Spring 2020

A Case Study Exploring the Nature of How Prekindergarten Teachers' Mathematics Instruction Decisions Relate to Their Mathematics Pedagogical Content Knowledge

Raleta Summers Dawkins
Old Dominion University, raletasummers@gmail.com

A CASE STUDY EXPLORING THE NATURE OF HOW PREKINDERGARTEN TEACHERS' MATHEMATICS INSTRUCTION DECISIONS RELATE TO THEIR MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE

by

Raleta Summers Dawkins
B.S. December 2004, North Carolina Agricultural & Technical State University
M.A. Ed. December 2008, North Carolina Agricultural & Technical State University

A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

EARLY CHILDHOOD EDUCATION

OLD DOMINION UNIVERSITY
May 2020

Approved by:

Melva Grant (Director)

Ian Sutherland (Member)

Brandon Butler (Member)

Lea Lee (Member)

ABSTRACT

A CASE STUDY EXPLORING THE NATURE OF HOW PREKINDERGARTEN TEACHERS' MATHEMATICS INSTRUCTION DECISIONS RELATE TO THEIR MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE

Raleta Summers Dawkins
Old Dominion University, 2020
Director: Dr. Melva Grant

The mathematics knowledge students develop in prekindergarten is key to their ability to make sense of more complex mathematics in the future (C. T. Cross, Woods, & Schweingruber, 2009; Ginsburg, Lee, & Boyd, 2008). Research continues to present evidence that there is a mathematics achievement gap between minoritized students living in lower socioeconomic communities compared to their peers before entering kindergarten (Arnold, Fisher, Doctroff, & Dobbs, 2002; Duncan et al., 2007; Sonnenschein & Galindo, 2015; Wang, 2010). The joint position statement issued by the National Association for the Education of Young Children and the National Council of Teachers of Mathematics (2010) states that all prekindergarten teachers working in public and private settings should utilize age and developmentally appropriate instruction to promote mathematics readiness. Yet there is limited research that provides data that captures non-licensed pre-K teachers' beliefs towards preschool mathematics or the mathematics instruction these teachers deliver as it relates to age and developmentally appropriate instruction.

In order to explore this topic, an exploratory qualitative study was conducted with two non-licensed prekindergarten teachers, framed by McCray's (2008) mathematical pedagogical content knowledge framework. Data were collected using one structured and two semi-structured

interviews, observations, questionnaire, and surveys. The qualitative analysis of these data yielded four themes that shed light on mathematics instruction provided by the two non-licensed pre-K teachers, and they were used to organize the results. Mathematics instruction is related to Theme 1: teacher beliefs and Theme 2: access to available resources. Mathematics in pre-kindergarten Theme 3: is primarily number sense; and Theme 4: mathematics instruction occurs in free-play during center time.

This dissertation is dedicated to Dakota Greysen Dawkins and my entire family—Mommie, Sister, Joyce, Dr. James, Dr. Smith, Ari, Grams, Ayana, Victoria, Brother, Dr. Colson, Dr. Underwood, Kyle and Xavier. Dr. Brenda N. Lewis, there are no words that can explain the love I have for you. You took me in and loved on me like I was one of your own babies. God places people in our lives at just the right moment, and for this I am externally grateful and indebted to you. I would not have remained at Old Dominion University without your encouragement, love, and years of support.

ACKNOWLEDGMENTS

I would like to thank my initial and final committee members for their support at various points throughout this process. Dr. Grant, I sought you out early in my journey at Old Dominion not knowing you would end up becoming my dissertation director. Your patience and constant editing as I disappeared and reemerged over the past few years has been instrumental to successful completion of this process. I now understand that a completed dissertation is much more rewarding than striving for perfection and remaining ABD. Dr. Angela Eckhoff. Although our journey ended before my dissertation was completed, without you I would not have made it through my course work, comprehensive process, or initial attempts with writing my proposal. For that, I have the utmost respect and appreciation for you. To each of my committee members, thank you for your patience with me.

Drs. Ian Sutherland and Helen Crompton, you two offered me opportunities to put my course work into real-world experiences. Due to your time investment and support, I achieved my goals of conducting research and publishing as a graduate student.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In recent years, increased focus has been placed on the delivery and quality of mathematics education in prekindergarten (pre-K) settings (Baroody, Eiland, & Thompson; 2009; Hachey, 2013; Kena et al., 2016). In 2018, approximately 64.7% of children aged three to five in the United States attended a pre-K at least 2 days per week (McFarland et al., 2018). Research shows the quality of these childcare learning centers varies tremendously in center type, funding sources, and teacher qualification (Whitebook, McLean, Austin, & Edwards, 2018). Pre-K can be publicly or privately funded. In public programs, such as Head Start, state and federal policies require teachers to have a state license or enrolled in a certifying program (Early Childhood Learning & Knowing Center, 2018). In private preschool settings, teacher certification is not always a requirement (Arnold, Fisher, Doctroff, & Dobbs, 2002). The focus of this dissertation is non-licensed pre-K teachers in the private sector.

Current research suggests that the quality of childcare learning centers differ greatly based on family demographics such as race and ethnicity. Additional factors that impact the rating of an early childcare learning center are safety measures, teacher licensing, time spent on learning activities, and externally conducted observations of process quality (Claessens & Garret, 2014; De Marco & Veron-Feagans, 2015). Research tells us that long-term student academic gains are often related to exposure to licensed pre-K teachers who have completed at least a bachelor’s degree (Barnett, 2003; Barnett et al., 2013). Private centers in low-socioeconomic (SES) communities tend to be staffed with non-licensed early childhood teachers. A family who lives in a low or moderate SES community typically has access to enroll their children in childcare learning centers within the community they live (Ferrandino, 2005; Malik, 2019; Young & Young, 2016).

When families from low and moderate SES communities do not qualify for universal pre-K programs, their overall ability to afford and secure enrollment in a high-quality private childcare learning center can be a challenge (Glynn, 2012). Glynn (2012) found that 52.7% of families with an average household income under $53,999 spend approximately 49.5% of their income on childcare, whereas families earning over $54,000 spend about 8.6% of their income on childcare (Glynn, 2012). Frequently, families that pay more for childcare do so because of the extended hours of supervision they need opposed to the quality of the selected center (Claessens & Garrett, 2014; Glynn, 2012). The children who attend these centers can benefit the most when enrolled in higher-quality centers.

Certified pre-K teachers can offer curriculum that will increase aspects of learning like mathematics readiness. However, the economic models employed by these centers result in less ability to hire certified teachers. The important question to answer then is, can childcare centers in low SES communities who employ non-licensed teachers provide access to quality curriculum in areas like mathematics readiness? Thus, the purpose of this dissertation has two foci including an exploration of how non-licensed pre-K teachers provide mathematics education, and how non-licensed pre-K teachers' mathematics pedagogical content knowledge relates to the teachers' mathematics instruction at childcare learning centers that primarily serve low-SES communities.

All pre-K teachers, licensed and non-licensed, must understand what mathematics content is, and how it should be taught (U.S. Department of Education, 2008). A vital role for pre- K teachers is to support the development of kindergarten mathematics readiness (Ginsburg, Lee, & Boyd, 2008; J. S. Lee & Ginsburg, 2009; Leong, Meng, & Rahim, 2015; U.S. Department of

Education, 2008). Current research indicates that young students are highly capable of learning and constructing complex mathematics understanding in early childhood settings when exposed to meaningful educational experiences (Clements & Sarama, 2011; Greenes, Ginsburg, & Balfanz, 2004; National Council of Teachers of Mathematics [NCTM], 2000). NCTM, the federally commissioned panel known as the National Mathematics Advisory Panel, and members of the Child Care and Early Education Research Connection community agree that building mathematics in the early years is a strategy that can promote overall academic success. This research explores the mathematics instruction practices of two non-licensed pre-K teachers and the resources they leveraged to teach mathematics to children from families living in low-to-moderate SES communities.

It is known that young students' performance in mathematics depends on their teachers' mathematics proficiency (Clements, Sarama, & DiBiase, 2004). Yet, there are very few studies that have examined non-licensed, pre-k teachers' knowledge, abilities, or beliefs as they relate to planning and implementing meaningful mathematics learning experiences. There is a large body of research in which early childhood teachers are frequently portrayed as disliking mathematics, lacking the confidence to teach mathematics appropriately, anxious about teaching the subject, and commonly avoid teaching it (Clements & Sarama, 2007; Ginsburg et al., 2008; J. S. Lee & Ginsburg, 2007a). Chen and McCray (2012) collected data on licensed pre-K teachers and found that these teachers agree that learning mathematics is developmentally appropriate for young students and that early mathematics instruction is necessary. The limit of this study and many others is that the research focused only on licensed pre- K teachers, but a significant portion of our children from low-socioeconomic communities are taught by non-licensed pre-K teachers (Whitebook et al., 2018). There seems to be very limited body of research that focuses on non-licensed teachers' mathematics instruction (Brown, 2005; J. S. Lee & Ginsburg, 2009). This dissertation focuses on non-licensed teachers and the findings will add to the research on how this critical group of teachers support pre-K education for children from families who live in low to moderate SES communities.

Students in low-SES environments typically receive less mathematics instruction as they are taught by non-licensed pre-K teachers working in private childcare centers. When mathematics instruction is provided in low-SES settings, it typically focuses on number sense such as rote counting, writing numbers, completing worksheets, and learning shapes when in whole group settings (Hachey, 2013; J. Lee, 2005, 2010). Despite such research findings, a large majority of students taught by licensed pre-K and lower elementary teachers seldom experience focused and intentional mathematics. This is often due to teachers' limited mathematical pedagogical content knowledge (MPCK) developed as they worked through their teacher preparation programs (Ball, 1988; Charlesworth, 2005; Ginsburg et al., 2008; Kilpatrick, Swafford, & Swindell, 2001; Linder, Powers-Costello, & Stegelin, 2011; McClure et al., 2017; Ma, 1999; Taylor-Cox, 2016). MPCK relates to one's collective understanding and ability to teach mathematics using knowledge of students' development, appropriate content knowledge, selection and use of developmentally appropriate instructional decisions, and disposition (Ball, 1988; McCray & Chen, 2012; Shulman, 1986). Non-licensed pre-K teachers may not have participated in or completed a formal teacher preparation program, but they still may have naïve conceptions of MPCK. This exploratory study endeavors to understand the perceptions of these teachers.

A large body of research regarding early childhood mathematics teachers and their MPCK are frequently conducted with teachers in public settings that focus on teachers working in kindergarten, first, second, and third grades (Bukova-Güzel, Cantürk-Günhan, Kula, Özgür, & Elçí, 2013; Groth, 2008; J. Lee, 2010; Leong, 2013; Linder, 2012; Vale, 2010). Studies that focus on upper early childhood teachers typically examine licensed pre-K teachers' mathematics beliefs before and after they participate in a professional development program or examine student achievement after an intervention is presented (Clements & Sarama, 2011; Clements, Sarama, Wolfe, & Spitler, 2013). These types of research have a great impact on the way in which mathematics is taught. However, only a few studies have focused on non-licensed pre-K teachers as participants (Ginsburg & Amit, 2008; Kaartinen & Kumpulainen, 2012; McCray & Chen, 2012; Tirosh, Tsamir, Levenson, & Tabach, 2011); only a few studies outside this dissertation study have focused on non-licensed pre-K teachers and the mathematics instruction they provide.

More research is needed so that all students have a chance at developing enough mathematics readiness upon entering kindergarten (Chatterji, 2015; National Assessment of Education Progress, 2019). Some exposure to learning in a pre-K setting is better than no exposure (Baroody et al., 2009; Peisner-Feinberg, Mokrova, & Anderson, 2017). With the demand for working families to secure childcare, families residing in low-SES communities will ensure non-licensed pre-K teachers have a job until universal preschool pre-K is available to all children and taught by licensed pre-K teachers. Until then, the mathematics instruction provided by non-licensed pre-K teachers and their MPCK should be studied to better support the teachers' ability to create and implement effective mathematics experiences. This is the gap in research this dissertation aims to explore.

Statement of the Problem

Publicly funded pre-K programs are available in North Carolina. Only about 28,757 (23%) pre-K aged students were able to attend those programs due to funding in the 2015 – 2016 school year (Peisner-Feinberg et al., 2017). In recent years, private pre-K childcare centers have come to play an even larger role in preparing young students to enter kindergarten. Many private pre-K programs help accommodate the growing need for childcare to families in lower-SES communities. In North Carolina, approximately 100,639 (77%) of pre-K aged-students were enrolled in private pre-K programs (Peisner-Feinberg et al., 2017).

Privately funded pre-K programs vary in terms of the students they serve and the credential requirements of their teaching staff. Centers can employ licensed teachers or non-licensed teachers depending on the state in which they are located and their associated accrediting body. Students who attend any type of pre-K program have been shown to improve in their kindergarten readiness (Claessens & Garrett, 2015). Yet there is still a gap in readiness skills between students who attend high-quality centers as opposed to lower quality (Chatterji, 2015). With the proper resources and support, current non-licensed teachers have the capacity to be trained to deliver meaningful mathematics instruction with the quality equivalent or better than licensed pre-K teachers (Chatterji, 2015; Duncan et al., 2007). To that end, assessments can be used to compare the non-licensed pre-K teachers' current practices to benchmarks associated with the MPCK framework (Arnold et al., 2002; Clements & Sarama, 2011). Once MPCK benchmarks are explored, professional development is an intervention that may build non-licensed pre-K teachers' MPCK (Rudd, Satterwhite, & Lambert, 2010).

Current research supports that there is value in early childhood education as it relates to kindergarten readiness skill development (De Marco & Veron-Feagans, 2015; Duncan et al., 2007; García, Weiss, & Economic Policy Institute, 2015). This dissertation is designed to address the gap in research regarding what is known about non-licensed pre-K teachers and what influences their mathematics instruction when working with students in low-SES environments. The following section discusses the significance of mathematics knowledgeable pre-K teachers in early learning environments. The next section describes some comprehensive barriers that can inhibit non-licensed pre-K teachers' use of research-based mathematics instruction. The discussion then moves to presenting this dissertation's guiding questions. This chapter concludes with a brief introduction to the study's framework and methodology.

The Power and Significance of Prekindergarten Teachers

For students to build complex mathematics understanding, they must have access to knowledgeable teachers (U.S. Department of Education, 2008). Clements (2001) explains that an effective teacher who intentionally teaches mathematics allows young students to experience mathematics more frequently and can have a stronger influence on student achievement regardless of poverty, language background, class size, or minority status (Darling-Hammond, 2000; Rothstein, 2010). Successful mathematics experiences can narrow the early childhood mathematics gap as students' mathematics self-efficacy grows (Sarama, Clements, Starkey, Klein, & Wakeley, 2008). Research conducted by Nye, Konstantopoulos, and Hedges (2004) looked at data related to lower elementary students and concluded that gains in students' mathematics proficiency during an academic year could increase 12%-14% when taught by a competent, capable, and knowledgeable mathematics knowledgeable teacher.

In early childhood education, competent and effective teachers understand that student-choice, or "free-play" learning, constitutes much of the day. Teachers in such learning environments should systematically incorporate mathematics within natural free-play opportunities (Early et al., 2010; Linder et al., 2011). In these classrooms, mathematics knowledgeable pre-K teachers intentionally create and manage activities that promote mathematics engagement, communication, dialogue, and practice (de Haan, Elberts, & Leseman, 2014). Pre-K teachers who understand foundational mathematics are vital to building and maintaining mathematics-rich classrooms.

Findings indicate there is a positive correlation between strong teacher MPCK, positive mathematics affect, and student achievement (Chen, McCray, Adams, & Leow, 2014; Rudd, Lambert, Satterwhite, & Zaier, 2008). Pre-K teachers who possess high levels of MPCK have the expertise to support mathematics readiness and mathematics skill development in a joyous but challenging manner (Clements, 2001; Rudd et al., 2008). However, there is a limited pool of pre-K teachers who possess strong MPCK as it relates to early childhood mathematics. Kilpatrick et al.'s (2001) and Ma's (1999) research highlight that many good teachers often lack a profound understanding of fundamental mathematics necessary to teach the subject. Although many good teachers can create inviting learning environments, those environments are not designed to build the development of standards (J. Lee, 2010). In many cases, sound and overall effective early childhood teachers receive limited training to teach mathematics to young students, debate the necessity of mathematics in early learning, and generally lack a deep understanding of what constitutes early childhood appropriate mathematics content and developmentally appropriate mathematics instructional strategies (Brown, 2005; Clements & Sarama, 2014; Ginsburg et al., 2008; J. Lee, 2010). Across the nation, many teachers at the elementary level are not adequately prepared to design and implement research-based or standards-based mathematics instruction necessary to develop and maintain mathematics achievement (C. T. Cross, Woods, & Schweingruber, 2009; Thiel, 2010; U.S. Department of Education, 2008).

To be effective, pre-K teachers need more than foundational content knowledge to design and embed meaningful mathematics experiences. Pre-K teachers need a working knowledge of ideas and teaching strategies from which to pull when planned instruction requires immediate modification. To appropriately utilize this storage of knowledge, teachers must possess an awareness of how students learn mathematics, formal and informal assessment techniques, and the typical scope and sequence for instruction (Arnold et al., 2002). Strong mathematics knowledgeable pre-K teachers seize spontaneous opportunities to engage mathematics throughout the day (Brown, 2005). They capitalize on teachable moments by engaging students during transitions, asking and answering questions, and recognizing how to build upon their prior knowledge.

The federal government understands the importance of employing effective teachers. On many levels, government agencies are continually working to amend, create, modify, and reauthorize policies that push to ensure teachers are adequately trained to become highly qualified to meet the academic needs of students. The Bush administration called it *No Child Left Behind* (Wong & Sunderman, 2007) and the Obama administration called it *A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education Act*, but both policies sought to ensure all teachers became highly qualified (U.S. Department of Education, 2010). Per Title IX, section 9101 of the *Elementary and Secondary Education Act*, to be considered a highly qualified teacher, one must meet specific requirements (U.S. Department of Education, 2010). One way to become a highly qualified elementary teacher is to pass a test of basic skills for the state in which the teacher will be licensed. Another way to become highly qualified is to collectively obtain a bachelor's degree and then pass a state licensing exam.

