement on the part of workshop participants, led parents to become mathematically curious. Knuth (2002) defined mathematical curiosity as “a desire to learn and know mathematics” (p. 126). By design, the MAPPS curriculum promotes active engagement and exploration on the part of participants. Participants had opportunities that moved “beyond solution-driven” experiences, but instead explored solutions by making sense of the mathematics. Parents who attended the workshop were given many opportunities to explore rational numbers. However, as parents began to explore the mathematical ideas, they also began to question the connections between whole numbers and fractions as well as between different mathematical operations. Parents brought their own questions and ideas as they began dwell in their own mathematical thinking.

Alexis. For Alexis, her frustration led to a desire to learn and understand mathematical procedures. Her desire to understand the mathematical ideas behind the procedures led to the

development of her own mathematical curiosities. In many of the examples described earlier in this chapter, Alexis began to question the relationships that existed between and across mathematical ideas such as how does work with whole numbers compare to work with fractions. Her own discovery into the mathematical reasoning with different strategies for whole number subtraction led her to question if the same mathematical justifications held true for whole number addition. When describing her thinking about whole number subtraction, Alexis stated, “I always was taught you had to go from right to left [when subtracting], but that isn’t right... I wonder if this would work for adding too?” Alexis was questioning whether the standard procedures were the only means for solving a problem.

In her final interview, Alexis even shared that she enjoyed finding connections between her prior learning experiences and her experiences in the mathematics workshop for parents. Alexis recognized that just doing mathematics for the sake of doing mathematics was not the only way to think about mathematics. Instead, Alexis was beginning to dwell in her own mathematical thinking. She was changing how she engaged with mathematical content. Alexis’s mathematical curiosities led to the development of many new understandings not only with rational numbers, but also in other areas mathematics. Her own desire to learn and understand the mathematical concepts was evident in her final interview. During the final interview, Alexis brought her child’s math test to discuss with the researcher. The test was about multiplying and dividing mixed numbers. Alexis wanted to discuss how the ideas explored in the workshop could help her to solve the problems on this test. She knew that fully understanding the problems required that she have more than one approach to solve these type of problems. Alexis had a desire and a new level of curiosity about understanding the mathematics.

Laura. “As parents we can explore new ideas if we think about what we know. I get how it works, but why,” said Laura. Laura was describing her own development of rational numbers. She believed that mathematical understanding involved more than just doing a mathematical problem using a set of standard procedures. Instead, mathematics was about forming an understanding of the concepts behind the procedure. Throughout the workshop, Laura shared the mathematical ideas that she understood. She also began to question the mathematical content she was exploring. For example, when justifying the standard procedure for converting a mixed number to an improper fraction, Laura explained how being asked to think about a mathematics question is different than just finding the answer. “I like how the picture makes me see why I multiply and add (see Figure 6),” said Laura. Continuing her thinking about changing mixed numbers to improper fractions, Laura asked, “Is that why it works the other way? Two goes into five twice because there are two circles and then the one left over is the one half (Figure 6)?” For Laura, simple questions from the facilitator prompted her to change from simply doing mathematics to wondering about the connections between mathematical ideas.

Laura brought many questions with her each night. These questions were primarily about the work of her children. Like Alexis, she was not focused on getting the right or wrong answer to solve problems. Instead, her own curiosity about how the strategies worked and their connections to standard procedures was important to her. Laura was seeking to understand the mathematical connections. Laura began to linger in the mathematical ideas and push herself to question her prior mathematical understandings.

Summary Research Question 1. The workshop changed the parents’ mathematical understanding specifically in the area of rational numbers. As defined in Chapter 2, rational

numbers are a “set of numbers that include the whole numbers and integers as well as numbers that can be written as the quotient of two integers $a \div b$, where b is not zero” (NCTM, 2010, p. 7). The original intent of the research question was to focus on fractions and decimals due to the difficulty that middle school students have when working with rational numbers, but during different sessions, the parents had many questions about whole number operations. NCTM (2010) recognized that computation with fractions and decimals is an extension of computation with whole numbers. The interpretation of fraction and decimal operations is essentially “the same as those with whole numbers but do require adaptations and the algorithms are different” (p. 8). Parents developed an understanding of the underlying mathematical concepts and procedures one must use when working with the multiple interpretations of rational numbers (i.e. whole numbers, fractions, and decimals.)

The notion that a rational number can take on many forms is challenging for many. The parents developed a deeper conceptual understanding of rational numbers. They developed different interpretations of various concepts including the nature of the unit and equivalence. They began to conceptualize the equivalence of different representations of rational numbers. As they began to interpret the different meanings of rational numbers, the parents began to explore rational number operations. Operations with rational numbers were a natural extension to the questions that arose from the parents about working with whole numbers. The parents also began to recognize the innate differences between the two. Justifying their answers through discourse and representation became common as parents connected new mathematical ideas to prior knowledge.

Chapter 3 describes how the five strands of mathematical proficiency are important when someone describes how someone learns mathematics. Four of the strands, conceptual

understanding, procedural fluency, strategic competence and adaptive reasoning, were evident throughout the workshop. Schoenfield (2007) asserts that being mathematically proficient requires mathematical knowledge but also requires tapping into prior knowledge and skills. Throughout the workshop, parents moved beyond being able to use a standard algorithm to solve a problem, and “began to make sense of what they knew” (Schoenfield, 2007, p. 71). Making sense of the mathematical ideas, led to the development of mathematical curiosity. Mathematical thinking and reasoning with rational numbers resulted from asking questions and seeking answers.

Research Questions 2 and 3

In what ways do parents’ understanding of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?

In what ways do parents’ beliefs about their involvement in supporting their child’s mathematical learning change through their participation in a 6-session mathematics workshop?

Research suggests that parents do not understand the current mathematics content standards (Kober & Rentner, 2012; Peressini, 1998). The methods of instruction, which are based upon current standards, are significantly different from the methods used when the parents were in grade school. These changes have left many parents unsure about how to support their children in learning mathematics (Peressini, 1997, 1998). Similar to prior research findings, workshop participants expressed frustration over current mathematics instructional practices. Many favored a traditional approach to instruction stating that it allowed everyone to communicate with mathematics and about mathematics in the same way. The lack of a common practice for learning mathematics hinders parental involvement with their children at home. The

workshops provided an opportunity for parents to engage in doing mathematics with non-traditional methods in a non-traditional setting. Parents were actively involved in the learning experience through discourse and exploration, which resulted in changes to their understanding of math concepts. These learning experiences also influenced the way the parents viewed how mathematics is taught at school and how instruction is supported at home. The connection between research questions two and three was evident when looking at data. The themes that emerged for the two questions closely mirrored each other. Therefore, the researcher chose to collapse the findings into one section devoted to both questions.

Building a Foundation of Mathematical Understanding

Van de Walle, Karp, and Bay-Williams (2016) describe doing mathematics as involving “more than just completing sets of exercises or mimicking processes” (p. 13). Sadly, the grade school mathematics experiences of the participants focused merely on completing algorithmic steps. A teacher taught a procedure, and they learned to mimic it. The parents defined “new mathematics” as teaching students to solve problems in ways that were neither traditional nor efficient. From the parents’ perspective before the workshop, the instructional practices being used with their children involved solving problems by any means. They could not see any connection between the way they were taught in grade school and the exploratory methods their children were using to solve problems. Before the workshop, parents did not connect the use of manipulatives, discourse, or exploration to relevant and useful instructional practices. These ideas were not a part of how parents defined mathematics teaching or learning until the completion of the workshop. By the end of the 6-week experience, parents recognized that the current instructional approaches help children to develop strategies and to activate prior knowledge when solving problems. Parents developed an understanding that mathematics

instruction should build a foundation that allows for flexibility in mathematical thinking and reasoning. By the end of the workshop parents were more open to change about what the teacher, children, and parents should be doing to help children develop a strong understanding of mathematical concepts.

Workshop One. At the end of a session, the facilitator led a discussion of three questions:

1. What was the teacher doing?
2. What were the participants doing?
3. How did you feel as a learner? (MAPPS, 2003)

After a brief pause to read the questions, the parents responded quickly. One participant said, “You asked us questions, but never told us how to do anything.” Another participant stated, “You asked me why I did something. And sometimes told me to talk about what I was thinking with (person’s name).” Laura added, “And many times when you asked me why, I didn’t know or I had to figure out my own thinking. Even when you asked us for answers, you made us explain it to each other. You wrote our answers down even if they were wrong.” Through these statements, the participants were describing a student-centered approach to learning. Based on statements about their own grade level experiences this was different from the teacher-centered approaches to learning that they were used to.