Although *No Child Left Behind* outlined the definition of highly qualified teachers, its definition does not establish a pathway to ensure that a highly qualified teacher on paper is an effective teacher in a real classroom (Thomas & Bainbridge, 2002; U.S. Congress, 2010). To effectively teach mathematics, all teachers must have a deep understanding of mathematics content knowledge, a vast knowledge base of instructional practices, and a generally positive disposition for mathematics. These are aspects of MPCK that this dissertation explored.

Barriers: Prekindergarten Teachers' Mathematics Pedagogical Beliefs

Ma (1999) concluded that effective and knowledgeable mathematics teachers must have a profound understanding of fundamental mathematics. The licensed and non-licensed teachers' fundamental mathematics knowledge needed to build student mathematics achievement is not equal to general mathematics knowledge necessary to be successful in mathematics-intensive careers. Effective mathematics teachers must understand mathematics sufficiently to break down content to make it understandable to all students. Possessing such mathematics understanding supports that effective teachers can successfully solve grade-specific problems and offer quality explanations, use assessment data to decode student misconceptions about the content, and design and implement instruction that makes the content meaningful to specific students (Hill, Sleep, Lewis, & Ball, 2007).

For pre-K teachers to efficiently deliver mathematics instruction, they must possess enough pedagogical content knowledge to create and maintain high-quality mathematics environments (Ball, 2000; NAEYC & NCTM, 2010; Thornton, Crim, & Hawkins, 2009). Shulman (1986) defined pedagogical content knowledge as the blending of content knowledge with an understanding of how to teach students the content. Building on Shulman, Campbell et al. (2014) defined MPCK specifically as "knowledge of mathematics teaching and learning that teachers might draw on or use in instructional practice when teaching the mathematics content" (p. 425). This section provided a brief review of how factors such as pedagogical content knowledge, personal beliefs, content knowledge, teacher preparation processes, and knowledge of how students learn have the potential to influence the mathematics instruction of pre-K teachers.

Purpose of the Study and Guiding Research Questions

The purpose of this dissertation is to explore non-licensed pre-K teachers' MPCK and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve low-SES communities. A discussion about McCray's (2008) framework is presented in greater detail in Chapter II. This study responds to this gap in research. The following questions guided this qualitative study:

1. What is the nature of non-licensed prekindergarten teachers' mathematics instruction when working in lower socioeconomic communities?
2. How does mathematics pedagogical content knowledge influence non-licensed prekindergarten teachers' instructional practices when working in lower socioeconomic communities?

Significance of the Study

The study's significance lies in the assumption that pre-K teachers' beliefs and MPCK influence the quantity and quality of the mathematics instruction they deliver. This dissertation places a central focus on pre-K teachers since historically there has been limited investment of research to identify the special challenges of pre-K teachers to successfully teach mathematics to students between 4 and 5 years of age (Ginsburg et al., 2008). Moreover, as teachers increase their level of MPCK, they can produce optimal learning environments. These environments are mathematics rich with increased teacher-student mathematics interactions (Reinking, 2015).

At the time of the present study, the work of D. I. Cross (2009) was the closest aligned study found. That dissertation explored teachers' self-assessment of their MPCK, how their level of MPCK aligned with their mathematics instruction, and how their MPCK helped or hindered their use of research-based recommendations and resources. In comparison to the current study, D. I. Cross's (2009) study was conducted at the high school level. Similarly, Wilkins's (2008) research specifically explored how elementary teachers' mathematics subject-matter knowledge, mathematics attitudes, and beliefs about mathematics pedagogy related to their use of inquiry-based learning. Wilkins's (2008) correlation suggests that teachers with positive mathematics dispositions more frequently plan and implement quality mathematics lessons.

Despite grade levels, great teaching occurs when educators have strong pedagogical content knowledge. Regarding mathematics, content knowledge and pedagogy vary drastically from preschool to elementary school and elementary school to secondary schooling. A considerable distinction between D. I. Cross (2009), Wilkins (2008), and this dissertation is the demographics of each study's participants. Based on current research, there are limited studies that explore how pre-K teachers' beliefs and perceived knowledge of components of MPCK relate to their mathematics instruction when employed outside of elementary school settings

Conceptual Framework

Pre-K teachers must consider many factors when planning for mathematics instruction. Factors that can influence instructional practices may include beliefs, perceived knowledge of MPCK components, and the teacher licensure. Beliefs held by teachers will likely relate to the amount of time spent planning and implementing mathematics instruction (Bates, Latham, &

Kim, 2011; Brown, 2005; Bukova-Güzel et al., 2013; Wilkins, 2008). Effective or not, the way many teachers learned is the way they opt to teach. These prior experiences frequently affect the mathematics instructional decisions teachers make (Bailey, 2010; Brown, 2005; Clements & Sarama, 2014; Gresham, 2007; Summers, Davis, & Hoy, 2017). The depth of content knowledge possessed by teachers often relates to how they deliver instruction (Hill, Rowan, & Ball, 2005; J. E. Lee, 2014; J. S. Lee & Ginsburg, 2009). The conceptual framework in Figure 1 illustrates the intersecting factors that may influence the mathematics instructional decisions selected by pre-K teachers. McCray's (2008) MPCK framework details the interactions among three factors: teachers' mathematics content knowledge, teachers' knowledge of teaching techniques, and teachers' knowledge of student development. A discussion on this conceptual framework occurs in greater detail in Chapter II. Figure 1 illustrates the intersecting factors that may influence mathematics teaching.

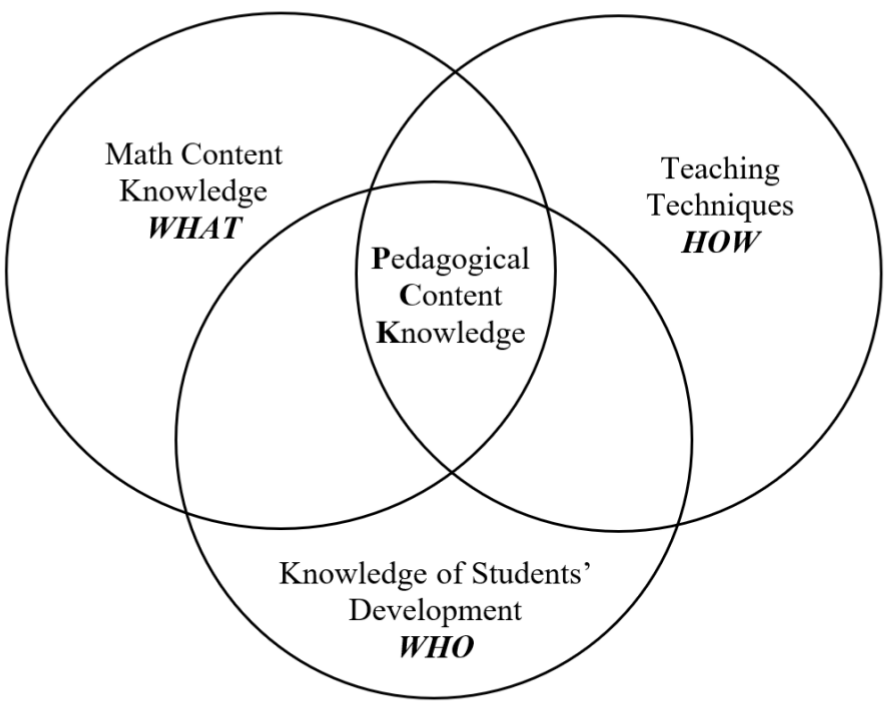


Figure 1. Mathematical Pedagogical Content Knowledge Framework. Source: McCray (2008), p. 295.

Overview of the Methodology

Most studies in early childhood education that focus on mathematics are quantitative in design and do not focus on non-licensed pre-K teachers who work in low-SES communities (Clements et al., 2013; C. T. Cross et al., 2009; de Haan et al., 2014; Dyson, Jordan, & Glutting, 2011; McCray & Chen, 2012). Therefore, this dissertation used an exploratory methodology to contribute to the limited research about non-licensed pre-K teachers and mathematics instruction. An exploratory research design is most suitable when there is a topic of interest, but there are few or very limited earlier studies that also focus on the topic. For this dissertation, the focus is on gathering insight and understanding of non-licensed pre-K teachers' mathematics instruction that can serve as a baseline for future, larger-scale empirical research. In this case, pre-K teachers represent teachers who educate students aged 4 and 5 years old. Two pre-K teachers currently serving in the same teaching position in low-SES areas participated in this research. Only non-licensed teachers serving as lead classroom teachers for at least 6 months were recruited as participants, and their participation was voluntary. There were no conceivable risks to the participants. Their identities were kept confidential during the dissertation Therefore, this dissertation used an exploratory methodology to contribute to the limited research about non-licensed pre-K teachers and mathematics instruction. An exploratory research design is most suitable when there is a topic of interest, but there are few or very limited earlier studies which also focus on the topic. For this dissertation, the focus was on gathering insight and understanding of non-licensed pre-K teachers' mathematics instruction that can serve as a baseline for future, larger scale empirical research. For this case, pre-K teachers represent teachers who educate students aged four and five years old. Two pre-K teachers currently serving in the same teaching position in low-SES areas participated in this research. Only non-licensed teachers serving as lead classroom teachers for at least six months were recruited as participants and their participation was voluntary. There were no conceivable risks to the participants. Their identities were kept confidential during the dissertation by using pseudonyms.

Using the selected methodology, the researcher could preserve the holistic and meaningful individualities of real-life events (Yin, 2016). Data collection for the study included semi-structured interviews, classroom observations, a review of available lesson plans, and the administration of the Preschool MPCK Interview (McCray, 2008) (see Appendix A). These data were analyzed using the analysis methods of key-word-in-context analysis approach and word repetitions (Leech & Onwuegbuzie, 2007; Ryan & Bernard, 2003), which supported the responses to the guiding research questions presented in Chapter IV. Additional data were collected using the Mathematical Development Beliefs Survey (Platas, 2008) (see Appendix B). The provided coding guide was used to analyze the survey responses (Platas, 2008). Based on data analysis processes, four key themes emerged. The themes that influenced Regina's and Catie's mathematics instruction included:

Theme 1 – Teacher beliefs;

Theme 2 – Access to resources;

Theme 3 – Pre-K mathematics is primarily number sense development; and

Theme 4 – Mathematics instruction occurs in free play

Based on the themes, influencers on non-licensed pre-K teachers' mathematics instruction include the teachers' (a) beliefs about mathematics teaching in pre-K, and (b) access to instructional resources. Both teachers agreed that mathematics instructional is appropriate, needed, and should be taught using developmentally appropriate methods.

Summary

This exploratory study had an overarching goal of exploring non-licensed pre-K teachers' MPCK and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve low-SES communities. This chapter provided an introduction to this dissertation by taking a brief look at the power teachers have to support student learning along with barriers that prevent teachers from delivering effective instruction. The discussion on MPCK is situated by tracking PCK from its foundation in the work of Shulman, Ball, and McCray. In the following chapters, the rationale, methods, results, and implications of this dissertation are discussed.

CHAPTER II

LITERATURE REVIEW

According to studies by C. T. Cross et al. (2009), the U.S. Department of Education (2008), and NAEYC and NCTM (2010), there is a need to explore prekindergarten (pre-K) mathematics instruction. In response to this request, the purpose of this study is to explore non-licensed pre-K teachers' mathematics pedagogical content knowledge (MPCK) and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve low-socioeconomic (SES) communities. Teachers do not make instructional decisions in isolation. All instructional choices are influenced by multiple factors, including teacher preparation processes, beliefs, content knowledge, pedagogical content knowledge (PCK), and knowledge of how students learn mathematics. In this chapter, a review of relevant literature is presented. To properly set the stage for this dissertation, Chapter II examines education literature about early childhood mathematics education, how young students learn mathematics, how pre-K teachers teach mathematics, and how beliefs relate to teaching.

Early Childhood Mathematics Education

The power of pre-k and pre-K teachers can be identified in the evolution of early childhood mathematics instruction. Pre-K centers and pre-K teachers can provide mathematics instruction to build readiness for students from low-SES communities. Through an examination of the literature, early childhood mathematics is found to be extremely important for pre-K students and continues to receive robust and widespread attention (Chen et al., 2014; C.T. Cross et al., 2009; Erikson Institute, 2014; Ginsburg et al., 2008; McCray, 2008; National Assessment of Education Progress, 2019; NAEYC & NCTM, 2010; Youmans, Coombs, & Colgan, 2018). Educational reforms outside of the United States have greatly influenced the modern perspective in the United States on early childhood education (Saracho & Spodek, 2008). Educational movements include the Arithmetic Movement, Infant Schools (Saracho & Spodek, 2008), Fröebel's German Kindergarten (Baader, 2004), and the Curriculum Reform Movement (Kliebard, 2004).

Infant Schools were established by Robert Owen, who posited learning should be guided based on students' experiences (J. Lee, 2010; Saracho & Spodek, 2009). These experiences revolved around unstructured play and with manipulatives (Kwon, 2002). Fröebel's German Kindergarten model was foundational in the development of early childhood education in the United States (Baader, 2004). Like Infant Schools, Fröebel alleged that children should learn through free-play without structured planning by teachers. Within the Fröebel program model, children were exposed to mathematics relating to numbers and shapes through gifts, which were primitive manipulatives (Saracho & Spodek, 2009). Both early learning programs were structured by a specific agenda, rationale, and theory. Each program valued student growth in number sense and problem-solving. Each movement considered mathematics important and required teachers to understand mathematics to work in a facilitator-like role (Baader, 2004; Saracho & Spodek, 2009).

In the historical existence of mathematics, we know little about the role that MPCK has on non-licensed pre-k teachers' ability to deliver mathematics instruction like teachers in Infant Schools or Fröebel's German Kindergarten (Dunphy, 2009; Ginsburg & Amit, 2008; J. E. Lee, 2014). Throughout the history of early childhood mathematics education in the United States, few early childhood teachers have been known to deliver mathematics instruction while assuming a facilitator-like role (Copley, 2004; C. T. Cross et al., 2009). Non-licensed, pre-K teachers often fail to provide intentional mathematics instruction, as they are uncomfortable

(Clements & Sarama, 2007; Claessens & Garret, 2014; Copley, 2004; Ginsburg et al., 2008; J. S. Lee & Ginsburg, 2007a). Proportionately, non-licensed pre-K teachers infrequently provide explicit and direct support to enhance the everyday mathematics knowledge students bring to pre-k (J. S. Lee & Ginsburg, 2009). There is a need for licensed and non-licensed pre-k teachers to improve the mathematics instruction they deliver (Rudd et al., 2008) as more attention is being placed on the mathematics capacity of early childhood teachers. Per the U.S. Department of Education (2008) and C. T. Cross et al. (2009), learning mathematics early in life predicts future mathematics achievement throughout high school and later overall academic achievement more consistently than early reading skills.

How Young Students Learn Mathematics

Young students can construct valid mathematics arguments (Baroody et al., 2009; Björklund & Alkhede, 2017; Frye et al., 2013; McCray, 2008; Perry & Dockett, 2002). Therefore, pre-K teachers should understand how young students learn in order to provide developmentally appropriate mathematics instruction. Knowledgeable pre-K teachers frequently deliver developmentally appropriate mathematics instruction by providing intentional opportunities to play. This form of intentional play promotes natural engagement with mathematics organically (Samuelsson & Carlsson, 2008). These simple experiences from unstructured play serve as many students' first exposure to "scientific inquiry" (Hamlin & Wisneski, 2012, p. 82). Through everyday experiences and natural play, young students continue to utilize mathematics. Learning to recognize the mathematics of play can enhance pre-K teachers' ability to embed lessons outside of whole group time with explicit or direct instruction (Anders & Rossbach, 2015; Schack et al., 2013; Sherin, Jacobs, & Philipp, 2011). When young students encounter opportunities to engage with informal, natural, mathematics, they begin constructing beliefs from their play. Students learn to make predictions based on consistent cause and effect experiences they encounter (Schunk, 2012). Before entering pre-K, students become knowledgeable of colors, shapes, quantity, and sharing fairly (Clements & Sarama, 2011; Ginsburg, Inoue, & Seo, 1999; Greenes et al., 2004).

Although the term was not coined during earlier movements, Carew (1980) conducted observations of children at home and in early childhood centers. Her findings provided supportive evidence that the ability to learn mathematics begins at infancy. This concept is now referred to as *everyday mathematics* (Clements & Sarama, 2011; Greenes et al., 2004). Ginsburg et al. (2008) describes everyday mathematics as “an essential and even inevitable feature of the child’s cognitive development . . . such as theory of mind or critical thinking [and] develops in the ordinary environment, usually without direct instruction” (p. 3). During snack, young children often notice when snacks are not shared equally and begin using terms such as more, less, or not fair. As young students experience these learning opportunities, their cognitive abilities strengthen, and they learn to think more critically about the previous knowledge they constructed (Ginsburg et al., 2008; Schunk, 2012).

Everyday mathematics is learned organically through young students’ play and innate life experiences. Everyday mathematics learning occurs before entering pre-K for all students independent of familial SES (Fuson, 2009). Their knowledge is likely to include some level of inaccuracies and irrational reasoning of mathematics as students construct this knowledge without intentional guidance (Ginsburg et al., 2008; Klein, Starkey, Clements, Sarama, & Iyer, 2008). Therefore, when teachers notice and acknowledge their students’ prior knowledge, there is more significant potential to support intentional mathematics instruction (Greenes et al., 2004; Griffin & Case, 1997; Linder et al., 2011; Rudd et al., 2008).

Using play is a great way to learn, but play alone may not guarantee mathematics proficiency (Kontos, 1999). Licensed and non-licensed pre-K teachers must be able to account for young students' knowledge of everyday mathematics and the big ideas of mathematics —a key aspect of content and students (Ball, Thames, & Phelps, 2008)—in order to make meaningful and intentional mathematics instruction. Teachers must be able to integrate their mathematics content knowledge and pedagogical practices with their knowledge of students' mathematics ability (Shulman, 1987). As students showcase different approaches to solving problems, teachers can adapt their instruction. When appropriate, pre-K teachers should incorporate various manipulatives and instructional resources to the same concepts in multiple ways. Pre-K teachers must facilitate and scaffold rich engagement and the development of mathematics (NAEYC & NCTM, 2010).

Dialogue is another key strategy in which young students learn. As teachers work with students, they must teach and practice communication using mathematics vocabulary (Perry, Dockett, & Harley, 2007). Actively using mathematics language enhances mathematics development. When pre-K teachers are knowledgeable about pre-K mathematics, they question and engage students in informal but intentional conversations about mathematics outside of direct instruction (Rudd et al., 2010). Mathematics knowledge can enhance the opportunity to seize teachable moments and build mathematics vocabulary. For example, the block center is a high traffic area during free play. As students are playing in the block center, a common activity of children is to build towers. Young students carefully place various blocks vertically to complete this task. Mathematics-knowledgeable teachers must be able to notice that this process of stacking and building has mathematics learning potential (Kilday, Kinzie, Mashburn, & Whittaker, 2012). A pre-K teacher could ask the learner if they could build something that is the same size using different sized blocks or engage the learner in a conversation about their building compared to another building and using mathematics vocabulary.

When teachers and students engage in a dialogue that is grounded in mathematics, it is referred to as Mathematical Mediated Language (Moseley, 2005). Moseley (2005) suggests Mathematical Mediated Language "serves to link conceptually related linguistic and mathematical knowledge" such that mathematical terminology can be joined with the everyday language of students, which "may influence their ability to see opportunities for teaching mathematical concepts not only in the context of an explicit math lesson but throughout the broader early childhood curriculum" (p. 385). Using mathematics vocabulary in daily conversations, teachers can make teachable moments more meaningful and help young students extend and elaborate their mathematics thinking. Teachers need content knowledge and the ability to informally access play to deliver additional, intentional mathematics instruction (Ginsburg et al., 1999).

Non-Licensed Pre-K Teachers and Mathematics

> Ginsburg, Lee, and Boyd remind us that young children can and do learn mathematical concepts, and they could learn much more if we supported their learning. But preschool teachers are given almost no preparation to teach mathematics. The consequence, apparent to me in visits to hundreds of preschool and kindergarten classrooms is that mathematics is simply not taught. (Stipek, 2008, p. 13)

Teachers are the key ingredient necessary to provide meaningful early childhood mathematics instruction (Herron, 2010; U.S. Department of Education, 2008). Teachers are often categorized by their educational qualifications if they are licensed or not (Barnett, 2003; Darling-Hammond, 2017; Kodagoda, 2014; Phillips & Morse, 2011). Requirements to become a lead pre-K teacher differ between private and public childcare settings (Swars, Smith, Smith, & Hart, 2009; Thiel, 2010; Whitebook et al., 2018). In the private sector, the requirements to serve as a lead pre-K teacher vary across states, based on center accreditations and the community where the center is located. In some instances, the only requirement to serve as a pre-K teacher is to have a high school diploma (Rudd, Lambert, Satterwhite, & Smith, 2009; U.S. Department of Education, 2008).

Unfortunately, non-licensed pre-k teachers are often seen as babysitters and not qualified educators when working in low-SES communities (Nelson & Lewis, 2016). Whether a pre-K teacher is licensed or non-licensed, they should provide intentional mathematics instruction to support mathematics development (de Haan et al., 2014). Although there is a need to provide meaningful mathematics instruction, many pre-K teachers struggle to offer appropriate mathematics instruction and are less confident in their ability to teach mathematics (Ginsburg et al., 2008; Moon & Lee, 2011). Current research indicates that pre-K teachers have limited mathematics content knowledge as they typically receive minimal, if any, preparation for teaching mathematics (Ginsburg et al., 2008; Thiel, 2010; Tirosh et al., 2011), which further relegates them to the role of babysitters opposed to teachers.

In early childhood, teachers' education level frequently affects the quality of instruction they provide (Barnett, 2003; Barnett, Jung, Youn, & Frede, 2013; Saracho & Spodek, 2014). There is evidence linking teachers' credentials to their students' achievement (Barnett et al., 2013; Chen et al., 2014; Claessens & Garrett, 2014; Carew, 1980; Darling-Hammond, 2017). In the United States, 30% of pre-K teachers in the private setting have not completed a formal pre-K teacher preparation program and only meet their state's minimum requirements (Whitebook et al., 2018). According to Claessens and Garrett (2014), teachers with at least a bachelor's degree in early childhood education typically provide more developmentally appropriate mathematics instruction compared to their non-licensed peers due to the lack of non-licensed teachers' knowledge of general pedagogy. With limited credentials, non-licensed "preschool teachers receive little or no preparation for teaching mathematics to their young children" (Tirosh et al., 2011, p. 114). The certification route taken by an early childhood teacher influences their pedagogical beliefs, MPCK, and mathematics instruction (Ball, 1998; J. S. Lee & Ginsburg, 2007a; McCray, 2008; Shulman, 1986). Although there is a wealth of research in the area of early childhood mathematics education, most of it focuses on licensed teachers who work in public pre-K settings and not the 30% of non-licensed teachers in the private sector. The need to produce teachers who are educated and prepared to teach early childhood mathematics is an important part of offering quality pre-K education. In the next section, PCK and MPCK are discussed to examine how components of MPCK are interrelated.

Pedagogical Content Knowledge

> Teachers of young children should learn the mathematics content that is directly relevant to their professional role. But content alone is not enough. Effective professional programs weave together mathematics content, pedagogy, and knowledge of child development. (NAEYC & NCTM, 2010, p. 11)

Marzano (2017) acknowledges that teaching is a complex profession that is dually an art and a science. A key indicator of this duality in this profession is characterized by high-quality, competent teachers that can positively affect student achievement (Hattie, 2012; U.S. Department of Education, 2008). Per the RAND Corporation (2012), "teachers matter more to student achievement than any other aspect of schooling" (p. 1). Studies conducted by the U.S. Department of Education (2008), Clements and Sarama (2014), and others indicate that students' mathematics mastery can compound over time when taught by effective teachers over consecutive years. However, Hanushek (2010) found that "it may not be possible for [a] student to recover" if ineffective teachers across multiple years teach them (p. 467). Therefore, exposing students to effective, competent teachers across the curriculum is extremely important to set the stage for their foundational learning experiences (Fenstermacher, 1979). Justly, students' achievement and teachers' content knowledge are significantly correlated.

There is a difference between knowing content and knowing how to teach that content to students. Shulman (1986) argues that teaching is a multi-dimensional concept. His work specifies that effective teaching joins together subject matter knowledge, general teaching pedagogical skills, and a unique domain of knowledge called PCK. Since his conception of general PCK, many subject areas have been altered and more advanced representation of subject-specific PCK have been created. In a broad scope, all teachers need to provide high-quality instruction that is systematically defined as pedagogical content knowledge (Chan & Yung, 2018).

Shulman (1986, 1987) believes that competent and effective teachers teach based on their understanding of content knowledge and their understanding of content-specific pedagogy. Shulman coined the integration of these two elements as PCK (see Figure 2). From this combination, Shulman (1986, 1987) presented the idea that student achievement is influenced and can be improved based on teachers' PCK. Shulman's (1986) PCK framework addresses the specific subject matter knowledge that should be taught, knowledge of instructional resources, and pedagogical knowledge as it relates to appropriate teaching and learning strategies. Shulman (1986, 1987) identifies key differences between the three types of teacher knowledge (subject matter, curriculum, pedagogical). Such that, PCK is an integrated set of knowledge that effective teachers can pull from to best teach the appropriate content knowledge to diverse groups of students in a developmentally appropriate manner.

Teachers with strong PCK more frequently facilitate meaningful learning experiences based on their understanding of how students learn and construct content misconceptions.

> Pedagogical content knowledge goes beyond the knowledge of subject matter per se . . . includes an understanding of what makes the learning of specific topics easy or difficult:

> the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. (Shulman, 1986, p. 9)

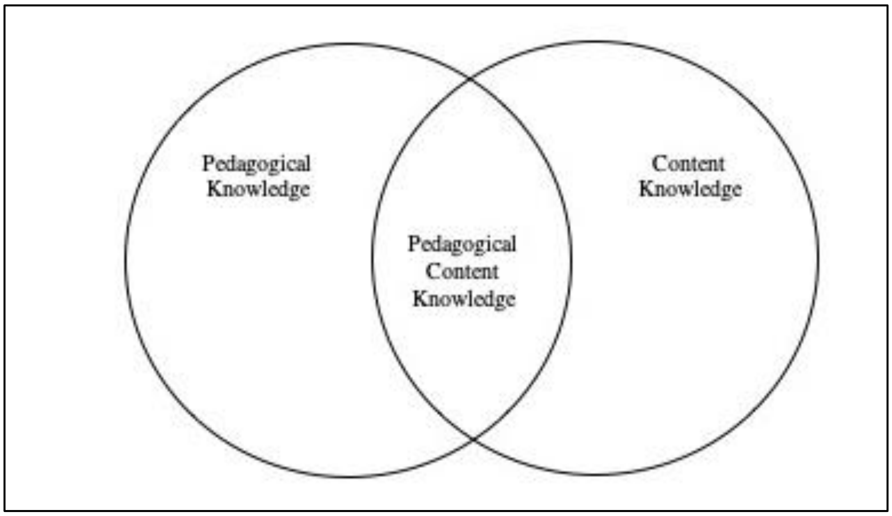


Figure 2. Pedagogical content knowledge. Source: Shulman (1986).

Although Shulman is recognized as the father of PCK, the concept is not new and continues to be refined. From Shulman's (1986) research on PCK, a movement to explore what teachers need to know and understand about specific subjects emerged. Shulman's work has been well received, and justly used as the theory that supports MPCK, technology PCK, and many other disciplinary areas. This dissertation in part focuses on MPCK; therefore, more discussion on PCK for mathematics follows.

Teaching and Learning Mathematics

Although attributes of effective teaching are similar across grades and subjects, there are aspects relating to beliefs, content knowledge, pedagogical practices, and understanding of students that alter the delivery of good mathematics teaching at the pre-K level. In the next section, aspects of PCK for mathematics are discussed related to teaching. Miller, Schiavo, and Busey (2008) acknowledge that teachers' mathematics knowledge influences student engagement, their use of instructional resources and materials, and student mathematics understanding. Their work on the Mathematics and Science Partnership *Knowledge Management and Dissemination Project* concluded that teachers with high levels of mathematics knowledge for teaching often promote meaningful engagement with specific mathematics content by designing and implementing lessons that utilize scenarios that link previous and new content (Mohan, Galosy, Miller, & Bintz, 2017). Such competent and effective teachers with higher levels of mathematics knowledge for teaching frequently teach using hands-on approaches that incorporate manipulatives and models to promote deeper understanding and opportunities for students to construct meaning (Clements & Sarama, 2007; Linder et al., 2011; Ma, 1999).

Ball (1988) conducted one of the initial empirical studies that addressed PCK for mathematics. Interestingly, the study's findings revealed that less than one-third of the preservice teachers interviewed successfully understood or could articulate valid rationales to justify mathematics. The later works of Ball (1990) further separated content and pedagogical knowledge to "knowledge of and about mathematics" (p. 39). MPCK was investigated with greater depth using upper elementary teachers by Ball et al. (2008). They identified effective PCK for mathematics. This concept incorporated more than PCK, as described by Shulman (1987). From the work of Ball (1990), the Mathematical Knowledge for Teaching framework evolved to conceptualize the PCK needed specifically for mathematics teachers.

The Mathematical Knowledge for Teaching framework deconstructed PCK into two parts—what is typically referred to as PCK along with subject-matter knowledge (see Figure 3). The two independent domains—common content knowledge and specialized content knowledge—comprise subject-matter knowledge. Common content knowledge relates to general mathematics knowledge and understanding that reside outside of teaching mathematics. For example, a mathematics concept that makes up common content knowledge includes general mathematics knowledge that most educated adults would know, such as telling time using an analog clock.

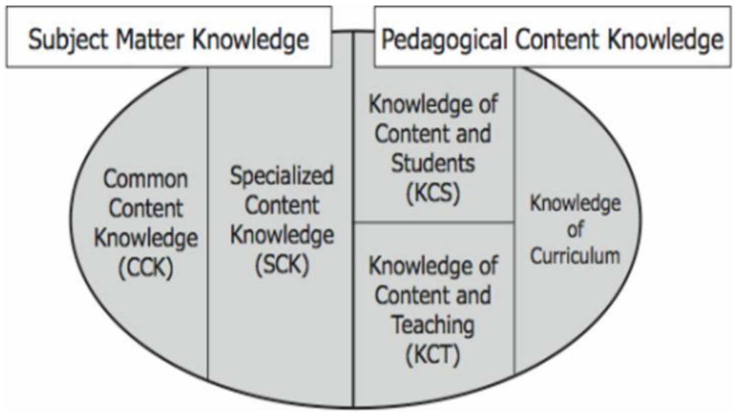


Figure 3. Domains of mathematical knowledge for teaching. Source: Ball et al. (2008).

Unlike common content knowledge, specialized content knowledge is knowledge of mathematics that is necessary to teach mathematics to others. This knowledge relates to understanding mathematics well enough to break down common content knowledge into smaller objectives, which then enables a student to represent and explain mathematics using processes, strategies, and vocabulary (e.g., understanding that although arithmetic and algebra are different, there is a relationship between the two mathematics domains). Arithmetic is the most basic of all branches of mathematics. It deals directly with the simple computation of numbers using the operations of addition, subtraction, multiplication, and division. Algebra also encompasses computation using operations, but the use of numbers and variables enables one to model situations and solve more complex problems.

Knowledge of content and teaching (KCT), knowledge of content and students (KCS), and knowledge of the curriculum are the domains that define PCK within the Mathematical Knowledge for Teaching framework. For this dissertation, PCK is the only domain of the

Mathematical Knowledge for Teaching framework considered. Each of these components of knowing aligns with the components as articulated by McCray's (2008) MPCK framework.

Even with growing attention to early childhood mathematics education, little research is available that focuses on effective early childhood mathematics teachers and what influences their mathematics instruction at the pre-K level. By conducting a general search of early childhood teachers and empirical mathematics studies, it certainly appears there is much research available on the topic of mathematics in early childhood education, but this is not the case. The definition of early childhood is inclusive of students from birth to 8 years old (Lamb & Bornstein, 2011). Most published research in the early childhood mathematics arena focuses on teachers at the elementary level or higher, not pre-K (Aguirre, Zavala, & Katanyoutanant, 2012; Gresham, 2007; Incikabi & Kildan, 2013; Newton, Leonard, Evans, & Eastburn, 2012; Sackes, Flevares, Gonya, & Trundle, 2012; Swars et al., 2009).

Research on Teaching and Learning Pre-K Mathematics

As an increased focus continues to be placed on the mathematics proficiency of young students, attention is also being placed on the mathematics capacity of early childhood teachers. With the increased emphasis on mathematics at the pre-K level, early childhood teachers must be adequately prepared to plan and facilitate rich, meaningful mathematics lessons. According to the U.S. Department of Education (2008) and C. T. Cross et al. (2009), learning mathematics early in life predicts future mathematics achievement throughout high school and later overall academic achievement more consistently than early reading skills. Moreover, learning to think mathematically and to apply mathematical practices is necessary and often embedded in the pre-K curriculum (Clements & Sarama, 2014; Greenes et al., 2004; NAEYC & NCTM, 2010). An effective and competent teacher impacts the quality of all classroom instruction that is delivered

(Ma, 1999). However, "little improvement is possible without direct attention to the practice of teaching" (Ball, Hill, & Bass, 2005, p. 14).

For example, pre-K teachers with higher PCK frequently promote mathematics engagement through multiple modalities of teaching and playful experiences (Samuelsson & Carlsson, 2008). Pre-K teachers with high levels of MPCK understand the importance of teaching mathematics in whole and small group settings, as well as intentionally embedding mathematics exploration in centers and free play (Linder et al., 2011). Teachers with higher levels of MPCK can effectively reinforce content mastery outside of teacher-directed instruction (Ginsburg & Amit, 2008).

McCray's Mathematics Pedagogical Framework

Ball et al.'s (2008) framework is more widely used to evaluate and understand MPCK, McCray's (2008) framework is designed explicitly to addresses preschool teachers' MPCK. This is key to note as Anders and Rossbach (2015) confirm "preschool mathematics comprises different content than elementary or secondary school mathematics" (p. 308). Mathematics content knowledge, pedagogical practices, and understanding of how students learn differ significantly between preschool and elementary (McCray & Chen, 2012).

Young students do not initially grasp mathematics using formulas, procedures, or written symbols. Instead, they explore and construct mathematics knowledge through hands-on engagement with meaningful manipulatives, play, and intentional mathematics instruction. MPCK knowledge is needed for teachers to understand what constitutes mathematics for young students in order to design and provide developmentally appropriate instruction. This instruction should support building mathematics vocabulary, using manipulatives, and engagement in playful experiences that promote exploration of mathematics relationships (McCray & Chen, 2012).

The Preschool MPCK Framework (see Figure 1) outlines the intersecting parts—or domains—of knowledge through which one can see Shulman's (1987) concept: what mathematics are for preschool students, how to most effectively teach the students the what, and ways of accessing the development of students' mathematics growth specifically for pre-K teachers. This is key to note, as Anders and Rossbach (2015) confirm "preschool mathematics comprises different content than elementary or secondary school mathematics" (p. 308). Mathematics content knowledge, pedagogical practices, and understanding of how students learn vary significantly between preschool and elementary (McCray & Chen, 2012).

Mathematics knowledgeable pre-K teachers must be able to expose and engage young students to mathematics through play, conversations, and capitalizing on teachable moments (Clements & Sarama, 2014; Ginsberg et al., 2008). Thus, a vital indicator that an early childhood teacher is cognizant of providing high-quality mathematics experiences occurs when they can cultivate a learning environment that offers students opportunities to explore mathematics in their everyday, natural classroom environment (Gasteiger, 2014; van Oers, 2010).

Pre-K Teachers' Mathematics Knowledge

In order to build mathematics readiness, mathematics knowledgeable pre-K teachers must know early childhood mathematics well (Copley, 2010). Unfortunately, research studies continue to indicate that most early childhood education teachers are not properly prepared to design and deliver mathematics instruction, particularly those who work with young children (Ma, 1999; Moseley, 2005). A discussion of influences relating to MPCK and pre-K teachers follows. Mathematics content knowledge is described as "the content and discourse of mathematics, including mathematical concepts and procedures and the connections among them; multiple representations of mathematics and procedures; and ways to reason mathematically, solve problems, and communicate mathematics effectively at different levels of formality" (NCTM, 1991, p. 132). In many preparation programs, elementary and secondary mathematics teachers are required to take at least one educational mathematics methods course. Leong et al. (2015) explored the mathematics content knowledge and MPCK of 567 elementary and 389 secondary preservice teachers. Their findings suggest that the development of MPCK in preservice teachers was less than proficient. Understanding that most pre-K teachers are not required to take any mathematics methods courses sheds light on how underprepared many early childhood and elementary teachers are.