Some of the participant responses were about math dialogue and exploration using models and diagrams. “Playing with the blocks. I was moving them around and thinking about what I knew. (Person’s name) was doing the same thing and we were sharing our ideas,” said one participant. Another added, “I got stuck and then you would have others say the answer and how they got it. It made me think about what I had done. Sometimes I realized I was on the

right track and others I was wrong.” Talking about the ideas and developing strategies were instrumental for all of the parents, but many described that some tools that were useful could also cause frustration. Laura said, “I got upset over some of the pieces (tangrams see Figure 4), but I knew there had to be a solution. I was thinking about things as I went.” The facilitator and researcher shared with the parents that learning should encourage high levels of thinking and reasoning. Although the parents did not recognize it at the time, the ideas they described after the first night were also the ways they described meaningful mathematics instruction and the importance of parental involvement by the completion of the workshop.

Alexis. Alexis expressed her frustration at the number of different strategies she saw to solve one mathematics problem. “Why can’t they do it the same way I learned?” Many times her frustration was based on having forgotten how to solve a particular type of problem. Another area of frustration for Alexis was that she did not know why her child was wrong when she did not understand the method her child had used. Alexis recognized that if both she and her child were doing the problem correctly, then they should both arrive at the same answer. As Alexis’s mathematical understanding began to develop, her beliefs about mathematics instruction started to change. Alexis stopped asking why there were so many ways to solve a problem; instead, she started to build connections that made her more receptive to trying different methods for solving problems and representing mathematical ideas.

Alexis described her grade school math instruction as a traditional instructor driven paper and pencil approach. The teacher would solve a problem on the board using standard algorithms or procedures and the students would repeat the steps for similar problems. Initially, Alexis was not opposed to this form of instruction. At the end of the workshop, her description of good mathematics instruction was very different. Alexis said, “Kids should be using the blocks and

learning why things work. Teachers should be asking them questions. It should be like the workshops. I like the idea of the kids understanding why it works.” Alexis recognized that the current instructional practices involved more than just developing procedures to solve a problem. These methods help students to think mathematically. The instructional practices in the workshop helped her develop connections between her prior experiences and what she considered “new” mathematical ways of teaching. Over the course of the workshop, Alexis shifted her thinking to recognize that it was not about doing all problems the same way, but instead developing strategies for different contexts. “I think I could understand more of what comes home and how (child’s name) is solving the problems if I sit and look at it. It isn’t really that different.”

During one session, a question arose about multiplication strategies. Parents explored and discussed the relationship between partial products (see Figure 10) and the standard algorithm using the problem sixty-three times twelve. When the facilitator asked why they placed a zero in the ones place on the second row when they were multiplying using the standard algorithm, Alexis replied, “That’s the rule.” Another parent responded, “It is a place holder.” When the facilitator asked the parents why it was a place holder, no one responded. Looking at partial products, Alexis explained that the zero was in the ones place because it was multiplied by ten. When asked if using partial products was different from the standard algorithm, the parents said no. Alexis recognized that writing partial products could help explain why the zero is included when using the standard algorithm. Alexis described how partial products aided her in understanding the steps of the standard algorithm.

I do think it would be easy for them to forget to put the zero in the ones place, but I guess my way is the same. That [partial products] just helps to me to see where every number goes. It really just seems like another way to do it. I would have understood multiplication better if someone had showed me this method.

Alexis was not only finding connections between different strategies but also beginning to understand the importance of instructional practices that allowed children to reason mathematically.

During the post-workshop interview, Alexis was asked if she had any additional comments about the workshop. Alexis explained that she understood that she had often been taught only one way to solve a problem but she now knew there were many other solution methods that children were exploring.

It isn't that what they are being taught is wrong; it is just different for me. The blocks helped me to see that my way is not wrong and neither is [child's name]. [Child's name] is learning to solve the same problems, but just to think about them differently. [Child's name] should be learning to think and if we do it differently, that is okay.

Alexis recognized that current standards-based teaching methods are about helping children build a foundation of mathematics concepts and skills that can be drawn on to solve different problems. This approach establishes a strong foundation of mathematical understanding instead of memorizing algorithms that can be forgotten.

Alexis was actively engaged in her child's academic success. Throughout the sessions, she discussed working with her children and their teachers to help them accomplish their education goals. Alexis shared that she did not always know how to help her child with math because often she had forgotten the rules or did not understand particular concepts. Alexis stated in several sessions that often when she worked with her child on her homework, the experience left both of them frustrated due to their inability to understand each other's methods for solving the problems. In her final interview, she described the changes that had occurred in the way she worked with her child. "If we get different answers, we need to figure out why. I need to ask [child's name] how he solved the problem."

While her view of parental involvement changed through the workshop experience, she still had concern about working with her child on mathematics assignments.

I am worried he will get it wrong and I can't help him. However, I think I am more open to taking a minute and thinking about what he did. And [child's name] needs to help me figure out his method. He should be able to tell me how he solved it. Instead of just telling him he got it wrong and having him fix it. I need to be asking him what he did. It is also important that he can explain it to me and not just say the teacher makes me do it this way.

Discourse was important for Alexis in the workshop, and it became an important component of how she viewed current instructional practices and her role in working with her child on mathematics.

Alexis brought her child's recently graded math test to discuss with the researcher at the final interview. She wanted to understand each problem, so she could help with the concepts he misunderstood. The researcher noted that Alexis explained how she would solve each problem on the test. She also wanted to think about other strategies that could be used to solve each problem. Alexis shared, "I want to be prepared for how he might tell me to do it. I am worried I won't know if he is right or wrong. Talking this out with you really helps me to think about what he might do to show me how he solved the problem." This is an example of the fact that through this experience Alexis did not change her level of involvement, but did change her type of involvement with her child. Mathematics instruction at home should mirror the mathematical practices in the classroom. Alexis wanted to prepare herself to best support the learning experiences her child would have at school and at home.

Laura. Laura's children were very active in the sessions. They visited the room where the workshop was taking place regularly. They were aware their parents were exploring mathematics. During one session, one of her children shared a method for dividing numbers using tally marks. The child drew the dividend out with tally marks and then circled groups of

tally marks based on the divisor. Laura said, “It [the method] doesn’t seem to be efficient. I know she will get the right answer, but why not just do the normal way.” The whole group discussed how the child was demonstrating division as a form of seeing how many sets of a given number [the divisor] were in a group [the dividend]. After some conversation, Laura was able to figure how the drawings and the standard algorithm for division were the same. Her frustration emerged from not understanding how the pictures reflected the mathematics. She described the method as a “guess and check” method of solving a problem.

So I see how it is related to what we have been doing, but does she get it. I know the problem wants her to divide. I worry that she won’t understand how to divide without drawing those pictures. Will she understand how to divide? She can’t draw pictures forever. It bothers me.

One of Laura’s main concerns with non-standard strategies was not mathematical correctness, but efficiency. She worried that the children would not have a procedure to rely on, but would instead draw pictures to solve problems. Throughout the sessions, the facilitator addressed Laura’s concerns about efficiency multiple times.

Similarly, her child used method for finding a least common multiple for two given whole numbers during a session. “I kind of saw what she was doing, but it looks odd. When we talked about it, I realized she was doing the same thing as me. It just didn’t make sense at first.” In this case, Laura was not concerned that her children were using different strategies, but her focus was on whether they understood what they were doing. Laura wanted her children to know that the problem solving methods they used were based on mathematical principles.

We have learned so many ways to think about a problem. I want to be sure that my children are learning math this way. I still struggle with why there are so many ways, but I see now the ways are related. I want my kids to learn math that way. I want them to think about what they are doing.

Laura believed that learning to think about different strategies and being able to compare and contrast solution methods is an important part of the learning process. Laura shared,

I really thought about how problems can be solved many ways. I have strategies I use, and now I know that [they are] based on the same ideas. Sharing the strategies made me think about the numbers and really helped me to understand how they work. I think kids should be doing this. They should not be telling me, we do not do it that way. They should be saying let me see how you did it.

Laura shared that she enjoyed thinking about multiple ways to solve a problem and believed it was also important for children to develop this kind of flexibility. “I like being able to solve a problem in different ways. I don’t do everything in life the same so I think it is important that kids learn to think about each problem and not just have one way.” Laura was open to new instructional practices including the development of mathematical knowledge and skills beyond one procedure.