Mathematics education embraces very broad and deep concepts such as number and operations, geometry, measurement, and data analysis (NCTM, 1991, 2000). Like most adults, many pre-K teachers frequently believe mathematics for young children is rudimentary, simplistic, or just fewer complex problems. Early childhood mathematics begins with the natural development of precursor concepts that support the development of Big Ideas of Early Mathematics (Erikson Institute, 2014). Nine Big Ideas should be developed between the ages of three and six: (a) sets, (b) number sense, (c) counting, (d) operations, (e) patterns, (f) measurement, (g) data analysis, (h) spatial relations, and (i) shapes. This is key to note as Anders and Rossbach (2015) confirm "preschool mathematics comprises different content than elementary or secondary school mathematics" (p. 308). Mathematics content knowledge, pedagogical practices, and understanding of how students learn vary significantly between preschool and elementary (McCray & Chen, 2012).

Ginsburg et al. (2008) identify that mathematics concepts for early childhood mathematics education go much further than counting, recognizing numbers, and naming shapes. Their work implies that mathematics concepts for early childhood education include broad strands of big ideas of mathematics that include algebra, geometry, measurement, numbers and operation, and patterns (NAEYC & NCTM, 2010; NCTM, 2000). Each of these big ideas has several subtopics that build a deeper understanding of the broader learning goals. For example, many teachers feel that mastery of numbers and operations occurs when students can rote count, name numerals, and showcase acceptable one-to-one correspondence. However, mastery of this mathematics strand also encapsulates learning to add and subtract (Charlesworth, 2005; NCTM, 2000). It also includes the language that supports counting, reading number symbols, reading number words, set production, quantitative comparison, set matching, and set-to-set matching (Moseley, 2005).

Pre-K Teachers Know How Students Learn.

Effective pre-K teachers notice the mathematics embedded within their learning environments such that when young students notice quantities and make comparisons, the pre-K teacher can create opportunities to engage students in detailed play with intentional attention to related mathematics (Kilday et al., 2012). They not only ask a student “how many,” but they engage the students in more in-depth conversations such that they can push the students to build and use comparative language such as more, less, or fair share. This type of comparative language is used when introducing the mathematics operations of addition, subtraction, multiplication, and division (Baroody, 2000; Van de Walle, Karp, & Bay-Williams, 2012). Early mathematics language and ideas are pre-K foundational knowledge that leads to mastery of more complex mathematics understanding. The ability to comprehend and understand specific mathematics content knowledge for early childhood education, the interconnections among these concepts, and their relation to building young student's foundational mathematics knowledge are directly related to Ball et al.'s (2008) construct of specialized content knowledge. Therefore, if pre-K teachers are expected to build mathematics proficiency, teachers must have richer understandings of specialized content knowledge (Ball et al., 2008). Due to content knowledge limitations, many pre-K teachers often feel inept in their ability to provide mathematics instruction in unplanned lessons (Ginsburg et al., 2008; Moon & Lee, 2011; Stoehr, 2017). Such limited opportunities for young students to engage in mathematics talk and language development impacts mathematics learning negatively.

Understanding mathematics concepts and being an effective mathematics pre-K teacher requires teachers to understand students' underlying development of mathematical content in order to selected appropriate activities (Ginsburg et al., 1999). Based on teachers' observations and analyses of student mathematical engagement with activities, pre-K teachers should be prepared to design meaningful and explicit instruction that fosters young students' mathematics development. To provide coherent mathematics instruction by seizing teachable moments, pre-K teachers need knowledge of mathematics content and how students learn mathematics that is based on teachers' deep understanding of both subject matter in mathematics and children's informal mathematics (Ball et al., 2008; Linder, 2012; Linder et al., 2011; McCray, 2008).

However, due to limited MPCK development, many pre-K teachers struggle with identifying, incorporating, and balancing mathematics instruction throughout the day. Herron (2010) conducted a qualitative study of three pre-K teachers who worked with underserved students. As an intervention to increase mathematics instruction, she introduced a scripted curriculum package along with a series of meaningful professional development sessions

(Herron, 2010; Linder & Simpson, 2018). The combination of both interventions increased the pre-K teachers' ability to notice and recognize students' mathematics engagement outside of whole group instruction. The participants appreciated the structure, scope, and sequence found in the prepackaged curriculum. She found that the use of a scripted curriculum package improved the teachers' disposition for teaching mathematics as well as their willingness to invest more time in mathematics instructional planning.

To successfully incorporate mathematics in everyday learning activities, pre-K teachers must possess in-depth knowledge of precursor mathematics concepts or the guidance of a curriculum that presents lessons in a developmentally appropriate manner (Erikson Institute, 2014; Ginsburg & Ertle, 2008). When pre-K teachers have a deep understanding, they can provide rich, meaningful opportunities in which students can engage with mathematics in daily routines. Teachers must seize teachable moments when they present themselves (Ginsburg & Ertle, 2008; Kilday et al., 2012). Knowledgeable teachers must observe children during play carefully and unstructured learning activities to identify "spontaneously emerging situation[s] that can be exploited to promote learning" (Ginsburg et al., 2008, p. 7).

Through professional development and early childhood mathematics methods courses, pre-K teachers can learn to recognize these natural experiences (Clements & Sarama, 2014; Rudd et al., 2009). Then they can learn how to intentionally design and implement lessons that build on their students' prior knowledge. Knowledgeable pre-K teachers can then begin directly teaching specific content that bridges the embedded informal mathematics experiences with intentional mathematics instruction. To become a productive, mathematics-knowledgeable pre-K teacher requires more than an understanding of basic mathematics. Effective teachers have positive beliefs regarding the curriculum, possess enough content knowledge, understand and utilize multiple pedagogical practices, and have a sense of how students learn (McCray, 2008; Shulman, 1986). When teachers can consider and account for each of these factors of MPCK, they can plan and deliver meaningful instruction.

Teacher Beliefs

Beliefs are "the most valuable psychological construct to teacher education" (Fenstermacher, 1979, p. 174). Beliefs is a significant factor that relates to a teacher's design and implementation of teaching and learning mathematics (J. S. Lee & Ginsburg, 2007a; Pajares, 1992). All prior experiences help form a teacher's beliefs about what it means to learn and teach mathematics as all teachers have personal beliefs that affect and influence their joy for teaching a subject and their instructional behaviors and decisions (Ashton & Webb, 1986; Bandura, 1977, 1997; Clements & Sarama, 2014; Perry et al., 2007). Teachers are continually filtering new information and experiences through their fundamental belief system and pedagogical understandings that perpetuate their delivery of instruction.

Teachers trust their personal beliefs, understandings, and ideas to design and implement meaningful experiences that support their students' academic growth. General affect, beliefs, content knowledge, and instructional practices frequently evolve as teachers reflect on their practice, work in diverse settings, and interact with varying students (Joram, 2007; Zambo & Zambo, 2011). In mathematics teachers must constantly reflect on how their beliefs influence their daily instruction and are given resources that promote building their mathematics teaching efficacy.

A teacher's beliefs have the power to impact and affect their students' natural interest in learning mathematics and their achievement (Aslan, Ogul, & Tas, 2013; Şeker & Alisinanoglu, 2015; Upadyaya & Eccles, 2014). Twenty pre-K teachers were asked to complete two self-reported questionnaires. Based on the analysis of the questionnaires, Brown (2005) found pre-K teachers' mathematics teaching efficacy was higher than it was in the 1980s, and more pre-K teachers believe mathematics is essential and necessary in pre-K. Chen et al. (2014) conducted a study that produced similar findings to Brown (2005). Chen et al. (2014) collected survey data on 346 early childhood teachers. Their findings indicate that more of the surveyed early childhood teachers were developing positive beliefs and confidence in teaching mathematics. Overall, 80% of pre-K teachers in the study were confident in their ability to plan for mathematics instruction. They can also better notice mathematics throughout the learning environment and can help students build an efficacious mathematics affect. However, with this improvement in positive beliefs, the study participants were still not as confident in their ability to teach complex mathematics content. Examples of complex mathematics, aside from numeracy, include operations and algebraic thinking, number and operations in base ten, measurement and data, classification, spatial relations, geometric reasoning, patterning, and problem-solving (Harvey & Miller, 2017; Youmans et al., 2018). Although beliefs play a dominant role in the instructional planning process, teacher beliefs can be hard to capture and interpret empirically. One major factor is that research about beliefs is often reliant on self-reported data.

Summary

This section of the chapter provided an in-depth discussion of pre-K teachers' MPCK and how this knowledge relates to the mathematics instruction they often provide in early learning environments. This review was conducted by exploring pedagogical content knowledge and Mathematical Knowledge for Teaching, and then discussing mathematics knowledge necessary for pre-K teachers, how children engage with mathematics informally, and how pre-K teachers' knowledge of mathematics and students is vital in order for them to provide meaningful instruction in a typical pre-K learning environment. To be effective, pre-K teachers must have the specialized content knowledge to understand and make meaning of the content specific to early learning mathematics (Ginsburg & Ertle, 2008). Pre-K teachers must also be able to properly observe and seize teachable moments throughout the day that capitalize on mathematics concepts and build upon young students' natural mathematics thinking, as this relates to KCS. When teachers have the proper domains of mathematics knowledge and the ability to understand how young students learn, they can adequately plan and implement meaningful mathematics instruction at any point throughout the day—planned or on the spot (Ginsburg & Ertle, 2008; Ginsburg et al., 2008). When pre-K teachers have a solid understanding of early childhood big mathematics, they are more prepared to help students build an essential mathematics foundation. When early childhood education stakeholders recognize the importance of exploring what mathematics pre-K teachers know, understand, and believe, those stakeholders can gain clarity as to what influences their mathematics instruction.

Based on the literature, pre-K teachers can potentially improve their mathematics instruction through increased MPCK development. The art of developing adequate MPCK is intricate and requires continuous effort. To provide effective mathematics instruction, pre-K teachers need to have sound content and pedagogical content knowledge (Shulman, 1986). Understanding both content and pedagogy is crucial to observing and analyzing children's mathematics thinking and then being able to integrate this knowledge into practice that builds on young students' experiences, interests, and needs (Ball & Bass, 2000). Therefore, this dissertation explores pre-K teachers' mathematics knowledge by investigating their MPCK and their mathematics instruction. Additionally, throughout this chapter, research was shared that described how pre-K teachers' MPCK could relate to the quality of mathematics learning experiences they provide. The dissertation's guiding conceptual framework was explored, starting with Shulman (1986) and moving to McCray's (2008) Mathematics Pedagogical Content Knowledge Framework for preschool and pre-K teachers. In the next chapter, the methodological design for this study is presented.

CHAPTER III

METHODOLOGY

The purpose of this dissertation is to explore non-licensed prekindergarten (pre-K) teachers' mathematics pedagogical content knowledge (MPCK) and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve lower socioeconomic communities. Chapter III details the research design as it pertained to this qualitative exploratory case study and the conceptual framework used to shape the methodological design employed. In this chapter, information about the settings, participants, data collection procedures, data analysis, an introduction of the emerging themes (Miles, Huberman, & Saldana, 2014) limitations and steps to build trustworthiness are presented. The following research question guided this study:

1. What is the nature of non-licensed prekindergarten teachers' mathematics instruction when working in childcare centers that serve lower socioeconomic communities?
2. How does mathematics pedagogical content knowledge influence non-licensed prekindergarten teachers' mathematics instruction when working in lower socioeconomic communities?

Paradigm

A constructivist epistemology paradigm framed this qualitative dissertation. Constructivism supports the idea that individuals construct knowledge and gain understanding through interactions with the world around them. Such that, even when individuals experience the same event or participate in similar experiences, their viewpoints are subjective (Creswell, 2019; Crotty, 1998). Although Crotty has identified several assumptions of constructivism, three specific assumptions are central to this dissertation study: (a) people construct meaning as they engage in their environment; (b) therefore, qualitative research often includes the use of open-ended questions which allow participants to share their views and perspectives; (c) people engage within their world and construct meaning and make sense of new knowledge based on their historical and social perspectives, and (d) generation of meaning is always social and arises through interactions.

Stake (2014) defines constructivist as a belief that knowledge is made up mostly of social interpretations rather than understanding external reality. Stake (2014) acknowledges the importance of the researcher within constructivism is that of a gatherer and interpreter who nourishes "the belief that knowledge is constructed rather than discovered" (p. 99). In this dissertation, findings are based on the interpretations of non-licensed teachers who teach mathematics to students aged four to five in pre-K classrooms. Of interest is the way in which non-licensed pre-K teachers design mathematics instruction based on their MPCK. The teacher participants constructed reality based on their individual and shared experiences. How they interacted with and made decisions based on the actions and reactions of students was complex and reflected a constructivist epistemology.

In terms of analysis, the interpretive theoretical perspective provides a framework for understanding the study's findings. The interpretive tradition asserts that the researcher should begin by examining the context to be studied through actions and inquiry, as opposed to predisposed assumptions. Interpretive studies exemplify how the researcher is interested in understanding how participants make meaning of a situation or topic of interest. Such meaning is mediated through the role of the researcher as an instrument (Merriam & Grenier, 2019; Moustakas, 1994). The analysis produced a set of emerging themes that may support the development of a theme in future explanatory research (Merriam & Grenier, 2019; Merriam & Tisdell, 2016).

Constructivist researchers focus on understanding and reconstructing the meanings that individuals hold about the selected topic of interest by examining their lived experiences in-depth (Crotty, 1998; Gubrium & Holstein, 1997). For this dissertation, the constructivist paradigm was used to examine and understand non-licensed pre-K teachers' MPCK and the mathematics instruction they use to promote mathematic understanding in young students from lower socioeconomic environments. In this dissertation, I observed non-licensed pre-K teachers in their classrooms; conducted interviews; reviewed relevant, available documents; administered survey instruments; and continually analyzed these data to gain an understanding and construct meaning about each participant's MPCK and its influence on their mathematics instruction.

Research Methodology

A qualitative research design is used in this study for several reasons. Qualitative designs are useful in discovering the meaning that people give to events they experience (Denzin & Lincoln, 2013), and when the nature of the research questions require exploration (Stake, 2014). Instead of asking why questions, qualitative research questions often begin with what or *how* in order for the researcher to gain an in-depth understanding of what is occurring related to the topic of interest (Patton, 2014; Yin, 2018). Utilizing the case study design allowed the exploration to preserve a holistic and meaningful trait of real-life events (Yin, 2018). Merriam, Stake, and Yin, three prominent researchers, focus on case study designs and offer meaningful techniques that influence the design, organization of data collection, and reporting of a study's findings. The design for this dissertation relied primarily on Yin's exploratory approach.

Exploratory Studies

There is a need to know more about non-licensed pre-K teachers' MPCK and its influence on their mathematics instruction at childcare learning centers that primarily serve lower socioeconomic communities. There are limited data available that focus on the selected topic of exploration. Due to the limited data available, there are no propositions or predetermined outcomes for this study (Stebbins, 2011; Yin, 2018). Simply put, there is not enough "experience, knowledge, or information from the literature upon which to base propositions in an exploratory study relating to this phenomenon" (Baxter & Jack, 2008, p. 552). Such a qualitative design is flexible and allows the researcher to take the initial steps needed to gain an understanding of what is happening with the constructs of the phenomenon and to seek insight for more formal exploration of the selected topic of interest (Stebbins, 2011; Swedberg, 2018; Yin, 2018).

Case Study

Yin (2018) suggests that there are three steps necessary when designing a case study. First, one must choose between studying single or multiple cases. For this study, a single case design was selected. Calkins (1983) and Yin (2018) indicate that single case studies can be appropriate when the study design is exploratory. The second step in Yin's (2018) design process is to choose if the unit of study is to be holistic or an embedded case. Based on Yin's description, this study is embedded as there are two units of analysis (i.e., non-licensed pre-K teachers) situated in the same context of interest (i.e., lower socioeconomic community). This case study research best aligns with what Yin (2018) calls an embedded, single case study. The third and final phase in Yin's process of designing a case study is to determine the theory used in the cases. The theory guiding this case study is the Preschool Mathematical Pedagogical Content Knowledge framework (McCray, 2008).

A strength of the exploratory case study design is how it can rely on multiple sources of data to inform its findings (Creswell, 2019; Swedberg, 2018; Yin, 2018). For this dissertation study, data were collected from sources that included a demographic questionnaire, classroom observations, in-depth interviews, review of available lesson plans, each participant's responses on the Mathematical Development Beliefs Survey (Platas, 2008), and the collection of participant's responses to McCray's (2008) structured interview.

Sampling

A funnel-like approach was used to identify childcare learning centers to participate in this study (Merriam & Tisdell, 2016). Once permission was granted to collect data within the centers, a purposive sampling strategy was used to identify teachers within the selected centers (Ames, Glenton, & Lewin, 2019; Leedy & Ormrod, 2010; Suen, Huang, & Lee, 2014).

Childcare Learning Centers

In 2018, approximately 64.7% of children aged three to five in the United States attended a childcare learning center at least two days per week (McFarland et al., 2018). Across socioeconomic demographics, the quality of childcare learning centers servicing this age group of children varies tremendously. Glynn (2012) found that 52.7% of families with an average household income under $52,999 spend approximately 49.5% of their income on childcare, whereas families earning over $53,001 spend about 8.6% of their income on childcare (Glynn, 2012). In all demographics, the overall ability to afford and secure enrollment in a high-quality childcare center that employs certified teachers can be a challenge. Families in lower socioeconomic demographics pay more for childcare due to the increased time their children attend a center, not because of the quality of the centers they select. Many factors impact a childcare learning center's quality rating—safety measures, caregiver credentials, time spent on learning activities, and externally conducted observations of process quality.

Although the quality of a childcare learning center cannot solely impact a child's kindergarten readiness, research indicates that children from lower socioeconomic households receive instruction in lower-quality centers that employ teachers who have less formal education and earned teaching credentials (Ginsburg et al., 2008). Because the purpose of this exploratory dissertation is to explore non-licensed pre-K teachers' MPCK and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve lower socioeconomic communities, it was essential to identify and select childcare learning centers that primarily serviced families in modest and lower-earning income brackets and employed non-licensed pre-K teachers. This study was conducted in an urban city that is divided into 10 zip codes and located in the southeastern region of the United States. The city's average family income was $44,978, the median income was $42,199, and the lowest average family income was $33,841 (U.S. Census Bureau, 2010). This dissertation targeted childcare learning centers located in two zip codes—the city's lowest and modest income sectors.

The state's Division of Child Development and Early Education website was used to identify childcare learning centers in the selected two zip codes that were awarded either a Two Star Child Care License or a Three Star Child Care License. The state issues a Star Rated License based on annual evaluations that focus on program standards and staff education. At the time of this study, there were 46 childcare learning centers within the two targeted zip codes. After reviewing the Star Rated License of the 46 centers, at the time of this study, only 21 centers held either a Two Star Child Care License or a Three Star Child Care License. For this study, selected centers had to (a) employ at least one full-time, non-licensed pre-K teacher; (b) operate a full-day pre-K class; and (c) approve the researcher's requests to conduct the study. This identification process concluded with the possibility of recruiting non-licensed pre-K teachers from three childcare learning centers.

Participants

The selection process for participants in this study followed the purposive sampling technique (Ames et al., 2019; Leedy & Ormrod, 2010; Suen et al., 2014). The researcher sought to recruit four participants from the three different childcare learning facilities identified. Upon receipt of the university's Institutional Review Board (IRB) approval, the researcher contacted the three centers' owners via a phone call and a follow-up email. Two center owners approved the researcher to begin recruitment. However, the third center was no longer in operation. Between the two centers, there were three potential participants. However, soon after the initial recruitment meeting, one teacher became ineligible to continue due to staff changes within her center. The remaining two non-licensed pre-K teachers consented to participate in this case study.

The two African American non-licensed pre-K teachers held the same position in the two childcare learning centers. The teachers performed similar duties and reported directly to each center's director. Each teacher (a) was over the age of 40; (b) had at least a high school diploma; (c) had a minimum of 15 years working in an early childcare center; (d) was employed as a full-time lead pre-K teacher; and (e) had an annual household income between $21,000 and $35,000. The justification for using a small sample size is supported, as Creswell (2013) notes, "typically . . . the researcher chooses no more than four cases" (p. 63), and similar qualitative research relating to pre-K specific early childhood mathematics only studied between one and four cases (Ginsburg & Amit, 2008; J. S. Lee & Ginsburg, 2007a; J. E. Lee, 2014).

Further justification for the use of two pre-K teachers is supported by from Yin (2018), who posits that a larger number of participants does not always correlate to a better representation of the selected case. Furthermore, Yin (2018) states that embedded single study design is better than a holistic single case study as "your chances of doing a good study will be better" (p. 53) and more robust. For this study, the two embedded units were sufficient to address the research questions. They strengthened the overall findings relating to non-licensed pre-K teachers' MPCK and its influence on their mathematics instruction.

Data Collection Methods and Procedures

The concept of methods, in general, refers to the appropriate use of techniques of data collection and analysis (Prasad, 2017). Stake (2014) and Yin (2016) state that the robustness of a case study's findings resides in the careful collection of data from multiple sources of evidence such that triangulation can occur. Triangulation is a means of data corroboration and is crucial to building credibility in a case study (Flick, 2008; Leech & Onwuegbuzie, 2007; Stake, 2014; Yin, 2016). The use of data triangulation can provide the researcher with a sense of confidence in the study's findings as the results reflect the participants' understandings as accurately as possible (Bowen, 2005). Due to the scope of this dissertation study, the primary sources of data were observations, interviews, and results from the Mathematical Development Beliefs Survey (Platas, 2008).

Classroom Observations

Merriam and Tisdell (2016) identified observational data as the rawest firsthand account of available data. Ball and Bass (2000) agree that classroom observations provide incredibly detailed imagery of the case. Conducting observations provided the opportunity to verify if the participants' verbal thoughts mirrored their classroom actions (Merriam & Tisdell, 2016).

This exploratory case study included three separate classroom observations of two non-licensed pre-K teachers. The observations were spaced over 8 weeks, and each teacher was observed for 4 weeks without overlap. Each observation lasted 4-5 hours. The first and third observations occurred during the morning half of the day, and the second observation occurred during the afternoon half of the day. Classroom observations were scheduled in advance with each teacher when they agreed and consented to participate in this dissertation study. During the first interview, the researcher reviewed the consent form, discussed any questions about the study the teachers had, and provided the teacher with a copy of their signed consent form (see Appendix C). During classroom observations, the researcher was a non-participant observer (Creswell, 2013).

A researcher-developed observation form was used as a guide. The observation form was used to capture observation data by tracking the frequency with which activities occurred, descriptions of the teacher's engagement and activities during whole-group, small-group, and free play. The observation form was built on elements of Ritchie et al.'s (2010) Emerging Academics Snapshot and was designed to identify teacher interactions with mathematics. The observation form was created, as many of the early childhood education observation protocols only address overall classroom quality and are not content-specific. The observation form supported the collection of robust data necessary for capturing classroom mathematics instruction in ways that supported a thorough interrogation of the research questions. Additionally, during classroom observations, field notes were recorded on the observation form to capture instances worth noticing that fell outside the scope of the observation form, such as personal reflections and the time spent on specific interactions (see Appendix D).

Interviews

Three interviews, two semi-structured and one structured, took place with each lasting approximately 20 minutes. Interviews should be intentional and intended to gather in-depth knowledge of a participant's varied and complex experiences as they relate to the case (Seidman, 2019; Villa, 2017). In this dissertation, interviews provided vital information as the teacher participants had the opportunity to share their perceptions, or as Stake (2014) describes, their reality of mathematics instruction (see Appendix E). The process of interviewing aligned with Seidman's (2019) three-step interview format. Three interviews were deemed suitable. Interview one collected information about each participant's prior knowledge, which included details relating to their personal experience with mathematics, their mathematics beliefs, and general teaching experiences. Interview two focused on mathematics instruction and the teachers' work in pre-K classrooms. This included discussing each participant's understanding of mathematics for pre-K and their current mathematics instruction. In Seidman's (2019) design, interview three focuses on gaining insight into the participants' perceived meaning of the phenomenon; in this study, non-licensed pre-K teachers' MPCK. The administration of a structured interview, the Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008), allows the researcher to gain insight into the teachers' MPCK (see Appendix A).

Additionally, Mason (2010) acknowledges that doing what is stated in the proposal is a valid reason for conducting a specific number of interviews. In this study, three interviews were deemed appropriate by the researcher as no new information was extracted in response to the research questions. Regina's interviews were completed in approximately 17 minutes, which was less than the anticipated time. Approximately 4-5 of those minutes consisted of wait time and the use of conversation fillers such as “uhm” or “let me think for a moment.” Catie’s interviews were completed in approximately 25 minutes, which was over the anticipated interview time. A large part of Catie’s knowledge was grounded around mathematics instruction that was taught based on lessons from a curriculum guide.

The two non-licensed pre-K teachers were interviewed directly after each classroom observation. During interviews two and three, the pre-K teacher teachers were asked clarifying questions requesting elaboration on specific interactions observed during the previous observation. Interviews followed observations to avoid teacher deviations in their planned instruction in efforts to make their delivery of instruction more mathematically rich. Conducting the interviews immediately after observations worked well for both teachers. For the morning observations, interviews were conducted immediately following the observations. For the afternoon observations, the center director or an assistant was available to support dismissal and the evening snack.

All interviews were audio-recorded and transcribed by a professional transcription service. Interview transcriptions were presented to teachers at follow-up interviews as a form of member-checking (Merriam & Tisdell, 2016). The interviews proved to be vital sources of data, as they allowed the teacher participants to share their perceptions and realities of the mathematics instruction that occurred in their classroom as well as their understanding of elements of MPCK (Stake, 2014). The combination of teacher interviews following classroom observations was complementary as they provided the opportunity for the researcher to ask clarifying questions and gain an understanding of the observations that might otherwise not have been available from observation alone, and strengthened the researcher’s interpretations.

Questionnaires, Documents, and Instruments

Other data were collected to support efforts to respond to the research question. These data included a demographic questionnaire, lesson plans, and responses to two validated instruments—the Mathematical Development Beliefs Survey (Platas, 2008) and the Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008). Descriptions of these data are presented below in the order in which they were collected.

The demographic survey. A demographic questionnaire is often used in qualitative studies to gather information about study participants (Patton, 2014). The questionnaire gathered general demographic information relating to participants' age, identity, years of teaching experience, and their annual household income. The results of the questionnaire provide insight into the lives and education of each participant. Both pre-K teachers completed 10 questions during the recruitment meeting (see Appendix F).

Documents. The documents collected included teacher lesson plans and curriculum documents relating to mathematics. The available documents between the two participants were limited. During the recruitment meeting, a request was made for all participants to provide their lesson plans for the 2 months before their first observation. Additionally, weekly lesson plans during the 4-week observational period were requested. Lesson plans and additional data sources were reviewed and used to corroborate and augment the data from other sources (Yin, 2016).

Reviewing weekly lesson plans allowed the researcher to identify where differences occurred between planned activities and actual instruction. Reviewing lesson plans allowed the researcher to alter and modify follow-up interview questions and to look for specific areas of interest for future observations.

The Mathematical Development Beliefs Survey. The Mathematical Development Beliefs Survey (Platas, 2008) examines four interrelated domains, with each area containing 10 statements. A Likert scale consisting of five possible responses ranging from "*strongly agree*" to "*strongly disagree*" was requested for each statement by the respondent. Participants were given this beliefs survey at the end of the second interview and returned the completed survey during the third interview. The four domains of beliefs and a statement from each follow: (a) age-appropriateness: "Children this age aren't old enough or mature enough to understand any math concepts"; (b) locus of generation (i.e., understanding whose responsibility it is for mathematics learning): "If I don't give them a lot of math activities and help them do it correctly, they won't learn any math"; (c) purpose of preschool: "Preschool is primarily a time to play and learn how to get along"; and (d) participant's comfort with mathematics instruction: "The children love math and I love thinking up new activities that they can do" (Platas, 2008, pp. 163–165; see Appendix B).

The Preschool Mathematical Pedagogical Content Knowledge Interview. The Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008) is a standardized, quantitatively scored interview protocol (see Appendix A). However, for this study, participants' responses were also coded using a qualitative approach. As stated previously in the interview section, this instrument is a structured interview that was administered after the third observation. This instrument includes real-world situations that address many preschool mathematics and processes. Key elements include patterns, one-to-one correspondence, problem-solving, spatial sense, and sorting by attributes. Participants were asked to think about each scenario and identify and explain the aspects of mathematics they see within that situation. The collective responses from the participants within these scenarios relate to each component of McCray's (2008) MPCK framework (see framework).

Research Steps

The researcher followed a set protocol to ensure that data collection was consistent and aligned with the study's goals (see Appendix G):

1. Participants were invited to participate in the study.
2. Participants completed the demographic questionnaire.
3. Classroom observation one was conducted.
4. Semi-structured interview one was conducted (when applicable, lesson plans collected).
5. Audio recordings of interviews were reviewed and submitted for transcription.
6. Data analysis began.
7. Classroom observation two was conducted.
8. Semi-structured interview two was conducted.
9. Participants reviewed the transcript from the interview one for member-checking.
10. Participants were asked to complete the Mathematical Development Beliefs Survey (Platas, 2008).
11. Audio-recording of Interview 2 was reviewed and submitted for transcription.
12. Data analysis continued.
13. Classroom observation three was conducted.
14. Participants reviewed the transcript from interview two for member-checking.

15. Participants were administered the Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008).
16. The researcher continuously engaged in data analysis and coding of the data for emerging themes (Miles et al., 2014).
17. Transcript of the interview three was provided to the participants for review.
18. The audit trail analysis was documented to ensure verifiable research steps throughout the process.

Data Analysis

In order to ensure the management and safety of the data, all data were organized chronologically into an Excel workbook. The data analysis of this exploratory case study incorporated collecting and analyzing the data simultaneously and throughout the collection process (Creswell, 2019; Merriam & Tisdell, 2016). Data analysis began after the first day of observations and interviews. All audio recorded data were transcribed. During the initial coding cycle, all audio recorded data were coded using the key-word-in-context analysis approach (Leech & Onwuegbuzie, 2007; Ryan & Bernard, 2003). Several cycles of review occurred as the researcher replayed audio-recording and read through the transcripts. Keywords were highlighted within the transcripts. Key phrases were extracted and placed in a new tab within the Excel workbook. Keywords were defined based on the context of the words surrounding them, a suggested by Ryan and Bernard (2003). The emerging themes were sorted as phrases and were highlighted within the individual Excel tabs. Figure 4 illustrates the categorization of keywords that emerged.

Figure 4. First cycle coding categories.

In the second round of coding, the analysis method of word repetitions (Leech & Onwuegbuzie, 2007; Ryan & Bernard, 2003) was used. This analysis was based on the Excel worksheet created in the first cycle coding stage. Repeated words were extracted from observation notes, documented engagements during observations, and interview transcripts. Keywords were highlighted by participants and related to the NCTM (2006) strands, how teachers planned for mathematics instruction, and how the teachers engaged with students during mathematics instruction. The words counted as repetition included interview transcripts, utterances collected on the observation collection tool, and notes made by the researcher. The second and third rows of Figure 5 indicate the repeated words used by the teacher participants during the second round of coding. The repeated words supported the extraction of the emerging themes that are presented in Chapter IV. Repeated words and phrases were counted to support the analysis method of word count to support the use of frequency results.

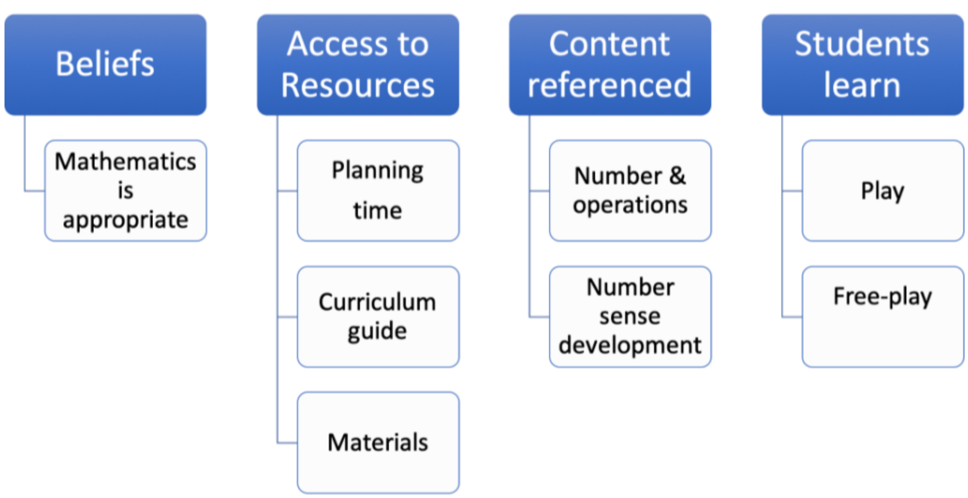


Figure 5. Second cycle coding categories and the emerging themes.

Analysis of responses for the Mathematical Development Beliefs Survey (Platas, 2008) occurred using the coding guide that was provided by its author, and the Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008) was coded using the provided coding guide by the author as well as key-words-in-context and word repetitions (Leech & Onwuegbuzie, 2007; Ryan & Bernard, 2003).

Credibility, Dependability, and Triangulation

Trustworthiness is crucial to the integrity of qualitative research. Qualitative studies require that the researcher take an active role in the collection and interpretation of data, which consists of the perceptions and experiences of others. The qualitative researcher must be rational and trustworthy. To increase the trustworthiness of this dissertation study's findings, the researcher used several strategies. To decrease threats to this dissertation's credibility, the researcher used the methodological approach of data triangulation (Lincoln & Guba, 1985; Merriam & Tisdell, 2016; Stake, 2014; Yin, 2016). Member checking was another strategy utilized in this dissertation study (Merriam & Tisdell, 2016). Additionally, the researcher provided an audit trail. The trail provided a detailed explanation of the data collection and analysis methods that were used throughout the study (Lincoln & Guba, 1985). Finally, the results of this dissertation were presented by providing meaningful emergent themes that will enable future researchers to make decisions about transferability and designs for future research (Stake, 2014).

Limitations

Both qualitative and quantitative research designs have potential limitations (Merriam & Tisdell, 2016). In the case of qualitative research, examining the limitations of the study help to clarify the contributions made by the researcher. In a case study, the subjective nature of the approach is often attributed to the role of the researcher. When using a qualitative design, the researcher is considered as a human instrument (Denzin & Lincoln, 2013). This means that the researcher primarily collects data and is responsible for analysis based on their training in observation and interviewing. In this dissertation, the researcher was cognizant of her biases and tried to preserve the credibility, consistency, and transferability of the study to minimize this limitation (Merriam & Tisdell, 2016). Although biases can never be avoided entirely, the researcher attempted to reduce them by collecting multiple sources of evidence to triangulate the data collected (Denzin & Lincoln, 2013).

Merriam and Tisdell (2016) suggest a purposive sampling strategy be put in place before data collection begins. The purposive sampling strategy can often be considered useful for novice researchers (Flick, 2008; Leech & Onwuegbuzie, 2007), but can also be a recognized limitation due to the possibility of exploring a highly homogenous set of participants (Ames et al., 2019; Edmonds & Kennedy, 2012; Suen et al., 2014). Next, teacher participants scheduled the days and times during which observations and interviews occurred. Therefore, knowing the researcher was visiting may have impacted the way each participant planned and worked within their classrooms. Thus, they may have inserted mathematics-related activities for that specific reason. Additionally, data collection occurred over 8 weeks, and observations were conducted in only two classrooms. In the future, it may be beneficial to collect data over a longer timeframe and with more teacher participants.

CHAPTER IV

RESULTS AND FINDINGS

The purpose of this study was to explore non-licensed prekindergarten (pre-K) teachers' mathematics pedagogical content knowledge (MPCK) and MPCK's influence on teachers' mathematics instruction at childcare learning centers that primarily serve lower socioeconomic communities. In this chapter, the results and findings from the study are presented in an exploratory case study, and the guiding research questions are addressed.