Laura viewed mathematics instruction as a process for sharing mathematical ideas. This was evident in how she viewed mathematics study at home. Prior to the workshop, Laura supported her children’s’ education by helping them with homework and school projects and attending school events. If she was unable to help one of her children with mathematics assignments, often her other children would pitch in. The researcher noted, throughout the sessions, that Laura was active in working with her children. She frequently shared that her children were comfortable using different methods so solve a given problem. Their methods were often different from hers, but in some cases also different from the other children. In most cases Laura could describe why the different strategies worked. “I can do math. I might not always know how they are solving it or remember it right away, but it comes back to me.” There were times when Laura was unsure about the strategies her children were using. Exploring these methods was important for her.

The workshop did not change Laura’s level of involvement in her childrens’ education, but it did change her views about how mathematics should be done at home. In particular, when

working problems, family members should all be sharing their mathematical thinking with each other. Laura stated,

I think I am more open to looking at what I know and what they did to see if I can understand it. I think it will be easier for me... Also they should be able to explain it to me. I want them to be able to explain to me what they are doing not just me looking at their work. I should be able to ask them if I don't understand and they [should be able to] help me to understand.

Her openness to new instructional practices, and how she would be involved at home, changed during the course of the workshop. She believed that both teachers and parents should encourage discourse. Children should be sharing their ideas with each other as well as with their teachers and parents. Similarly, both parents and teachers should be asking children to share their thinking. Laura was receptive to new ways of teaching and learning mathematics at home and in school. In her mind, the two should mirror each other.

Discovering Mathematical Ideas: The “Ah-ha” Moment of Learning

Providing opportunities to explore and engage in mathematics was very important for the participants. In one session, Laura referred to a new mathematical thought as her “ah-ha” moment. The idea caught on with other parents. They believed that “ah-ha” moments of learning should occur for children in the mathematics classroom. The parents also recognized the importance of mathematical discourse, representation, and manipulatives to help students develop the conceptual understanding necessary for an “ah-ha” moment to occur.

The parents did not describe their grade school experiences as providing them with opportunities to explore math concepts from different perspectives. In other words, the educational experiences of the parents did not provide context for “ah-ha” moments to occur. The workshop not only changed the way parents perceived mathematics instruction but also

made them question exactly how the instruction in their children's classrooms were different. Were their children being provided with opportunities to make sense of mathematics?

Alexis. The workshop provided Alexis with the opportunity to explore many mathematical ideas. These experiences provided her with many new "ah-ha" moments. An example of an "ah-ha" learning experience for Alexis was working with base-ten blocks. "The base-ten blocks really helped me to see why we add and subtract." Alexis was referring the use of the standard algorithm for addition and subtraction. "I think I knew that is where the one came from, but I have never thought about it until now." Using the base-ten blocks allowed Alexis to understand the standard procedure for adding or subtracting. This was an "ah-ha" learning moment. Similar to her own experiences in the workshop, Alexis believed that "ah-ha" moments, were about learning the mathematical concepts behind the standard procedures. "Children should be learning this way. It makes sense. I know I saw why we do what we do in math"

Alexis wanted her child to know why mathematics procedures worked, and although Alexis believed that the use of manipulatives to develop mathematical ideas was important, she had some concerns. Alexis wondered if her child was learning math by active engagement. "I don't know if [child's name] is really learning to think about it [math] with the blocks. [Child's name] knew what they [base-ten blocks] were, but wasn't able to tell me how to use them." She continued by saying,

I want [child's name] to be able to explain his method to me. I think [child's name] doesn't always know what is going on in math and that is where his mistakes come from. I think I could look at different ways and at least now, I think I could attempt to understand what someone did to solve the problem, but I want [child's name] to do that. If they [teachers] are teaching them to think about it and know the reasons why then he should be sharing what he is doing.

Alexis worried that her child was learning to use a different strategy, perhaps one that was more difficult for him to understand, just for the sake of learning a new strategy not to achieve a deeper conceptual purpose. Alexis said, “Why teach that method of multiplication with lines [lattice]? It is not easier than the way I do it. It just makes it harder for me to help him. If he isn’t going to learn to think about it, just teach it the normal way.”

Alexis believed that helping someone to understand the mathematics was a benefit of learning through conceptual understanding. This type of learning should involve manipulatives and mathematical discourse. Together these methods provided learners with opportunities to construct their own understanding.

The blocks helped me to see the math, but usually when we talked you guys sat and talked it out with me. I would not have figured it out by myself. Is that how [child’s name] is learning or is he just being taught a new way? He should be talking it out and listening to others. I know I learned a lot by just listening.

Conceptual ideas in mathematics should be evident at home when parents are working with their children. Alexis believed that children should share how they solved a problem, and parents should be open to the non-standard strategies that children use. “We don’t always do things the same way. He gets frustrated that we don’t and me too. But if he is learning it then when I ask him he should be able to help me understand or know that it is okay that we don’t do it the same way.” Alexis recognized the importance of learning for understanding or experiencing the “ah-ha” moment. For Alexis the “ah-ha” moment did not mean teaching non-standards strategies without mathematical understanding. After experiencing these types of moments at school, children should be able to share those experiences with their parents when discussing what happened at school or working on homework assignments.

Laura. In her interview and during the workshop, Laura used the “ah-ha” phrase to describe her learning experiences. In one session, the group expressed an interest in discussing

linear functions. The group explored linear functions by looking for the meaning of the numbers (slope and y-intercept) in a real-world example. Laura's sons were in the room. She called them over and asked them if they knew what linear functions were. One son said yes. He described how to find the slope and y-intercept, but he could not describe what the values meant. In the workshop session, Laura said, "I want them to have the ah-ha moment that I just had. I never thought about it that way and I want them to think about it that way. The meaning. There is a reason it all works. I can see it." Using the real world example allowed Laura to understand the slope as a constant rate of change and the y-intercept as the initial value in the linear function. In her final interview, she explained that she felt that the workshop helped her as a parent to understand both mathematics concepts and mathematics instruction more clearly. "The math is not hard, but putting it all together has been interesting. I have had so many times [in the workshop] where I learned why something works. I get why teachers are doing things differently. It is to help the kids."

Laura understood that the new instructional practices engaged children in reasoning mathematically instead of being taught a specific method for solving a problem. "I am starting to think about why we do what we do in mathematics. The different things we did just show that you are thinking about the numbers and the question: Is my kid doing that in school or are they just being taught a new way?" Laura explained the importance for her to explore concepts with different manipulatives and representations in the sessions. This helped her to better understand the underlying mathematical ideas. In a few different sessions, Laura asked her children if they knew what the different manipulatives were and if they used them in the classroom. Her questions were met with positive responses on all occasions except when asked about their use of tangrams. The different mathematical tools provided in the workshops allowed Laura to

visualize mathematical ideas and to make sense of her thinking. Laura believed schools should be providing opportunities for active engagement with manipulatives and discourse in mathematics as well.

After one session, the parents voiced their concerns over the efficiency of a particular method one of their children had shared. Laura said, “I don’t understand why she would do it that way. Her teacher taught her that and it seems to be too much. Too much room for mistakes. She also doesn’t understand why it works.” The facilitator stressed the idea of looking at different types of strategies and thinking about the mathematics behind the strategies. In particular there was concern about how children communicate their ideas. Her children could show a strategy they had learned to use but could not always explain their work. Laura hoped that if children were exploring a particular concept at school, then they should be able to discuss their mathematical thinking at home as well. “As parents we can explore new ideas if we think about what we know. I get how it works, but why. Do they (kids) know why? I want them to know why it works.” Laura wanted her children to possess a greater level of understanding which, after experiencing it herself, she believed emerged from exploration and mathematical discourse. For Laura these methods led to “ah-ha” moments. Laura was comfortable in her mathematical ability to support her children at home. Though she did not always understand the procedures they used, she wanted children to be able to share their learning with her. In some cases, provide her with the opportunity to experience the same “ah-ha” moment with them at home.

Summary of Research Question 2 & 3. Before the workshop, for many parents “doing” math meant using paper and pencil to solve a problem with a standard procedure. Throughout the workshop, parents recognized how they regularly solve problems using non-standard

strategies depending on the situation at hand. They use different methods to solve problems in their everyday lives. This is a common practice in the same way that the methods used for instruction assist children in developing a greater understanding of the concepts. The idea behind the current instructional practices is not to teach new strategies, but to help children understand the underlying mathematical concepts. It is important for children to develop number sense and mathematical flexibility to think through different approaches (Kilpatrick, Swafford, & Findell, 2001). By the end of the workshop, parents believed that the current methods of instruction were important for their children's mathematical development.

After the workshop, parents were more open to new instructional practices. They stated that exploring and engaging in mathematical activities were important components of how everyone, children and adults, learn mathematics. Instruction should be student centered, incorporate the use of manipulatives, and involve discourse in the classroom. The parents believed that new ideas and new ways of thinking should be evident in the interactions between parents and children. The moments of understanding that Laura called "ah-ha" moments were important learning experiences for the parents.

The parents already supported their children in the ways they were able. The workshop did not change their level of engagement; instead, it changed their type of engagement. By the end of the workshop, parents understood that the practices at home should mirror the instruction at school. At the end of the workshop, there were new concerns about current instructional methods. Prior to the workshop, parents questioned the different mathematical procedures being taught. But after the workshop, parents were accepting of the new instructional practices. However, parents wanted to be sure their children were being given a mathematical foundation. Many parents believed that children should not be learning different methods just for the sake of

learning something new, but rather for building a strong foundation for their understanding of math concepts.

Summary

Learning “depends on what happens in the classroom as teacher and students interact” (Ball & Forzani, 2011, p. 17). Though the research of Ball and Forzani (2011) refers to children, the same idea applies to this study focusing on the participation of parents in the workshop. . In the case of this study, the workshop was the classroom and the parents were the students. Opportunities to represent and explain their ideas were their mathematical learning experiences. These learning experiences influenced the parents’ rational number understanding as well as their perceptions of teaching and learning mathematics. The research participants choose to be part of the workshop because they were already the type of parents that were actively engaged in the education of their children. Recognizing that a significant difference exists between how the parents learned mathematics and how their children are learning mathematics encouraged the parents to attend. Before the workshop, differences between the two instruction experiences caused frustration among parents.

The workshops influenced the parents’ mathematical understanding of rational numbers. By engaging in math activities, the parents established a foundation for understanding mathematical concepts, which allowed them to link their prior knowledge to new mathematical ideas. Exploration and discourse allowed the parents to develop an understanding of the mathematical procedures covered during the sessions. These changes provided the opportunity for parents to become fluent with different procedures. In addition, developing procedures became more about how to solve problems instead of memorizing one mathematical algorithm to

use in every situation. Justifying one's mathematical ideas also became an important component for parents in the workshop.

Changes in their mathematical understanding also influenced the way parents perceived engagement in mathematics at home and at school. Parents believed that mathematics instruction should include exploration, representation, and discourse. Children should be actively engaged in their mathematical learning. Teachers and parents should encourage children to develop deeper understanding of mathematical concepts about rational numbers. Children should be sharing their mathematical ideas and exploring different strategies instead of focusing on whether a homework problem is right or wrong.

At the end of the workshop, there existed some concerns about mathematical teaching and learning that the workshop could not overcome. Even as parents increased their conceptual understandings and procedural fluency, they questioned the efficiency of children developing so many different strategies to solve one problem. Furthermore, parents still questioned their own ability to understand all of the procedures, even while recognizing that the procedures are based on mathematical principles. Lastly, the parents wondered if all mathematical instruction includes the development of conceptual understanding or is the purpose sometimes to teach a new algorithm without a full understanding of what the algorithm means.

Chapter 5: Conclusion

Research has shown that there exists a relationship between parental involvement and a child's academic well-being (Henderson & Mapp, 2002; Kiernan & Mensah, 2011). Hindrances such as a lack of mathematical ability or the understanding of current instructional practices in mathematics have kept parents from being actively engaged in mathematics with their children (Deplanty, Coulter-Kern, & Duchane, 2007; Sheldon & Epstein, 2005). The implementation of parental involvement programs have shown to increase a parent's mathematical confidence and willingness to support their children in mathematics. This study sought to explore a mathematics workshop for parents in a rural middle school. This qualitative study examined the influences of a mathematics workshop for parents on a parents' mathematical understanding of rational number concepts, perceptions of current mathematics instructional practices, and perceptions of parental engagement in mathematics. The findings, although resulting from a small study unique to a particular context, inform and support mathematics leaders and researchers as they seek to develop parental engagement activities.

This chapter will begin with purpose of the study and continue with the following objectives: (a) interpretation of the findings; (b) limitations; (c) implications for practice; (d) recommendations, and (e) final discussion.

Purpose of the Study

The primary focus of the qualitative study was to obtain data from parents' experiences in a mathematics workshop. Using interviews and workshop audio recordings, the

researcher sought to understand how parents change and develop their understanding of rational numbers. The researcher sought to understand if parental participation in a mathematics workshop changed how parents perceive current instructional practices and their perceptions of parental involvement in mathematics.

Hoover-Dempsey and Sandler's (1995, 1997) conceptual framework for parental involvement provided the foundation for understanding hindrances to parental involvement when student achievement is the expected outcome. Level one of the framework focuses on the personal motivation and life context that must be overcome for level two, the parental mechanism for involvement, to change. Two recognized hindrances to parental involvement in mathematics are parental content knowledge and prior educational experiences. In this particular study, the research sought to understand if changing and developing parents' mathematical understandings in rational numbers and parents' perceptions of mathematics teaching and learning could influence their views of mathematics engagement at home. By understanding the supports or barriers within the workshop, school divisions and researchers can better understand the use of these types of mathematics workshops in the educational setting.

Research Design

This research study followed a qualitative case study design. The research participants were two parents who participated in all workshop sessions. The parents were interviewed twice, pre and post workshop. The interviews included a mathematical think-aloud that provided parents the opportunity to share procedures and strategies for solving rational number problems. The interviews allowed parents to share their perceptions of current teaching practices and parental involvement. Workshops were audio-recorded each week. When possible, session notes on chart paper, mathematical activities, and Take-It-Home assignments were collected.

Data analysis started with the transcription of pre-workshop interviews and continued throughout the workshop sessions and the final interview. Data interpretation resulted in the emergence of themes using both inductive and deductive coding. The research questions explored in this study are as follows:

1. In what ways do parents' knowledge of rational numbers develop and change through their participation in a 6-session mathematics workshop?
2. In what ways do parents' understanding of current mathematics instructional practices change through their participation in a 6-session mathematics workshop?
3. In what ways do parents' beliefs about their involvement in supporting their child's mathematical learning change through their participation in a 6-session mathematics workshop?

Interpretation of the Findings

The study yielded several key findings associated with a mathematics workshop for parents. To begin the following section, an overview of the findings from the study will be presented. I organized the findings into two key categories: (1) findings related to parental mathematical understanding of rational numbers and (2) findings related to current instructional teaching practices and perceptions of parental involvement.

Mathematical Understanding of Parents

The National Research Council (1989) states, "Students retain best the mathematics that they learn by processes of internal construction and experience" (p. 59). Furthermore, "to understand what they (students) learn, they must enact for themselves the verbs that permeate the mathematics curriculum: examine, represent, transform, solve, apply, prove, and communicate" (NRC, 1989, p. 58). In the mathematics workshop, the parents were the students. Parents were

actively engaged in doing mathematics. Though the original intent was to focus on fractions and decimals, the parents' questions led to discussions about whole number operations. Although the parents brought prior knowledge to the workshop, the sessions gave them the opportunity to examine, represent, and communicate mathematical ideas.

As described in Chapter 3, to understand how the parents' mathematical abilities in rational numbers changed and developed, the five strands of mathematical proficiency, or the learning of mathematics, were examined. Mathematical proficiency is defined as five interweaving strands of mathematical understanding (Figure 14). The five strands are conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Swafford, & Findell, 2001). Each strand is an important component in the learning of mathematics. The first four interweaving strands allow one to build connections to concepts, use procedures flexibly, represent and solve mathematical problems, and justify their thinking. The fifth strand, productive reasoning, involves the recognition that mathematics is useful and therefore, the individual can view himself/herself as a learner and doer of mathematics (NCTM, 2014). "The five strands are interwoven and interdependent in the development of proficiency in mathematics" (Kilpatrick, Swafford, & Findell, 2001, p. 116). The interweaving of the five strands was evident as parents changed and developed their understanding of rational numbers.

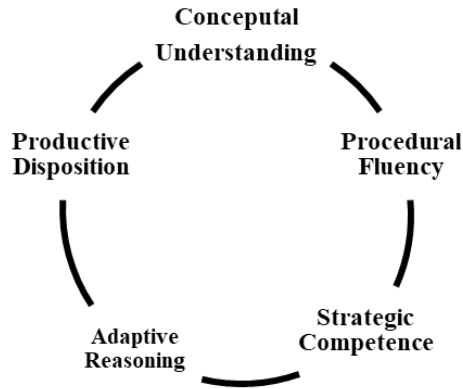


Figure 14 .Strands of Mathematical Proficiency

The workshop allowed parents to explore mathematical ideas about rational numbers. At the beginning of the research study, parents were unable to justify or explain multiple representations of rational numbers. The workshop provided an opportunity for parents to construct a mathematical meaning of rational numbers by understanding how numerical and visual representations connect to each other. The construction of mathematical knowledge is referred to as conceptual understanding. “A significant indicator of conceptual understanding is being able to represent mathematical situations in different ways and knowing how different representations connect to each other” (Kilpatrick, Swafford, and Findell, 2001, p. 119). Parents developed conceptual understanding of the multiple representations of rational numbers. Fundamental to understanding the multiple representations of a rational number is the concept of unit. Understanding the unit enabled the parents to describe the size of and the relationship between fractions and decimals.