Chapter IV is divided into two sections. First, an introduction to each participant is presented. The second section presents the study's results and the findings that emerged from the data analysis. Four themes came out of the analyses from this study, and they were used to organize the case presentation. Mathematics instruction is related to Theme 1: teacher beliefs and Theme 2: available resources; Theme 3: pre-K mathematics is primarily number sense development, and Theme 4: mathematics instruction occurs in free-play during center time. After the results are presented, research questions are addressed.

Study Participants

Two non-licensed pre-K teachers who worked at two different childcare learning centers were identified and agreed to participate in this study. Both learning centers were located within lower socioeconomic communities. This introduction provides a foundation for understanding who the participants are and a little about their perceptions of themselves as pre-K mathematics teachers. Participant 1 is Regina at Childcare AKAdemy, and Participant 2 is Catie at the Learning and Leading Center; pseudonyms are used for participant and childcare center names.

Regina

Regina is a 48-year-old African American woman. She is a non-licensed pre-K teacher at Childcare AKAdemy and has been working in an early childhood environment for over 16 years. Her background parallels her students, as she was born, raised, and currently lives in the same zip code as the childcare learning center where she works. The childcare center is in the city's zip code with the lowest average family income of $33,841 (U.S. Census Bureau, 2010). Regina is working on completing an Associate's degree in early childhood development.

During the initial recruitment meeting, after sharing the purpose of the study, Regina immediately gave a nervous chuckle, a quick head shake, and declared, "I was not good at math when I was young, but I know numbers are important." Since Regina did not consider herself a mathematics teacher, she was slightly apprehensive and questioned if she was an appropriate person to study. As she signed the consent form, she confidently said, "I do think knowing math and numbers are important." Despite this initial declaration by Regina, her responses on the belief survey (Platas, 2008) help us to understand more about her perceptions about herself and her mathematics instructional practice. This idea about beliefs is discussed further in theme one.

Regina's classroom was compact but organized. The room was designed around three multi-use tables arranged to form a U-shape in the center of the room. Whole group instruction took place inside the area of the tables. The tables were multi-purposed to serve as center work areas and for meals. Throughout the classroom, there were specific mathematics-focused resources on shelves and in storage bins labeled to describe the contents, such as blocks, puzzles, and counting materials. These instructional materials were used during center time at the tables. There were also visible centers situated around the perimeter of the room, including domestic living, block play, a reading area, and shelves with various instructional materials. The daily classroom schedule consisted of dedicated time for snacks and meals, whole group learning, free play centers, and recess. On the walls were laminated posters that displayed numbers one through ten, colors, and shapes as well as a modestly sized (i.e., large enough for kids to see when seated) monthly calendar that supported calendar routines related to number sense development.

Catie

Catie is a 58-year-old African American non-licensed pre-K teacher at the Learning and Leading Center. She has worked as an early childhood teacher for over 25 years. Catie was born and raised in a modest-income community, very similar to the current community where she teaches. The center was located in the city's zip code with a modest median family income of $42,199 (U.S. Census Bureau, 2010). Catie has earned an Associate's degree that is not related to early childhood education or teaching. Currently, Catie is pursuing a bachelor's degree in teaching young children, birth to kindergarten.

During the initial recruitment meeting, Catie shared that mathematics was not one of her favorite subjects. As she signed her consent form, she shared, "I know I didn't learn mathematics the way it's taught now, but I'm always eager to learn more to use in my class, so please share any suggestions and feedback." She did not exhibit any concerns about becoming a participant. Before leaving the recruitment meeting, she shared, "I will never forget the meaning of *Please Excuse My Dear Aunt Sally.*" This saying is a common mnemonic device for recalling the order of operations in many U.S. mathematics classrooms. Although Catie did not see herself as a mathematics teacher, she believes that the earlier children begin learning mathematics, the stronger their understanding of foundational skills can develop, which can increase their kindergarten readiness.

Catie's classroom was large and visually separated; upon entering the classroom, one could see well-defined, segregated, and labeled spaces, including spaces for dramatic play, block building, music and movement, computer, manipulatives and games, science, and discovery, reading, and an art center with sand and water, as well as a time out area. The utilization of the spaces was very clear without explanation from Catie. There were many instructional resources within the room for Catie and the children to use. Catie posted artifacts from previous mathematics activities around the room, including charts and graphs that depicted students' favorite fruit, the number of letters in their names, and ages as well as daily attendance records. There was also a large colorful carpet positioned in the center of the classroom that was used as a multi-functional resource and contained shapes of different colors and sizes, number words, numerals, and the alphabet. The whole group carpet area was the primary location where mathematics instruction was seen during observations.

Results by Themes

The themes that influenced Regina's and Catie's mathematics instruction included:

Theme 1 – Teacher beliefs;

Theme 2 – Access to resources;

Theme 3 – Pre-K mathematics is primarily number sense development; and

Theme 4 – Mathematics instruction occurs in free play

Theme 1: Teacher Beliefs

Regina and Catie shared similar beliefs about pre-K mathematics and the content appropriate for early childhood mathematics, but they varied significantly in their design and delivery of mathematics instruction. The Mathematical Development Beliefs Survey (Platas, 2008) was used to assess the pre-K teachers' beliefs about teaching mathematics in their pre-K classroom (see Appendix B). The results from this survey combined with analyses of the teacher interviews and classroom observations supported the development of the first theme, teacher beliefs. The results of this theme support the findings associated with the research questions.

The Mathematical Development Beliefs Survey contains 40 belief statements relating to early childhood mathematics teaching and learning. Using a 6-point Likert scale that consists of responses ranging from "strongly agree" to "strongly disagree" teachers select their beliefs towards each statement. The four domains of beliefs are (a) age-appropriateness of mathematics instruction for young students, (b) who is responsible for mathematics learning within an early learning environment, (c) purpose of preschool, and (d) comfort with mathematics content and pedagogy.

Using Platas's (2008) coding guide, scores were generated that described Regina's and Catie's beliefs about pre-K mathematics teaching and learning within a childcare learning center that primarily serves lower socioeconomic communities. Some items were reverse coded, and all items associated with each subscale were added together then divided by the number of items in the scale to compute a rating for each subscale, domain. The maximum score for each domain is 50 points making the highest possible collective score 200. To discuss the results, Table 1 displays the individual subscale scores for each participant, along with the median of the two scores. The highest subscales for both pre-K teachers were domain (a) belief that preschool students are capable of learning mathematics and mathematics can be taught using age and developmentally appropriate instructional methods, and domain (d) the teachers' comfort with providing age and developmentally appropriate resources for young students to increase kindergarten mathematics readiness ($M = 49.5$).

Table 1

Means for the Beliefs Subscales Scores for Non-Licensed Pre-K Teachers

Domain	Regina's Scores	Catie's Scores	*Mean* of Scores
Domain (A): Age-Appropriateness of Math as a Preschool Subject. High Score = Math is Age Appropriate	50	49	49.5
Domain (D): Teacher Comfort with Classroom Support of Mathematical Development. High Score is Very Comfortable with Classroom Support of Mathematical Development	50	49	49.5
Domain (B): Classroom Locus of Generation of Mathematical Knowledge High Score is Teacher as the locus	45	39	42
Domain (C): Primary Classroom Goals: Social and Emotional vs. Mathematical Development High Score is Mathematical Development More Important	33	40	36.5
Total Beliefs Score	178	177	177.5

Although both pre-K teachers' total belief scores were very similar ($M = 177.5$), their scores differed most significantly about their beliefs in the purpose of pre-K, domain (c) the primary classroom goal: Social and Emotional vs. Mathematical Development. This domain summarizes the teachers' belief as it relates to the priority placed on mathematics instruction versus social and emotional development. Regina's belief that social and emotional development is more important than mathematics development is evidenced by her low sub-scale score compared to Catie's higher score, which suggests that Catie prioritizes mathematics development; other data collected for this study provide evidence that confirms this difference between these two pre-K teacher's beliefs within domain (c).

During Interview 1, Regina shared the purpose of pre-K was to "teach students the discipline they need to be successful and well-behaved when they move on to kindergarten."

This belief aligned with her score on the Mathematical Development Beliefs Survey for domain (c) of the survey. Regina's belief survey and interview responses also matched the interactions observed during classroom observations. These findings align with previous research, which posits that teachers of young students believe social skill development should take precedence over academics (Abry, Latham, Bassok, & LoCasale-Crouch, 2015). On the other hand, Catie identified the purpose of pre-K is a combination of social-emotional development and academics that change throughout the school year. Like Regina, this finding was confirmed by interview and observation data. To Catie, the purpose of pre-K varied:

> it depends on each child's needs. I strive to balance support for them evenly. However, I have to be observant and pay attention to the kids to know what they need most of at any given time. Like when student N. comes in late, I know most likely his mom didn't stay home last night and that's why his grandma brought him late. Knowing personal information about my students helps me know if they need to be pushed academically at the moment or need support with coping skills. When student N. comes in like this, he needs a hug and a bit of down time to compose himself. We've practiced this, and once he is ready, he joins the group. At that time, I expect his full attention as his emotional needs have been taken care of for the moment. This is just a simple example, as it just happened today, but I have to help balance the two [social emotional development and academic development] as they are still learning how to engage with their peers and to navigate life away from their parents. (Catie, personal communication, November 7, 2018)

Both Regina's and Catie's belief score for domain (c) was confirmed with other data collected during this study.

Regina perceived that she was capable and confident in her ability to plan and deliver meaningful, developmentally appropriate mathematics instruction. Conversely, Catie's calculated score for the same domain (b) suggests that she perceived being less confident in her ability to plan and deliver developmentally appropriate instruction (see Table 1). Let us consider Regina first. Question 14 in the beliefs survey states, "I am unsure how to support math development for young children" (Platas, 2008, p. 1). Regina strongly disagreed with that statement. Question 18 states "teachers can help preschoolers learn mathematics" (Platas, 2008, p. 1). Regina strongly agreed with this statement. These responses contributed to Regina's high score for domain (b). However, there were other data from this study that did not support her self-reported confidence to plan and deliver mathematics instruction as found by the Mathematical Development Beliefs Survey (Platas, 2008). For example, during the three observations, she never engaged in explicit mathematics instruction with children to teach specific skills or objectives. However, she did work with children to develop numbers sense through memorization. Catie's data was more consistent and did not show the same types of discrepancies as described for Regina.

Summary of Theme 1. A teacher's beliefs about mathematics relate to their ability to plan and deliver mathematics instruction. Both teachers strongly believed that young students can engage in developmentally appropriate and meaningful mathematics instruction. Per the Mathematical Development Beliefs Survey (Platas, 2008), Regina strongly believed she was capable of delivering mathematics instruction that is age-appropriate and necessary for preschool mathematics. Catie's responses to the Mathematical Development Beliefs Survey (Platas, 2008) indicated she believes mathematics instruction is age-appropriate for young children and should be taught in pre-K settings. Although Catie has access to a mathematics curriculum, and this resource influenced her design and implementation of mathematics instruction, her confidence level on the beliefs survey was lower than Regina's.

Theme 2: Access to Resources

One key difference between Regina's and Catie's mathematics instruction was the availability of curriculum to support mathematics instruction. The results for theme two emerged from dialogue during interviews, a review of the *Passports* curriculum guide (HighReach

Learning, 2007), and a review of available lesson plans. Regina and Catie were asked if they used a curriculum. Both teachers replied “no,” and shared they did not know the meaning of the word. Both teachers were informed that a curriculum or an instructional resource could be anything they used to help them know what, how, and why they teach mathematics. Regina disclosed,

> I don’t have any of that [curriculum or teaching resources], but I do think teaching math is important. Sometimes I write out a lesson plan. My director would like for me to do them weekly, but I get busy and don’t have time. Then, sometimes, I think writing them is a waste of time. I post them on the parent wall. The principles I follow to teach what I think they need is, whatever I can do with numbers. You know, blocks, little games with the dice - we roll them, and they count them. Shapes are important too, colors, reading numbers on a pretend telephone in the domestic living center, and making numbers out of playdoh. (Regina, personal communication, September 28, 2018)

This interview comment was confirmed by other responses Regina provided for the Mathematical Development Beliefs Survey (Platas, 2008). Regina did not offer detailed lesson plans for this study, but as the interview continued, she shared that on occasions, “I have a great idea and I make note of it so I remember, and post them.” Regina posted these notes and made them available for her director and parents to know what her intended learning goals were (see Appendix H). She used such notes to guide her instruction; these posted notes were her approach for lesson planning. In addition to the notes, Regina’s guidance in selecting learning objectives was based on what she felt was important. Based on observations, Regina used teacher-made resources to bring to life the ideas listed in her notes. In whole group, Regina used her handmade number and shape flashcards that were strung together with a binder ring. The use of teacher-made resources did not appear to hinder her students from participating in her lessons. The cogent points of limited resources influencing Regina’s instruction include (a) what was taught was limited to the ideas that she could conceptualize or imagine, and (b) her artistic creativity for making appropriate resources and materials for teaching mathematics about which she conceptualized and wrote notes.

During the first observation, Catie frequently referred to a document as she transitioned throughout the day. The document she referenced was her weekly lesson plan. Although Catie was not familiar with the word curriculum, she did create lesson plans. Once she shared the document, the template allowed Catie to map out her daily activities in broad terms, to identify books for story times, special activities and visitors, and the embedded focus skills for each center. In the area of whole-group activities, she included the skills and concepts that were addressed each day. The sections included the song of the day, the color of the week, the shape of the week, an alternating mathematics and science activity, and the beginning sound of the week, as well as the theme. Although the lesson plan accounted for mathematics, it did not always focus on a specific mathematics strand, such as number and operations or algebra. Catie explained how she decided what to teach, "I use this *theme* book to help me fill out my lesson plan sheet." What Catie called her *theme* book, was the *Passports curriculum guide* (HighReach Learning, 2007). Catie provided copies of her lesson plans for the two weeks before the first observation and shared the *Passport* book. During the interview, Catie confessed,

> I didn't know there was so much to teaching mathematics until I started using this guide. Having the theme book helps me add more math within my day, as a lot of what the theme book says I can do that is related to math, I would not even think about as math. It's exciting at times as my kids enjoy the activities that I would have never planned for with this guide or if I did, I would not have considered it math work. When I think about math, there are a lot of different ways to do it. When I was doing it on my own [planning for mathematics instruction], I just thought you can incorporate math when you are working with numbers, I was really afraid that I wouldn't be able to do a lesson plan. But when I got the book and really started to use it, it's pretty easy and fun. (Catie, personal communication, October 30, 2018)

With the support of the curriculum guide, Catie created and submitted weekly lesson plans throughout the data collection process. The Passports curriculum was her step-by-step guide for planning to implement developmentally appropriate mathematics instruction in sequential order. Each week, Catie selected from the pre-planned mini-lessons and center ideas that supported the multi-week themes. The lessons provided authentic learning experiences that integrated concepts across subjects.

Summary of Theme 2. A key difference between Regina's and Catie's delivery of mathematics instruction was the availability of resources. Resources are tools teachers can use to plan strategically for intentional mathematics instruction throughout the day. Access to such resources typically allows teachers to plan effective mathematics activities that help students make sense of new concepts. Children learn best when they can construct new concepts based on their prior knowledge (Copple & Bredekamp, 2009). In this study, the instructional resources available to Catie were different from Regina's. In this study, Catie's access to the *Passport* curriculum and instructional materials enabled Catie to deliver more rigorous and effective mathematics instruction compared to Regina, whose mathematics instruction was reliant on limited access to resources.

Catie had access to the *Passports* curriculum guide and many commercially produced learning resources designed for young learners. These resources guided her ability to design and implement more effective mathematics instruction, even when she did not perceive herself to be an effective mathematics teacher. Catie had time to focus on modifying lessons from the curriculum guide to differentiate instructional delivery based on student needs instead of having to create materials from scratch. While Regina had to think about what mathematics to teach, create the needed resources for teaching, and then conceptualize an approach for engaging her young learners because she did not have access to a published curriculum. Regina relied on her intuition to provide mathematics instruction based on her belief that mathematics should be taught in pre-K and her perceived knowledge on the importance of teaching about "numbers."

Regina's limited access to a published curriculum or commercially produced instructional resources posed a significant barrier for planning and delivering effective and developmentally appropriate mathematics instruction. If Catie did not have access to these types of resources, her planning and delivery of mathematics instruction would likely have been more similar to Regina's, whereas if Regina had access to similar resources as Catie, it is likely that her mathematics instruction would have been free of the previously mentioned barriers, and her perceptions about early child mathematics would likely expand beyond number sense development.

In the next theme, information relating to the mathematics concepts each teacher taught is discussed. In this section, the reader will see that the frequency with which Catie used mathematics language and utterances of mathematics throughout the observations far exceeded the frequency with which mathematics language was heard in Regina's classroom. The availability of the published curriculum may account, in part, for this difference. Catie's use of thematic teaching as designed in the *Passports* guide allowed for her to combine students' interests with intended academic goals while infusing mathematics throughout the day (Copley, 2010). This level of intentional integration was not apparent in Regina's classroom, but she had limited access to resources.

Theme 3: Pre-K Mathematics is Primarily Number Sense Development

Pre-K teachers must possess enough mathematics content knowledge to plan developmentally appropriate instruction. Current research supports that many pre-K teachers have some mathematics knowledge but lack a deep understanding of the strands (Even & Tirosh, 2002). The NCTM (2006) indicates there are five mathematics strands that build upon each other from grades pre-K to 12. The strands are number and operations; algebra; geometry; measurement; and data analysis and probability. Of the strands, number and operations is highly emphasized in early childhood mathematics (C. T. Cross et al., 2009; NAEYC, 2009; NAEYC & NCTM, 2010; NCTM, 2006; National Research Council, 2001). Both teachers provided the most instruction within the strand of number and operations.

For number and operations, there are three components within the strand, which include number, operations, and computation development (NCTM, 2006). However, Regina and Catie rarely engaged in mathematics instruction that addressed objectives associated with operations, computation, or go in-depth within number sense development. In the present study, number sense development focused on rote and rational counting to 30, one-to-one correspondence, and quantifying sets. Based on the data collected, Regina's and Catie's mathematics instruction aligned with current research which states that number sense development is vital in pre-K (Charlesworth, 2005; Ginsburg et al., 2008; Linder et al., 2011; McClure et al., 2017; Taylor-Cox, 2016). Between Regina and Catie, there were 307 uses of mathematics or utterances about mathematics made during interviews and observations. Data reveals that 71% (218) of those utterances and documented actions during observations related to the mathematics strand number and operations (see Table 2). This count did not include any student utterances.