The development conceptual fluency led to computational fluency which moved parents beyond just memorizing mathematical procedures or rules with no understanding; instead, parents developed an understanding of the underlying concepts needed to solve mathematical problems. Though computation with rational numbers is an extension of computation with whole numbers,

the mathematical procedures when moving from one set to the other require some adaptations. Creating visual and concrete models, provided opportunities for parents to explore the complexities of working with rational numbers. Parents recognized that studying mathematics was more than just a pencil and paper process. Possessing conceptual fluency and flexibility when working with rational numbers afforded parents the chance to build a foundation for procedural fluency and the ability to perform mathematical operations “flexibly, accurately, and efficiently” (Kilpatrick, Swafford, & Findell, 2001, p. 121).

Developing a conceptual understanding of rational numbers provided the parents with the opportunity to justify their mathematical thinking through dialogue and mathematical representation. The ability to justify one’s thinking implies that parents possess a sufficient knowledge base to provide a mathematical reason for using a particular method to solve a problem (Kilpatrick, Swafford, & Findell, 2001). Justification for parents meant using manipulatives, visual representations, and verbal explanations to support their reasoning and solve problems. Justification draws on two strands of mathematical proficiency, strategic competence and adaptive reasoning. Kilpatrick, Swafford, and Findell (2001) asserted that when formulating or representing a problem one was using strategic competence, but adaptive reasoning took over when one began to determine if the strategy was effective.

Parents developed a productive disposition or an openness to seeking new ways of understanding. The development of a productive disposition provided parents with the opportunity “to experience the rewards of making sense of mathematics” (Kilpatrick, Swafford, & Findell, 2001, p. 133). This occurred naturally, as parents began to interweave their conceptual understanding, procedural fluency, adaptive reasoning, and strategic competence to solve problems. Parents began to recognize the importance of building a strong conceptual

foundation. In most cases, the interweaving of the strands makes it difficult to separate them from one another. This was clearly true for the parents in this study. Parents developed a rich mathematical understanding by using new information to modify their prior mathematical ideas. As parents developed mathematical proficiency in rational numbers, they became doers of mathematics by seeing mathematics as more than simply memorizing facts.

Active engagement and social interactions allowed the parents to develop mathematical curiosity. Though not a strand of mathematical proficiency, the development of mathematical curiosity came from building a foundation for mathematical understanding. The parents no longer solved a mathematical problem just for the sake of solving a problem, but instead sought to find connections between mathematical ideas. The parents began to dwell in the mathematics. The development of mathematical curiosity was a natural occurrence as the parents conceptualized rational number. Parental curiosity helped to facilitate many of the workshop discussions. Alexis said, “I would think that adding fractions would be like adding whole numbers, but it is different.” The development of mathematical curiosity is a disposition towards learning mathematics that supported their mathematical understanding in rational numbers.

Parent Perceptions of Instruction & Parental Involvement

Prior research has shown that parents do not understand the current mathematics instructional practices (Kober & Rentner, 2012; Peressini, 1998) and question their ability to support their children in learning mathematics (Jackson & Remillard, 2005). Participants reported that they had learned mathematics in grade school by learning a mathematical procedure for solving a given mathematical problem. The parents expressed frustration about understanding the different mathematical procedures their children were currently learning. As the parents began to develop a conceptual understanding of rational numbers, their perceptions changed.

Parents believed children should be learning mathematics through exploration and dialogue. “Children should be having “ah-ha” moment in school. It is important for them to understand what they are learning.” Parents changed their definition of mathematics to match that of Van de Walle, Karp, and Bay-Williams (2016) who described reform mathematics as challenging students through explorations.

Parents recognized the need for mathematics instruction to support children in constructing their own mathematical understanding. In changing their perceptions of mathematics instructional practices and parental involvement, the parents developed a belief in the importance of mathematical discourse. Learning mathematics requires children to share their mathematical ideas. Furthermore, parents perceived the importance of building a foundation of conceptual ideas by making connections among different representations. These practices should be evident at home and at school. Similar research by Civil, Guevara, and Allexsaht-Snider (2002) suggests that moving beyond rote memorization is a component of building conceptual understanding among parents. Laura shared, “I think it is important for [my child] to learn the why behind the rule.”

After the workshop, two barriers existed in parental perceptions of current mathematics instructional practices. First, parents expressed concerns that students were not actively engaged in their learning. Parents were concerned that mathematics instruction was not building conceptual understanding, but instead focused on teaching alternative methods for solving a problem. “I want my child to learn to think about a problem not just do it differently than me. If teachers are just teaching a different method, isn’t that just the same way I learned?” And the parents were concerned there was a lack of mathematics dialogue in the classroom. “[Child’s name] can’t tell me what they are doing. They just tell me the teacher said to do it this way. If

they are learning to think about it they should be able to explain how it works.” The second barrier for parents involved a fear of not being able to understand the mathematics their children are learning. “Some of the ways we shared in here did not make sense to me. Once we talked about them, I understood them. What do I do if something comes home that I can’t follow?”

The parents wanted to support their children in mathematics, but doubted their own mathematical understanding. As they developed their understanding of rational numbers, they changed their definition of supporting children in the study of mathematics. Supporting no longer meant simply checking for a right or wrong answer. Instead, supporting the child meant understanding how he/she solved the problem. Dialogue between the parents and children was key for parents to understand a child’s mathematical thinking. Civil, Guevara, and Alleksaht-Snider (2005) reported that mathematical interactions between parents and children support the development of mathematical ideas for everyone involved. In this study, changes in mathematical knowledge and perceptions of current instructional practices influenced the mechanisms of parental involvement. Parental involvement in mathematics should move beyond a right or wrong answer, to interactions between parents and children on the mathematical content.

Final Discussion of Findings

Workshop attendance was lower than originally expected. However, barriers to parental involvement were addressed in the development of the program and the purpose of the study was met. The purpose was to understand how a mathematics workshop for parents influenced parental thinking in mathematics. The parents developed a conceptual understanding of rational numbers and non-standard procedures for working with rational numbers. The development of justification and representation in mathematics was evident in the parents’ thinking. The idea of

doing mathematics simply for the sake of doing mathematics changed as parents developed mathematical curiosity. The National Research Council (1989) describes how verbs such as examine, solve, communicate and transform must be used to construct mathematical thinking. To do this “students must work in groups, engage in discussion, make presentations, and in other ways take charge of their own learning” (NRC, 1989, p. 59). Participation in the workshop provided parents with the opportunities to examine concepts, communicate about mathematical ideas, and solve problems involving rational numbers.

Changes in mathematical understanding influenced the way parents perceived mathematics instruction. Parents wanted their children to learn mathematics by constructing their own knowledge. Instructional practices should include dialogue, representation, and manipulatives. Parents believed that learning new procedures for solving mathematical problems was important if children were provided with the opportunity to explore the conceptual ideas behind the procedures. However, concerns existed for parents that children may be learning new mathematical procedures with no conceptual understanding; and, if this was true, parents wanted teachers to teach the standard algorithm.

Changes in mathematical knowledge and in parental perceptions of current instructional practices, influenced parents perceptions of their involvement at home. The parents believed that discourse in mathematics is important at home and at school. Children should be sharing their mathematics ideas with their parents and teachers. Parents believed it was important that children share their thinking with their parents. “We normally just compare answers, but if they are different I can ask how [my child] found the answers. Or if I am looking over homework and see something different I can ask them to explain it.”

Throughout the findings, there were two components that parents believed should be part of the study of mathematics at home, at school, and in future workshops for parents. The two components were mathematical dialogue and the use of representations. First, they saw the importance of dialogue. Parents, teachers, and students should be actively engaged in mathematical discourse. Second, the use of visual and concrete representations should be part of the learning process for all who are engaged in the study of mathematics. Representations and manipulatives provided the parents with concrete representations of abstract mathematical ideas. Dialogue and representations provided parents with opportunities to engage and explore mathematics on their own and with others. The same opportunities should be provided to children.

Limitations

There are several limitations to this study. As a qualitative study, it is not intended to be generalizable to a larger population (Lincoln & Guba, 1985). The reader should be aware when considering the transferability and applicability of this study due to the small purposeful sample. The researcher sought to increase participation by overcoming known barriers to parental involvement, but only two parents participated in all six workshop sessions. The parents in this study were not representative of all parents in all rural middle schools. Furthermore, participation does not represent the diverse school population. Parents opted to participate in this study, thus demonstrating that they were actively engaged in their child's education prior to the workshops. Participant experiences may only be reflective of the parents who attended these specific workshops.

Prolonged engagement with participating parents helped to build relationships, but the parents who attended the workshop were already actively engaged in the education of their

children. Their agreement to participate is evidence of their parental involvement. The parents were actively engaged in working with their children at home. The parents were comfortable talking about their own mathematical experiences in school and at home. Similarly, the parents were willing and able to verbally share their mathematical thinking with the facilitator and the researcher. The parents were encouraged to share both correct and incorrect ideas within the workshop setting. The two parents were actively engaged in mathematical dialogue with each other and the facilitator. Their ability to share their mathematical thinking may not be similar to other parents in other workshops. This should be recognized as a limitation of the study when generalizing to all school settings.

Similarly, as a parent and teacher with strong beliefs in education, there are some limitations to how I interpreted the findings. I engaged in peer review with the facilitator to explore and understand my field notes. This discussion informed me of any possible bias. Similarly, I choose to remove any mention of the school's mathematics program from the workshop and this report since the research was not part of the school's academic program. The intention of this study was to focus on the workshop and how it influenced parents in their understanding of mathematics. The sessions were designed to follow the Mathematics for Parents Partnership Program, but due to the small number of participants, the workshop sessions were fluid. Questions and ideas were discussed that were not components of the planned curriculum. A recognition of the fluid nature of the workshop should be understood in interpreting the data.

Practical Implications

Many schools host parent math nights. Traditional math nights allow parents and children to engage in a doing a math activity, but they do not allow parents to explore

mathematical ideas on a deeper level. Therefore, in order to benefit parents and students, schools should plan to develop structured parental involvement programs that provide opportunities for parents to be actively engaged in mathematics. Parental programs need to be developed which allow parents to acquire specific knowledge and strategies that correlate to the mathematics education of children. These programs need to provide parents with the opportunity to share their mathematical ideas with others.

In order to develop parental involvement activities, school administrators must be equipped with the proper tools for the successful implementation of parental programs (Epstein, 2010). The findings of this study offer school administrators an approach for implementing a mathematics program for parents. A program that will increase a parents' conceptual understanding of rational numbers. School administrators can use the findings of this research to develop programs in different mathematical strands. This will support administrators as they work to meet the academic needs of the families with children in their school. A mathematics workshop can provide opportunities for parents to explore mathematics using hands-on approaches to learning in the school and to foster parental support for the study of mathematics in school and at home. Administrators should use these findings to develop programs that allow parents to integrate mathematics exploration with dialogue and representation. Additionally, schools can implement mathematics workshops using a developed program such as MAPPS or develop a school-based mathematics program that correlates with the schools' mathematics curriculum.

The agreement to participate and the relationships that formed were an important component of the workshop. The small number of participants and prior experiences of the facilitator in leading mathematics professional development for teachers allowed the facilitator to

create a safe-space for parents to work. This safe learning environment provided the parents with the flexibility to ask questions that were outside of the planned workshop curriculum. Parents took risks in asking questions that supported their development of mathematical curiosity. School administrators should consider the fluid nature of the program afforded parents a safe environment for engaging in mathematics.

Furthermore, it should be noted that the workshop participants were actively engaged in the workshop. Parents were provided with opportunities to explore mathematics using a concrete-representational-abstract (CRA) sequence. The workshop provided the parents with the opportunities to explore mathematics with the use of manipulatives. The concrete explorations were followed by opportunities to draw pictorial representations before moving to abstract symbols. Van de Walle, Karp, and Bay-Williams (2016) defined CRA as learning through exploration of new knowledge or the enhancement of prior knowledge. School administrators should recognize that the use of CRA in the workshop was a means of generating parental dialogue. Their ability to explain their thinking was both intuitive for them as well as enhanced by the use of CRA practices throughout the workshop setting. Throughout the course of this study, it was apparent that the parents were interested in engaging in the study of mathematics.

In doing this study, it was found that parents recognize the importance of parental involvement in mathematics. However, parents are both curious and frustrated with the current trends in mathematics instruction. The development and implementation of a mathematics workshop provided a learning environment for parents to develop a deeper conceptual understanding of rational numbers, which in turn influenced the parents' perceptions of current instructional practices. In general, parents should recognize that they are doers of mathematics regardless of their prior grade-school learning experiences. Incorporating a mathematics

workshop for parents into a school's mathematics program can provide an opportunity for parents to understand and support mathematics teaching and learning. Parents should request that programs similar to this be offered in their school.

It is important that school administrators and parents understand that parental involvement is highly effective in improving achievement for all children. It is also essential that schools and parents recognize the hindrances that exist to parental involvement. This study sought to overcome known barriers by providing childcare and dinner, but participation was still low. School administrators must implement a mathematics workshop in a way that meets the needs of all parents in the school. This may include looking at alternative means for engaging parents in mathematics such as webinars, online videos, or sample solved problems. These alternatives may be a means for providing learning opportunities for parents when barriers such as time are present. Parents should be included in the planning and implementation of these types of workshops to shed light on how to overcome the known barriers to parental involvement for their school demographics.

Recommendations for Future Research

One of the primary findings of this research study is the influence that a mathematics workshop can have on developing and changing parents' mathematical content knowledge in working with rational numbers. Future research on mathematical understanding might explore different areas of mathematical content knowledge. Exploration should look at the development of number sense and operations across grade levels. Workshop participants became mathematically curious as they developed a deeper conceptual understanding of mathematics, additional studies might seek to understand parents' perceptions of their mathematical abilities and attitudes towards mathematics.

Changes in mathematical content knowledge influenced the way parents' perceived the current mathematical instructional practices and parental involvement in mathematics. These findings are useful for supporting the use of mathematics workshops as a viable means for parents to provide mathematical support for the academic success of their children. Further research might address the development of mathematics workshops for parents across different grade levels to better understand formats for future implementations. Though the parent participants questioned the implementation of standards-based instruction in the schools, they reported an improved willingness to support the use of discourse, exploration, and representation in mathematics instruction both in school and at home. Parents recognized the importance of developing a conceptual understanding when working with rational numbers, but future studies should explore other mathematical content strands.

The findings of this study reveal opportunities for future research on mathematics workshops for parents. It is recommended that future research include a longitudinal study of a workshop spanning a full school year or longer. Collecting data over a longer period might help to identify potential changes in the types of parental involvement mechanisms and allow researchers to explore the long-term impacts of a mathematics workshop for parents. Furthermore, it would allow research to understand the influence a workshop may have on a child's academic success in mathematics.

Future research about mathematics workshops should also seek to understand the active participation of the school faculty on parents' perceptions of mathematics teaching and learning. This study did not involve the educational setting other than using the school building. For example, parents posed questions about the school's mathematics program that the researcher

and facilitator could not answer. Active engagement on the part of the school could support new areas of research on home-school connections.

Conclusion

Anderson and Minke (2007) recommend that schools provide consistent and relevant professional development for teachers to help foster relationships with parents, but the same is also true for parents. As a parent and an educator, learning is important to me. This area of research piqued my interest after I had many conversations with parents at the bus stop. The conversations centered around the negative aspects of the school's mathematic curriculum. I believe parents need opportunities to foster a mathematical learning environment at home. Pre-conceived notions of what mathematics teaching and learning should entail makes it difficult for parents to support their children in the study of mathematics. Alexis and Laura, two middle school parents, wanted to support their children in mathematics, but there were concerns about how they could help. Although these two parents were part of the study, they could have been my neighbors or friends who express similar frustrations. Creating and facilitating workshops like the one in this study is important, as they provide a way to support parental understanding of current mathematics teaching and learning practices. The development of parental workshops needs to be grounded in the idea that parents are also learners of mathematics. The workshop changed the way the parents conceptualized mathematical ideas. In developing their conceptual understanding of rational numbers, parents became more fluent in mathematical procedures, creating representations, and in justifying their ideas in mathematics.

In the framework for parental involvement, Hoover-Dempsey and Sandler (1995, 1997) recognized the need to overcome barriers to parental involvement if one wishes to change the way in which parents are involved in the education of their children. By developing parents'

mathematical understanding, changes occurred in the way parents perceived the current instructional practices. Parents believed that mathematics instruction should engage children in learning. Children should be actively exploring mathematics to develop a deeper understanding. The parents recognized that they were able to think flexibly in mathematics, but prior educational experiences made them question their own understandings. Workshop experiences provided parents with the chance to build connections to skills they had forgotten or never really possessed.