Table 2

Frequency of References to Mathematics Content During Observations and Interviews

Summary of Findings Related to Regina's and Catie's References to Content During Instruction	*n* (%)
Number and Operations	218 (71)
Measurement	22 (7.17)
Geometry	13 (4.23)
Algebra	27 (8.79)
Data Analysis and Probability	27 (8.79)
Total	307 (100)

Regina and Catie worked heavily on number sense development during the morning whole-group learning time as it related to student daily attendance. During this instructional time, there were several instances of the students reciting memorized material such as rote counting, skip counting by 5s and 10s, and reciting the days of the week and months of the year; providing opportunities for students to engage in these forms of mathematics strongly aligned with both teachers' responses to Question 25 on the Mathematical Development Beliefs Survey (Platas, 2008). Question 25 from the beliefs survey focused on the teacher as the locus of generation of mathematical knowledge and how each teacher agreed or disagreed that they should help their students memorize number facts. Daily attendance, consisted of counting how many students were present and absent. Examples of these activities engaged the students by allowing them to use pointers to help determine how many students were present and how many were absent. Catie frequently asked more questions and prompted the students to use pictures of classmates to check their answers by making a simple "T" chart that represents present and absent students. Once the "T" chart was completed, Catie encouraged the students to use one-to-one correspondence to review their answers by having a student use the pointer to carefully touch and count the pictures of the students on the left side of the board. Catie would remind the students “you only move to the next number once you touch the picture with the pointer and you should not say another number until you touch the next picture” (Catie, personal communication, October 30, 2018). In addition to extending the activities, Catie consistently gave feedback and provided guidance when students struggled in these number sense development activities. Catie often went to the board to reiterate the work that was completed by a student to double-check and make sure the students’ work was accurate. Catie’s use of the curriculum guide assisted in her planning and implementation of mathematics activities such as these.

Responses given during the Preschool Mathematics Pedagogical Content Knowledge Interview (McCray, 2008) also supported how Catie could showcase her understanding of number sense, which appeared to be more in-depth when compared to Regina. Regina was more confident in her abilities compared to Catie. However, Catie earned more points throughout the Preschool Mathematics Pedagogical Content Knowledge Interview (McCray, 2008). Using McCray’s scoring guide, for Scenario 1, Regina’s collective level of MPCK was 26 points out of 63 (41.3%), while Catie’s was 46 points out of 63 (73%). Teachers were asked, “Where do you see any math in this play?” (McCray, 2008, p. 3). Catie’s initial response and elaborations were specific and focused on number sense:

> The students needed to use the shoeboxes as cribs, but only had enough shoeboxes for some of the babies. The students did use the shoeboxes, but still needed more cribs. Therefore, the children picked up the two babies with hair and said that those babies didn't need to nap because they were the oldest babies. They believed the little babies (the ones with no hair) needed to nap in the cribs. So they had enough cribs to settle the “babies” down for naptime. As they prepared to settle the babies, they noticed the size of the babies and the shoe boxes differed. Therefore, they realized the biggest baby should nap in the largest shoebox.

> This was like a “take-away” problem, you had three babies and took away two away. To extend number sense practice, I could remind them that they had three babies, and they put two of them aside, so my question to my students would be, “how many babies are left? or Look at the babies, how many babies have a lot of hair? How many babies do you have that have no hair? (Catie, personal communication, November 14, 2018)

This response was given without any prompting. Where Regina’s first response when asked the same question was,

> This is a funny scenario to think about. When I look at them [the students in the scenario] playing, naturally, I don't see any math. But since you are asking about math in this story, and your study is on math, I know there is some math in the situation. So, in general, if you're not focused, like me, you wouldn’t see anything except for kids playing. Let’s see, there are babies. Knowing how many babies are there is an example of counting. (Regina, personal communication, October 18, 2018)

Throughout this dissertation study, Catie consistently gave more specific responses, while Regina needed more prompting to the same questions.

Summary of Theme 3. Within the strands, pre-K teachers possess the most perceived knowledge and confidence in teaching about number sense development (Hachey, 2013; J. Lee, 2010). Even though pre-K teachers are most familiar with the number and operations strand, they still need more in-depth awareness of what the complete strand entails. Catie randomly worked with numbers during recess by engaging students in the outside sand center. Although they engaged with mathematics frequently, it was primarily related to consistently developing an awareness of numbers.

Theme 4: Mathematics Instruction Occurs in Free-Play

The teachers in this study used various methods to teach mathematics to promote learning. However, in Regina’s beliefs survey (Platas, 2008), she states, “in preschool, children construct their mathematical knowledge without the help of a teacher,” which is considered a form of free play. Free play, in this study, is student-initiated, flexible, and typically occurs during center and recess times. Although both teachers believed in the benefit of free play, free play academic time looked different from class to class.

During an interview, Regina shared, “students play to learn.” During observations, Regina’s classroom mathematics instruction occurred based on student-initiated encounters. Regina was seen walking around the room monitoring behavior but did not interact with the students unless the students invited her. There were two mathematics engaging activities observed during free play that incorporated mathematics, which arose from teachable moments. As Regina walked the classroom to monitor behavior, she stopped to engage with a group of three students in the Play-doh center. During this stop, there was a conversation about the shapes being stamped out. Regina asked the students to tell her the name of the shapes. Each time, the students pointed and said the correct name of the shape. In another Play-doh instance, Regina engaged with the student by sitting next to him and dialogued with him as he rolled imaginary worms. Again, the student invited Regina to see how he could roll his dough into big and small worms and wiggled them at her as if they were coming after her. However, Regina did not extend the student’s mathematics knowledge in that potential teachable moment.

As an example of free play, a second teachable moment occurred when a student approached Regina to show he could count. The student brought over various instructional resources that were stacked to form towers. He showed Regina that he could take the building apart and share how many pieces he used to make each tower. During each of these moments, Regina followed up by asking the student to tell her which tower was the tallest or shortest. Then she asked if he could look and tell her how many of the connecting blocks were blue, yellow, green, and red. During an informal conversation, Regina expressed to the researcher that was the first time she thought to use such a student-initiated moment to extend mathematics focused engagement. Following that engagement, the student was instructed to return to his selected center. These instances represented mathematics teaching during play and depicted teacher engagement as well as Regina's growth in her practice during center play.

A different example of free play was practiced by Catie, who disagreed with statement 23 from the Mathematical Development Beliefs Survey (Platas, 2008) concerning young students' engagement in free play without their teacher. Through observations, Catie was observed using a combination method of engaging with students during free play time, providing small group instruction, and floating around to visit students in centers as they engaged in free play. Catie believed,

> Children learn through play when they are playing and putting patterns together, stacking stuff with a purpose and counting. Some kids enjoy playing more and can learn that way and some kids just enjoy reading books instead of typical play, but she is learning the way she likes. In the domestic living station, kids start playing with the money. I go over there and play with them sometimes. And I said let's build a house, so we got the bricks, built the house, then one student has to pay to live in the houses. Sometimes we talk about the patterns made with the bricks. Since the houses are important to them and they feel proud of their work, I let them keep the houses up for a little while. (Catie, personal communication, November 7, 2018)

Just as Catie provided detailed responses to questions during the Preschool Mathematics Pedagogical Content Knowledge Interview (McCray, 2008), she elaborated in detail about free play as mathematics instruction. In addition to the examples Catie shared during the interview, there were documented instances of teaching through free play throughout Catie's day. Teachable moments occurred randomly throughout the day, from arrival to the end of the day.

Summary of Theme 4. Free play is a vital aspect of early childhood learning, as play allows young students to use naturally occurring experiences to develop mathematics concepts and skills (Clements & Sarama, 2005). Both teachers acknowledged the value and necessity of free play as a way in which students learn best while exploring. Each teacher permitted their students to move around independently while selecting their activities and materials to work. It was during the spontaneous teachable moments that each teacher conversed with students about mathematics topics that the students presented to them.

Engagement with students occurred more frequently in Catie's classroom, which may have been based on the support Catie had in the form of the curriculum guide. Unfortunately, Regina was like many teachers who work with students from lower socioeconomic backgrounds and did not know when and how to interact with her students during free play to capitalize on the teachable moments and support mathematics more intentionally (Perry & Dockett, 2002; Perry et al., 2007).

Summary of Results

Four themes evolved from this study. Regina and Catie believe that mathematics is an appropriate academic subject in pre-K and can be taught using developmentally appropriate instructional strategies. Nevertheless, each teachers' mathematics instruction varied based on three factors: access to resources, opportunities to leverage teachable moments, and use of play as a method of providing mathematics instruction. Upon exploring access to resources, it was discovered that the availability of a prescribed curriculum, commercial and teacher-made instructional materials, and the allocation of dedicated time for planning impacted the delivery of mathematics instruction greatly. Both teachers new about mathematics, but were most frequently observed and shared insight on their perceived knowledge and confidence in providing mathematics instruction related to the number sense development component of the number and operations NCTM's (2006) strand. Even with a knowledge of number sense development, there was a misalignment between how the teachers taught mathematics. During observations, Regina and Catie used teacher-directed instruction during whole group learning time. However, the only mathematics instructional methods that were discussed during the interviews and observed during the observations were student-initiated teachable moments that arose during free play activity times.

Findings: Research Question 1 Response

What is the nature of non-licensed prekindergarten teachers' mathematics instruction when working in childcare centers that serve lower socioeconomic communities?

Regina and Catie are non-licensed pre-K teachers who work in lower socioeconomic environments. When looking at the nature of pre-K mathematics instruction from their perceived perspectives, theme one implies the teachers strongly believe teaching mathematics is appropriate and should be taught to young students during their pre-K education. Access to curricular resources impacts the effectiveness of the mathematics instruction that teachers provide. Based on all data collected in this study, teachers are confident in their ability to teach about number sense development, and this strand of mathematics is most important for pre-K students to learn. Overall, young students learn mathematics through free play instructional opportunities.

Pre-K students should learn mathematics with the support of their teachers. These non-licensed pre-K teachers are confident about teaching mathematics relating to number sense development and that students can learn about mathematics through play. When resources are available, teachers are exposed to more opportunities for including mathematics strands beyond number with more frequency for instruction, which has potential for providing students with a larger foundation upon which to build mathematical understanding in the future (NCTM, 2000).

Findings: Research Question 2 Response

How does mathematics pedagogical content knowledge influence non-licensed prekindergarten teachers' mathematics instruction when working in lower socioeconomic communities?

Synthesizing both participants' data, it is clear how these non-licensed teachers' personal beliefs about mathematics in pre-K related to their mathematics instruction. Both teachers strongly agreed that mathematics is an appropriate and needed academic focus for young students. During each observation and every interview, the teachers provided evidence to support the development of this theme. Revisiting the Preschool MPCK framework (McCray, 2008), MPCK is at the intersection of teacher's mathematics content knowledge, their teaching techniques, and their beliefs about how children learn (see Figure 1). For the non-licensed pre-K teachers of this study, using the lens of MPCK, one must conclude that their mathematics instruction was primarily about number sense development; using the teaching technique of independent student choice centers, the teachers believe that young students learn through play. The main influencers for each teacher's practice were the teacher's beliefs and her access to curricular resources, which manifested in very different ways of delivering mathematics instruction. Without mathematics curricular resources, non-licensed pre-K teachers' access to mathematics content and pedagogical approaches are very different, as was illuminated within this exploratory case study.

Summary

The results were shared using the themes that emerged from the analyses, and included four themes:

Theme 1 – Teacher beliefs;

Theme 2 – Access to resources;

Theme 3 – Pre-K mathematics is primarily number sense development; and

Theme 4 – Mathematics instruction occurs in free play

The findings for these two non-licensed Pre-K teachers, Regina and Catie, showcase how mathematics instruction was very different. Two key influencers accounted for much of the variance between the two teachers' instructional practices: (a) their beliefs about mathematics in pre-K and (b) their access to instructional resources. Both teachers agreed that mathematics instruction is appropriate, needed, and should be taught using developmentally appropriate methods. However, Regina more strongly believed socioemotional development in the area of discipline was more important than teaching mathematics, while Catie believed socioemotional support and mathematics instruction should be taught together and at times one may require more focus than the other. In the area of resources, each teacher had access to different instructional materials. Catie worked in a pre-K center that provided her with a layer of academic support in the *Passports c*urriculum guide that was not afforded to Regina. Catie's understanding and usage of the curriculum guide augmented her selection of delivery of mathematics instruction. In Chapter V, a discussion is presented that relates to the implications based on the findings in Chapter IV.

CHAPTER V

DISCUSSION

This study is a response to implications for research from the National Association for the Education of Young Children and the National Council of Teachers of Mathematics (2010) and the National Mathematics Advisory Panel (U.S. Department of Education, 2008) as it relates to non-licensed prekindergarten (pre-K) teachers' mathematics pedagogical content knowledge (MPCK) and MPCK's influence on teachers' instruction. Using the lens of McCray's mathematics pedagogical content knowledge framework, this study examined two non-licensed pre-K teachers' MPCK and MPCK's influence on the teachers' mathematics instruction at childcare learning centers that primarily serve low-socioeconomic status (low-SES) communities. Chapter V begins with a discussion about the nature of Regina's and Catie's mathematics instruction. The following section provides a discussion on how components of MPCK influence their mathematics instruction. The third section provides limitations, implications, and recommendations for future research that presented in response to the following research questions:

1. What is the nature of non-licensed prekindergarten teachers' mathematics instruction when working in childcare centers that serve lower socioeconomic communities?
2. How does mathematics pedagogical content knowledge influence non-licensed prekindergarten teachers' mathematics instruction when working in low-socioeconomic communities?

Teachers' prior experiences shape their beliefs. Beliefs influence the way teachers design and deliver mathematics instruction (Grossman, Schoenfeld, & Lee, 2005). Regina and Catie share a confidence in their ability to teach mathematics. They also share beliefs that young students are capable of learning mathematics, that young students should learn mathematics in pre-K, and that they as pre-K teachers are equipped and willing to teach mathematics. Regina and Catie had not received any formal teacher preparation, but their prior experiences helped to shape their beliefs, which influenced them to include mathematics instruction in their academic schedule. Additional to beliefs, access to resources, awareness of mathematic concepts, and mathematics instructional models influenced each teacher's mathematics instruction. A discussion of these themes is presented next.

Access

Having access to instructional resources, especially a curriculum, influences the nature of non-licensed pre-K teachers' mathematics instruction. With access to a curriculum guide, Catie strategically embedded mathematics throughout the day and within free-play learning opportunities. Access to instructional resources can ultimately impact the frequency and depth of the mathematics instruction a teacher can provide (Björklund & Alkhede, 2017; Brown, 2005). The *Passports* curriculum (HighReach Learning, 2007) allowed Catie to present mathematics instruction that combined explicit math concepts throughout other classroom activities and learning. The curriculum guide provided Catie with structure in designing and delivering her mathematics instruction (Baroody, Clements, & Sarama, 2019; Clements & Sarama, 2014; Moseley, 2005). Although instructional materials make a difference in each teacher's delivery of instruction, not all teachers are afforded a copious supply of materials.

Without many mathematics instructional resources, Regina's beliefs on the importance of mathematics shaped her desire to teach the subject. Regina, like many pre-K teachers, made do with the resources she was afforded. Brown (2005) found that when teachers are given instructional resources, professional development, and ongoing coaching support, they will utilize mathematics resources more frequently. This combination of added access to resources and support systems can boost a teacher's confidence in teaching mathematics and increase his or her mathematics affect. Having access and understanding of a curriculum was a key influencer for how Catie planned and delivered mathematics instruction. However, not having a curriculum did not cause Regina to avoid teaching mathematics. Although both teachers taught mathematics, it was evident that the number of varying resources enabled Catie to provide more frequent mathematics engagements.

Number Sense

The nature of non-licensed pre-K teachers' mathematics instruction is also influenced by a teacher's familiarity with the foundational mathematics concept of number sense. All pre-K teachers should possess a deep understanding of mathematics. The findings of a few studies indicate that there are no positive correlations between teachers' content knowledge and mathematics instruction (Claessens & Garrett, 2014; Schwartz & Riedesel, 1994; Wilkins, 2008), while there are many more studies that suggest how teachers' content knowledge frequently influence their selection of what content they teach and how that content is taught (Ginsburg et al., 2008; Grossman et al., 2005; Hachey, 2013; Hill et al., 2005; J. Lee, 2005, 2010; Ma, 1999; U.S. Department of Education, 2008; Youmans et al., 2018). Teachers with a "profound understanding of fundamental mathematics . . . do not invent connections between and among mathematics but reveal and present them in terms of mathematics teaching and learning" (Ma, 1999, pp. 120, 122).

This study did not aim to explore or collect any data that could document an actual teacher's mathematics content knowledge level. However, this study did explore the frequency with which Regina and Catie spoke words and were observed engaging in activities related to the foundational mathematics concept of number sense. Based on the frequency of word and action patterns, it was found that Regina and Catie addressed elements of number sense most frequently. Regina and Catie had an awareness of many pre-K mathematics topics. However, like most pre-K teachers, they were both familiar with the mathematics strand of numbers and operation. They both agreed that number sense is the most valuable component of the number and operations strand young students should master during pre-K; this belief is consistent across many pre-K teachers (Charlesworth, 2005; Ginsburg et al., 2008; Linder et al., 2011; McClure et al., 2017; Taylor-Cox, 2016). This finding indicates that the more in-depth knowledge a teacher has for a content area, the more confident they may be in delivering instruction, the more positive affect they may have toward the subject, and the more achievement gains can typically be confirmed.