Many schools host parent math nights. Traditional math nights allow parents and children to engage in a doing a math activity, but they do not allow parents to explore mathematical ideas on a deeper level. Parental programs need to be developed which allow them to acquire specific knowledge and strategies that correlate to the mathematics education of their children. These programs need to provide parents with opportunities to share their mathematical ideas with others. The researcher found that, in many cases, the activities in the developed curriculum led to questions and concerns directly related to the learning experiences of their children. Schools should be prepared to incorporate their own curriculum into a workshop program to help parents better understand the school's instructional program. A school-based mathematics program for parents would also allow parents to feel comfortable asking questions about the teaching and learning of mathematics in the school. Since neither the researcher nor the facilitator were involved in the school setting, we could not answer specific school based questions. It is important for school administrators and researchers to understand the implications of mathematics programs for parents for making a difference in mathematics education for parents and children.

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Fall 2017 Mathematics Workshops for Parents

Mathematics Workshops for Parents are designed specifically for parents of sixth grade students. Mathematics instruction in the U.S. has changed dramatically over the past decade.

This is where you, the parent come in...these workshops will provide you with the opportunity to explore mathematics teaching and learning through small and large group activities.

*Free child care for children 6 years and older will be provided during the workshop.
Children under 6 will not be allowed to attend the sessions or the child-care.
Free dinner will be provided for parents and children at the beginning of each workshops.*

Questions
Contact Kristina Anthony, VCU

This program is part of a research study through the Virginia Commonwealth University School of Education. Participants will be asked to attend all six sessions. Pre/post interviews will be conducted with a small portion of the participants. Participation in the interviews is not a requirement to participate in the workshops. Interviews and workshop discussions will be audio-recorded.

APPENDIX B: Pre Workshop Interview Questions

Thank you for your time. I appreciated your agreeing to meet with me today. During the interview today I will ask many questions, please keep in mind that I am interested in what you think and your experiences. Please know there are no “right” answers to my questions. I am interested in understanding your perceptions on mathematics and parental involvement.

- A. Before we start, I am interested in knowing why you decided to participate in the mathematics workshop for parents?
- B. What do you believe is your role in your child’s academic success?
 - a. Do you feel that your role is the same for reading and mathematics? Why?
 - b. Do you believe there is a connection between your level of involvement and your child’s academic success? Explain.
 - c. If you were to recognize hindrances to your level of involvement in your child’s education, what would you describe them to be?
 - d. Are these barriers the same for all subjects?
- C. In thinking about your role in your child’s education, in what ways do you perceive your role in the school setting?
 - a. What types of communication do you have with your child’s teachers? How do the types of communication impact your involvement?

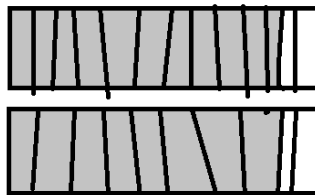
- b. Is the communication the same for different content areas? For example, the language arts versus the mathematics teacher, do you have the same forms of contact?
- c. What factors hinder your involvement with the school and/or teacher specifically when it comes to mathematics?

D. Tell me about the last time you did mathematics with your child.

- a. What was the reason?
- b. What did you or your child say or do?
- c. How do you think the discussion went?
- d. Why do you think it went like that?
- e. Would you say this is a typical experience? Explain.

E. Suppose the following scenarios arise when working with your child on mathematics, how would you discuss the ideas with them? Just to remind you there are no “right” answers that I am looking for in talking about these problems.

- a. Your child is asked to compare $\frac{8}{10}$ and $\frac{11}{13}$. Based on his/her drawing they believe the two fractions are the same.



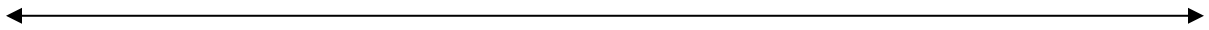
Do you agree that his/her drawing shows the two fractions are equal? Why?

How would you compare the two fractions? Clearly, explain your method. (If the participant uses common denominators ask them to think about it a different way.)

b. A homework problem asks your child to solve the problem $\frac{7}{8} - \frac{1}{4}$ using two unique strategies. Can you demonstrate two methods for solving the problem? (If possible, explain how the two strategies are similar and/or different.)

c. A test question asks your child to put the numerical representations below on the number line in least to greatest order. Place each number on the number line and explain your reasoning for the placement.

a) .452 b) $\frac{1}{3}$ c) $\frac{8}{7}$ d) .55 e)



F. Because we parents are not in school with our children all the time we often get small pieces or imagine what their school day looks like such as what they are during for lunch or whom they are talking to in the hallways. I would like you to describe what you believe/imagine is happening in your child's math classroom.

- a. What is your child doing?
- b. What is the teacher doing?

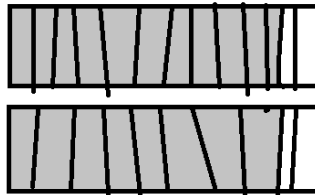
G. Is there anything you would like to add to our conversation? Thoughts.

APPENDIX C: Post Workshop Interview

Thank you for participating in the mathematics workshops for parents and for meeting me for the final interview. Similar to the first interview I will ask many questions, please keep in mind that I am interested in what you think and your experiences. Please know there are no “right” answers to my questions.

- A. In reflecting back on your experience in the workshop as there anything that happened that was a critical moment for you in mathematics?
 - a. Ask for clarity in mathematics if it is mentioned.
 - b. Ask for clarity in parental involvement if it is mentioned.
 - c. Ask for clarity in current instructional practices in mathematics if mentioned.
- B. What do you believe your role is in increasing your child’s academic success?
 - d. Specifically, in your child’s mathematics success?
 - e. Describe struggles and successes you face in in working with your child in mathematics?
 - f. Do you believe there is a connection between your level of involvement and your child’s academic success in mathematics?
- C. In thinking about your role in your child’s education, in what ways do you perceive your role in the school setting?
 - a. What types of communication with the teacher do you need to increase your involvement?

- b. What personal motivators/factors could increase your level of involvement with the school and/or teacher specifically when it comes to mathematics?
- D. Since our last interview, have you had the opportunity to discuss mathematics with your child?
- a. If so tell me about the interaction.
- i. What was the reason?
 - ii. What did you or your child say or do?
 - iii. How do you think the discussion went?
 - iv. Why do you think it went like that?
- b. If not, let's look at the last interaction you described with your child in our first interview.
- i. Would you interact the same? Explain.
 - ii. Last time you felt that the discussion went....Do you still feel the same? Explain.
 - iii. Would you do it the same or different if that interaction was to arise again? Explain.
- E. Suppose the following scenarios arise when working with your child on mathematics, how would you discuss the ideas with them?
- a. Your child is asked to compare $\frac{8}{10}$ and $\frac{11}{13}$. Based on his/her drawing they believe the two fractions are the same.



Do you agree that his/her drawing shows the two fractions are equal? Why?

How would you compare the two fractions? Clearly, explain your method. (If the participant uses common denominators ask them to think about it a different way.)

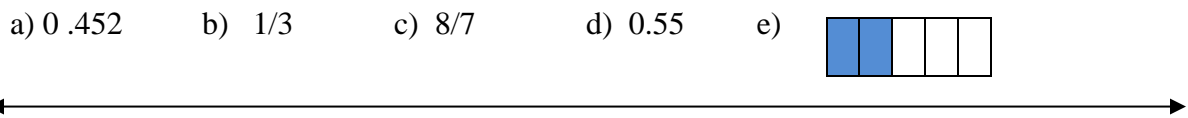
What if your child said they were the same since both pictures are missing two pieces, what would you say?

b. A homework problem asks your child to solve the problem $\frac{7}{8} - \frac{1}{4}$ using two unique strategies. Your child could only describe one. The response was the answer is $\frac{6}{4}$. When asked to explain your child said in the numerators you have 7-1 so the answer is 6. In the denominators, you have 8-4 so the answer is 4.

Do you agree with their thinking?

Could you demonstrate two methods for helping them to solve the problem? (If possible, explain how the two strategies are similar and/or different.)

c. A test question asks your child to put the numerical representations below on the number line in least to greatest order. Place each number on the number line and explain your reasoning for the placement.



F. Because we parents are not in school with our children all the time we often get small pieces or imagine what their school day looks like such as what they are during for lunch or whom they are talking to in the hallways. I would like you to describe what you believe/imagine is happening in your child's math classroom.

g. What is your child doing?

h. What is the teacher doing?

G. Is there anything you would like to add to our conversation? Thoughts.

APPENDIX D - RESEARCH SUBJECT INFORMATION AND CONSENT FORM

TITLE: Mathematics Workshops for Parents: Exploring Content Knowledge and Perceptions of Parental Involvement

VCU IRB NO.: [REDACTED]

INVESTIGATOR: Kristina Anthony

If any information contained in this consent form is not clear, please ask the study staff to explain any information that you do not fully understand. You may take home a copy of this consent form to think about or discuss with family or friends before making your decision.

PURPOSE OF THE STUDY

The purpose of this research study is to understand the role that Mathematics Workshops for Parents play on a parent's mathematical content knowledge, perceptions of current instructional strategies, and parental involvement in mathematics for parents of students at [REDACTED]. The study is part of a dissertation research project through Virginia Commonwealth University's School of Education. You are being asked to participate in this study because you are the parent or guardian of a [REDACTED].

DESCRIPTION OF THE STUDY AND YOUR [YOUR CHILD'S] INVOLVEMENT

For this research project, you will be one of twenty-four people who will participate in six two-hour workshops during October and November. Workshops will be held on Monday nights for six consecutive weeks. Workshop participants will be observed during the mathematics workshops to look at changes in mathematical content knowledge and perspectives of mathematics teaching and learning. The workshop sessions will be held at [REDACTED].

Workshops will explore fractions and decimals using a variety of methods including the use of manipulatives, pictorial representations, and real world problem solving to explore the mathematics. Groups of 2- 4 parents will explore the mathematical topics within small groups. The small groups will share ideas and methods for thinking about the situations provided by the facilitator. Large group discussions will center on the work of the small groups. Participants are asked to actively participate in the workshops by sharing mathematical thoughts. Large and small group discussions will be led by a facilitator. The large and small group sessions will be audio recorded.

Each week participants will be given an activity to complete during the week individually and with their children if time allows. The assignments will ask participants to expand on ideas explored in the workshop sessions.

Eight parents will be asked to participate in interviews pre and post workshop. These interviews will last 45-60 minutes and be digitally recorded and transcribed. Interviews will cover mathematical content knowledge, perceptions of parental involvement, and perceptions of current instructional practices in mathematics. All interviews will be held at either the public library in a closed meeting room or in the parent's residence, depending on what is most convenient for participants.

Participation in the interviews will be based on a random computer generator selecting the names of possible interview participants. Workshop participants will be phoned and asked to participate in the interviews based on the order of the random name selection. Participants will be called until the eight interviewees are selected. Participants who opt out of the interview can still participate in the workshops. An email notification to all participants will be sent once the eight interviewees are selected.

Before the completion of the study you will be given the opportunity to review the findings of the interviews and observations to ensure that meaning developed from the research process accurately reflects your experiences and your views.

RISKS AND DISCOMFORTS

It is unlikely that participation in this study will cause you risk or discomfort. There may be some loss of confidentiality within the study. The researcher will remove all identifying descriptors and names from any documentation to minimize the loss of confidentiality. However, sometimes talking about life experiences can cause people to become upset. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose

BENEFITS TO YOU AND OTHERS

You may not get any direct benefit from this study, but the information we learn from this may help look at how parental involvement and mathematics are handled within the school setting.

COSTS

There are no costs for participating in this study other than the time you will spend in the groups and filling out questionnaires.

PAYMENT FOR PARTICIPATION

There is no compensation for this study. Dinner will be served at each session and child care will be provided for children 6 and older. These are provided to help parents overcome the known barriers to parental involvement.

CONFIDENTIALITY

Potentially identifiable information about you will consist of demographic data form, and audio recordings that will be completed at the beginning of the workshops. A codebook will be used by the researcher to assign each participant a pseudonym. The pseudonym will replace your name in documented field notes and interviews. The codebook, demographic sheet, and consent forms will be kept in a locked file cabinet in a locked office at VCU.

All electronic information will be kept on a password protected computer in a password protected file at VCU. Audio recordings will be downloaded to a password protected file on the password protected computer. Audio recordings may contain identifiable information if small groups use names, but the researcher will remove the names in the audio transcriptions. Audio recordings will be deleted one year after the completion of the research project. Transcriptions will be stored for 5 years.

Due to the nature of the project, there is no method to guarantee absolute privacy and confidentiality within the study. Parents will be working together during the sessions to explore mathematical ideas.

VOLUNTARY PARTICIPATION AND WITHDRAWAL

Your participation in this study is voluntary. You may decide to not participate in this study. Your decision not to take part will involve no penalty or loss of benefits to which you are otherwise entitled. If you do participate, you may freely withdraw from the study at any time. Your decision to with draw will involve no penalty or loss of benefits to which you are otherwise entitled.

QUESTIONS

If you have any questions, complaints, or concerns about your participation in this research, contact:

Student Investigator
Kristina Anthony
School of Education, Virginia Commonwealth University



Primary Investigator
Dr. William Muth
School of Education, Virginia Commonwealth University



If you have any general questions about your rights as a participant in this or any other research, you may contact:

Office of Research
Virginia Commonwealth University
800 East Leigh Street, Suite 3000
P.O. Box 980568
Richmond, VA 23298

Telephone: (804) 827-2157

Contact this number to ask general questions, to obtain information or offer input, and to express concerns or complaints about research. You may also call this number if you cannot reach the research team or if you wish to talk with someone else. General information about participation in research studies can also be found at

http://www.research.vcu.edu/human_research/volunteers.htm.

APPENDIX E - Demographic Information Form

Mathematics Workshops for Parents
Demographic Information Form

Name _____

Phone Number _____

Email _____

Instructions: *Please answer the questions below. The answers will only be used to describe the study sample.*

1. What is your age? _____

2. What is your sex?

Female Male

3. With which racial or ethnic category do you identify?

African American Asian/Pacific Islander Caucasian Latino

American Indian Other: _____

4. What is your marital status?

Single Married Separated

Divorced Widowed

5. What is your highest education level?

Completed some high school High School Graduate

Completed some college Associates degree

Bachelor's degree Master's Degree

Advanced degree beyond a Master's Degree

APPENDIX F -Interested Phone Script Follow-up

Hello (Possible Workshop Participant Name), my name is Kristina Anthony and I spoke to you at the Back to School Night the other evening at [REDACTED]. The reason I am calling is to discuss your participation in the Mathematics for Parents Workshop.

The workshops are designed to have parents explore mathematical topics in whole group and small group settings. Discussions will revolve around fractions and decimals as well as how these topics apply in the real world. There will be six “two” hours sessions. Parents who attend will receive dinner at the beginning of each session as well as childcare will be provided for children 6 and older.

Do you have any questions about the workshops?

(IF YES) Answer the questions. Would you be interested in participating?

(IF NO) Would you be interested in participating?

(IF YES) Thank you for agreeing to participate in the workshops. The first session will be held on Monday, September ____ at the middle school. Do you have any questions about your participation in the workshops?

(IF NO) I appreciate you talking with me today about the program. Please if you have any questions about the workshops, please feel free to contact me.

APPENDIX G - Selected Parent Telephone Script

Hello (Insert Workshop Participant Name), my name is Kristina Anthony and I spoke to you at the Back to School Night the other evening at [REDACTED]. The reason I am calling is to discuss your participation in pre/post interview portion of the Mathematics Workshops for Parents research project.

Participation in the interviews is not a mandatory portion of the project, but I am seeking eight participants to interview before and after the project. Interviews will last approximately 45-60 minutes and can be held in your home or a place of your choosing. These interviews will be audio recorded for me transcribe after the interview.

Interview questions will help me to understand parental involvement, mathematical content knowledge and beliefs about teaching and learning from a parent's perspective. I am not looking for a right or wrong answer, but instead I want to understand your perceptions around mathematics and parental involvement.

Do you have any questions about the interviews?

(IF YES) Answer the questions. Would you be interested in participating?

(IF NO) Would you be interested in participating in the interviews?

(IF YES) Thank you for agreeing to participate in the interviews. I am open to scheduling the time and location of the interviews that works best for you. Is there a day or time that you would like to meet for the pre-workshop interview? (Schedule the interview.) I am excited that you have chosen to participate in the Mathematics Workshops for Parents. Please at any time if you have any questions or concerns feel free to let me know.

(IF NO) I appreciate you talking with me today and am excited to have you participate in the Mathematics Workshop for Parents. As I said before, participation in the interviews does not hinder you from participating in the workshops. Please at any time if you have any questions and concerns feel free to let me know. I will see you on _____ at the first session.