Free Play

The nature of mathematics instruction is also influenced by a teacher's pedagogical knowledge. Both teachers used the instructional method of free play. Free play is a vital aspect of early childhood learning, as play allows young students to use naturally occurring experiences to develop mathematics knowledge (Clements & Sarama, 2005; Clements et al., 2004; Ginsburg et al., 2008; Kontos, 1999; Linder et al., 2011; Samuelsson & Carlsson, 2008; van Oers, 2010). When provided with adequate scaffolds, learning through play is a powerful strategy that promotes the development of higher-level thinking skills (de Haan et al., 2014; Ginsburg et al., 2008; Samuelsson & Carlsson, 2008). There are many opportunities during free-play for young students across low-SES communities to acquire and experiment with mathematics (Charlesworth, 2005; NAEYC & NCTM, 2010). Regina and Catie noted that students learn best through play and exploration. Each teacher permitted her students to move around independently while selecting their own activities and materials with which to work. Learning throughout free-play centers was a common instructional practice for Catie with the support of her curriculum guide. Unfortunately, Regina, like many teachers who work with students from low-SES backgrounds, did not know when and how to interact with her students during free play to teach and support mathematics learning (Perry & Dockett, 2002; Perry et al., 2007). Although there was a difference between the actions during center time between Regina and Catie, they both acknowledged the value and necessity of free play.

There is a mathematics achievement gap (Chatterji, 2015) upon entering kindergarten between young students from low-SES communities and their peers of higher SES. Therefore, mathematics must be taught within pre-K. Beliefs is the overarching influencer that guided Regina and Catie to plan and deliver mathematics instruction. The teachers' instruction was based on their belief that number sense was the primary mathematics topic to be taught in pre-K. The teachers' beliefs also supported their use of teaching number sense through the instructional method of free play. These findings support that being a non-licensed pre-K teacher does not mean a teacher delivers less meaningful mathematics instruction.

Influence of Mathematical Pedagogical Content Knowledge

This dissertation's guiding research questions were developed to explore the nature of non-licensed pre-K's MPCK and if MPCK influences the teachers' mathematics instruction. The findings from this research indicate that the participants' beliefs and access to resources had more influence on their mathematics instruction that they delivered compared to their MPCK as a collective concept, which was gauged based on the results of the Preschool Mathematical Pedagogical Content Knowledge Interview (McCray, 2008). However, there are elements of the Preschool MPCK Framework (McCray, 2008) that could be seen as an influence on each teacher's mathematics instruction. The what and how components of the Preschool MPCK Framework (McCray, 2008) showcased how number sense was the most frequently taught through unintentional free play. This dissertation's findings suggest that for the two pre-K teachers in this exploratory case study, their mathematics beliefs influenced how they planned and delivered mathematics instruction more than MPCK.

Implications, Limitations, and Recommendations

This dissertation introduces a new understanding of non-licensed pre-K teachers working in low-SES communities, which is not well documented in the current literature. These findings show that while MPCK had a limited influence on these pre-K teachers' mathematics instruction, their beliefs were also influential to their practices. Based on understandings gained from this exploratory case study of Regina and Catie, additional exploration is needed that focuses on non-licensed pre-K teachers working in low-SES communities, a greater depth of understanding of the mathematics they teach, their access to materials, and what pedagogies they employ for teaching mathematics in early learning environments. The following limitations, implications, and recommendations are presented as they may enhance the understandings about the nature of mathematics instruction that non-licensed pre-K teachers design and deliver when working in low-SES communities.

Limitations

Researcher bias is when an individual's feelings, opinions, or preferences impact the study's results (Creswell, 2019; Roulston & Shelton, 2015). As an early childhood educator for many years, the researcher's opinions had a large impact on how she interrupted the data. The researcher's desire to add her own perspective to the voices of the participants was problematic. To combat researcher bias, the researcher constantly engaged in bracketing (Moustakas, 1994).

The act of bracketing was used throughout the data analysis phase in recognizing, documenting, and acknowledging personal bias.

The exploratory nature of the study is also a limitation. Exploratory research focuses on examining a topic that has not previously been studied in-depth. Due to the limited nature of prior research, there was no true structure for how to design or conduct this dissertation. Exploratory research is a very flexible and fluid qualitative methodology (Stevens, Loudon, Wrenn, & Cole, 2012). Additionally, the use of purposive sampling deepened the limitation of the design by limiting the possible number of participants. Due to attrition, the total number of teachers was reduced to two. The few number of participants limited the ability to generalize the findings across public pre-K centers that employed non-licensed pre-K teachers. The small number of participants also limited the surplus of data used to develop the themes. Although the researcher is confident in the results and findings within this dissertation, having more participants would have increased the credibility of this dissertation's results and findings.

The final limitation is that of observer bias. Observer bias occurs when the researcher's biased perspectives influence observations within a setting (Roulston & Shelton, 2015). Throughout the observations, the researcher often found herself trying to justify and provide explanations as to why the participants engaged in specific actions. To combat observer bias, the researcher also engaged in bracketing.

Implications

This dissertation only studied two non-licensed pre-K teachers, but the study's findings lend themselves to suggest actions for researchers, policy reformers, and center administrators. As non-licensed pre-K teachers, Regina and Catie are responsible for providing quality, developmentally appropriate mathematics instruction to the students they serve in low-SES communities. Despite the low SES level of the community, all students are held to the same kindergarten readiness standards. This study is important to the field of early childhood education as it showcases that non-licensed pre-K teachers do provide mathematics instruction. With the appropriate instructional supports, resources, and training, non-licensed pre-K teachers have the power and ability to deliver effective mathematics instruction to learners from lower socioeconomic communities. Additionally, this study is important as it allows the voices of non-licensed pre-K teachers to tell their stories related to the mathematics instruction delivered within their classrooms.

Recommendations for Further Research and Practice

The first recommendation relates to extending the exploratory study by recruiting non-licensed pre-K teachers across the nation to participate in a quantitative study that will evaluate the teachers' MPCK for preschool mathematics. Based on the results, a random sample of participants should participate in an additional phase that seeks to measure the teachers' MPCK from a qualitative perspective. Within the qualitative phase, teachers should be asked to complete tasks such as designing a pre-K mathematics lesson, executing the lesson, and debriefing the lesson with an instructional coach. Building on the first recommendation, researchers should recruit a large sample of non-licensed pre-K teachers who utilize a research-based curriculum and another sample of non-licensed pre-K teachers who do not have access to a curriculum. Then, researchers should conduct a cross-comparative study that looks within and across the cases to explore the differences in mathematics instruction provided by each group of teachers and if the curriculum makes a difference in the quality of their mathematics instruction. This study could then later be extended, looking at the mathematics achievement of students. The last recommendation for researchers is to repeat the study above using only licensed pre-K teachers who utilize a research-based curriculum and another sample of licensed pre-K teachers who do not have access to a curriculum.

Next is the recommendations for policymakers, community college coordinators, and childcare center owners and administrators. First, policymakers, along with state agencies, should invest funding that is specifically designated to provide mathematics professional development support to public pre-K programs that currently employ non-licensed pre-K teachers. In order to support pre-service pre-K teachers, early childhood education associate degree programs should develop preschool-specific mathematics methods courses that include a practicum experience. Students within the early childhood program would be required to complete the methods course and practicum before graduating. The final set of recommendations is specifically targeted at supporting current in-service, non-licensed pre-K teachers.

To help the current population of in-service non-licensed pre-K teachers, childcare learning center owners and directors should begin seeking support from local and national agencies. There are many agencies, such as Child Care and Development Block Grants, Smart Start, and the U.S. Department of Health and Human Services, that provide center-wide support. These opportunities may spark the non-licensed teacher's desire to earn a teaching certification or mathematics education endorsement. Owners and directors should also seek in-service mathematics professional development and on-site coaching as an immediate strategy to support their teachers' current delivery of developmentally appropriate and research-based mathematics instruction. By providing opportunities for growth, non-licensed pre-K teachers have the opportunity to enhance their mathematics instructional practices.

Conclusion

Recent research indicates that young students who develop strong number sense often perform academically better in both literacy and mathematics (Clements & Sarama, 2014; C. T. Cross et al., 2009; Ginsburg et al., 2008). A strong mathematics foundation can develop in pre-K when students have multiple, meaningful opportunities to engage with skills aside from rote memorization (Ball & Bass, 2008; U.S. Department of Education, 2008). Although young students encounter mathematics routinely within their play, they must also encounter intentional instruction and guidance from knowledgeable teachers (Frye et al., 2013; Ginsburg et al., 2008; Leong, 2013), as knowledgeable teachers "are the key ingredient necessary to provide meaningful early childhood mathematics instruction" (Herron, 2010, p. 361). Pre-K teachers provide mathematics instruction that is essential to developing mathematics readiness in young students (Clements & Sarama, 2011; Ginsburg et al.; Youmans et al., 2018). Therefore, the researcher designed this study to explore non-licensed pre-K teachers' mathematics MPCK and MPCK's influence on the teachers' mathematics instruction at childcare learning centers that primarily serve low-SES communities.

Based on the findings of this study, non-licensed pre-K teachers do provide mathematics instruction. Throughout this dissertation, two non-licensed pre-K teachers provided insight into their day-to-day lives as they delivered mathematics instruction in low-SES communities. The participants provided mathematics instruction primarily based on influences unrelated to MPCK. These influencers included their personal beliefs about pre-K mathematics, their access to instructional resources, and administrative support. In relationship to MPCK, the teachers' design and delivery of mathematics instruction stemmed from the women's awareness of the mathematics topic of number sense that was delivered through the instructional method of student free play.

The conclusions gained from the findings demonstrate the importance of providing support for non-licensed pre-K teachers to enhance the instruction they are currently providing in their classrooms. This study did not evaluate the quality or developmental appropriateness of the instruction delivered. Therefore, the researcher hopes that this dissertation will contribute to the body of research that impacts the development of more non-licensed pre-K teachers who can intentionally provide mathematics instruction. Providing more strategic mathematics instruction may help reduce the developing mathematics readiness gap in current public education that plagues students from low-SES communities. Based on this dissertation's findings, (a) policymakers should invest funding to support the professional development of non-licensed pre-K teachers working in low-SES communities; (b) educational coordinators for early childhood teacher preparation programs should require that a preschool mathematics method course be added to their curriculum; and (c) center owners and directors should seek opportunities for professional development and mentoring opportunities that may be beneficial to improving the mathematics instruction provided by non-licensed pre-K teachers.

REFERENCES

Abry, T., Latham, S., Bassok, D., & LoCasale-Crouch, J. (2015). Preschool and kindergarten teachers' beliefs about early school competencies: Misalignment matters for kindergarten adjustment. *Early Childhood Research Quarterly, 31,* 78–88. doi:10.1016/j.ecresq.2015.01.001

Adler, P. A., & Adler, P. (2003). The reluctant respondent. In J. A. Holstein & J. F. Gubriu (Eds.), *Inside interviewing: New lenses, new concerns* (pp. 153–173). Thousand Oaks, CA: Sage.

Aguirre, J. M., Zavala, M. R., & Katanyoutanant, T. (2012). Developing robust forms of pre-service teachers' pedagogical content knowledge through culturally responsive mathematics teaching analysis. *Mathematics Teacher Education and Development, 14*(2), 113–136. Retrieved from https://files.eric.ed.gov/fulltext/EJ1018658.pdf

Ames, H., Glenton, C., & Lewin, S. (2019). Purposive sampling in a qualitative evidence synthesis: A worked example from a synthesis on parental perceptions of vaccination communication. *BMC Med Research Methodology, 19,* Article 26. doi:10.1186/s12874-019-0665-4

Anders, Y., & Rossbach, H. G. (2015). Preschool teachers' sensitivity to mathematics in children's play: The influence of math-related school experiences, emotional attitudes, and pedagogical beliefs. *Journal of Research in Childhood Education, 29*(3), 305–322. doi:10.1080/02568543.2015.1040564

Arnold, D., Fisher, P., Doctroff, G., & Dobbs, J. (2002). Accelerating math development in head start classrooms. *Journal of Educational Psychology, 94*(4), 762–770. doi:10.1037/0022-0663.94.4.762

Ashton, P. T., & Webb R. B. (Eds.). (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York, NY: Longman.

Aslan, D., Oğul, I. G., & Tas, I. (2013). The impacts of preschool teachers' mathematics anxiety and beliefs on children's mathematics achievement. *International Journal of Humanities and Social Science Invention, 2*(7), 45–49. Retrieved from http://www.ijhssi.org/papers/v2(7)/Version-2/I0272045049.pdf

Baader, M. S. (2004). Fröebel and the rise of educational theory in the United States. *Studies in Philosophy & Education, 23*(6), 427–444. doi:10.1007/s11217-004-4453-0

Bailey, L. B. (2010). The impact of sustained, standards-based professional learning on second and third grade teachers' content and pedagogical knowledge in integrated mathematics. *Early Childhood Education Journal, 38*(2), 123–132. doi:10.1007/s10643-010-0389-x

Ball, D. L. (1988). *Knowledge and reasoning in mathematical pedagogy: Examining what prospective teachers bring to teacher education* (Doctoral dissertation, Michigan State University). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.739.3592&rep=rep1&type=pdf

Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *Elementary School Journal, 90*(4), 449–466. Retrieved from https://www.jstor.org/stable/1001941

Ball, D. L. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education, 51*(3), 241–247. doi:10.1177/0022487100051003013

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 83–104). Westport, CT: Ablex.

Ball, D. L., & Bass, H. (2008). Measuring teacher quality in practice. In D. H. Gitomer (Ed.), *Measurement issues and assessment for teacher quality* (pp. 80–98). Thousand Oaks, CA: Sage Publications.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how do we decide? *American Educator, 29*(1), 14–17, 20–22, 43–46. Retrieved from https://deepblue.lib.umich.edu/handle/2027.42/65072

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389–407. doi:10.1177/0022487108324554

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: Freeman.

Barnett, W. S. (2003). Better teachers, better preschools: Student achievement linked with teacher qualifications. *Preschool Policy Matters, 2.* New Brunswick, NJ: National Institute for Early Education Research.

Barnett, W. S., Jung, K., Youn, M., & Frede, E. C. (2013). *Abbott Preschool Program longitudinal effects study: Fifth grade follow-up*. New Brunswick: National Institute for Early Education Research, Rutgers-The State University of New Jersey.

Bates, A., Latham, N., & Kim, J. (2011). Linking preservice teachers' mathematics self-efficacy and mathematics teaching efficacy to their mathematical performance. *School Science and Mathematics, 111*(7), 325–333. doi:10.1111/j.1949-8594.2011.00095

Baroody, A. J. (2000). Does mathematics for three- and four-year-old children really make sense? *Young Children, 55*(4), 61–67.

Baroody, A. J., Clements, D. H., & Sarama, J. (2019). *Teaching learning ECE programs Baroody Clements Sarama Wiley handbook.*

Baroody, A. J., Eiland, M., & Thompson, B. (2009). Fostering at-risk preschoolers' number sense. *Early Education & Development, 20*(1), 80–128. doi:10.1080/10409280802206619

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544–559. Retrieved from https://nsuworks.nova.edu/tqr/vol13/iss4/2

Björklund, C., & Alkhede, M. (2017). Sharpening the focus on numbers and counting: preschool educators differentiating aspects of mathematical knowledge for teaching. *Mathematics Teacher Education and Development, 19*(3), 117–134. Retrieved from https://files.eric.ed.gov/fulltext/EJ1163822.pdf

Bowen, G. (2005). Preparing a qualitative research-based dissertation: Lessons learned. *The Qualitative Report, 10*(2), 208–222. Retrieved from https://nsuworks.nova.edu/tqr/vol10/iss2/2

Brown, E. (2005). The influence of teachers; Efficacy and beliefs regarding mathematics instruction in the early childhood classroom. *Journal of Early Childhood Teacher Education, 26*(3), 239–257. doi:10.1080/10901020500369811

Bukova-Güzel, E., Cantürk-Günhan, B., Kula, S., Özgür, Z., & Elçí, A. (2013). Scale development for pre-service mathematics teachers' perceptions related to their pedagogical content knowledge. *South African Journal of Education, 33*(2), 1–21. Retrieved from https://files.eric.ed.gov/fulltext/EJ1136074.pdf

Calkins, L. (1983). *Lessons for a child: On the teaching and learning of writing.* Melbourne, Australia: Heinemann.

Campbell, P. F., Nishio, M., Smith, T. M., Clark, L. M., Conant, D. L., Rust, A. H., . . . Choi, Y. (2014). The relationship between teachers' mathematical content and pedagogical knowledge, teachers' perceptions, and student achievement. *Journal for Research in Mathematics Education, 45*(4), 419–459. doi:10.5951/jresematheduc.45.4.0419

Carew, J. V. (1980). Experience and the development of intelligence in young children at home and in day care. *Monographs of the Society for Research in Child Development, 45*(6-7), 1–115. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/7219418

Charlesworth, R. (2005). Prekindergarten mathematics: Connecting with national standards. *Early Childhood Education Journal, 32*(4), 229–236. doi:10.1007/s10643-004-1423-7

Chan, K. K. H., & Yung, B. H. W. (2018). Developing pedagogical content knowledge for teaching a new topic: More than teaching experience and subject matter knowledge. *Research in Science Education, 48*(2), 233–265. doi:10.1007/s11165-016-9567-1

Chatterji, M. (2015). Achievement gaps and correlates of early mathematics achievement: Evidence from the ECLS-K-First grade sample. *Education Policy Analysis Archives*, *13*(46), 1-38.

Chen, J.-Q., & McCray, J. (2012). A conceptual framework for teacher professional development: The whole teacher approach. *NHSA Dialog: A Research-to-Practice Journal for the Early Intervention Field, 15*(1), 8–23. doi:10.1080/15240754.2011.636491

Chen, J.-Q., McCray, J., Adams, M., & Leow, C. (2014). A survey study of early childhood teachers' beliefs and confidence about teaching early math. *Early Childhood Education Journal, 42*(6), 367–377. doi:10.107/s10643-013-0619-0

Claessens, A., & Garrett, R. (2014). The role of early childhood settings for 4–5 year old children in early academic skills and later achievement in Australia. *Early Childhood Research Quarterly, 29*(4), 550–561. doi:10.1016/j.ecresq.2014.06.006

Clements, D. H. (2001). Mathematics in the preschool. *Teaching Children Mathematics, 5,* 270–275.

Clements, D. H., & Sarama, J. (2005). Math play: How young children approach math. *Early Childhood Today, 19*(4), 50-57.

Clements, D. H., & Sarama, J. (2007). Effects of a preschool curriculum: Summative research on the *Building Blocks* project. *Journal for Research in Mathematics Education, 38*(2), 136–163. Retrieved from https://www.du.edu/marsicoinstitute/media/documents/effectsofapreschoolmathematicscurric.pdf

Clements, D., & Sarama, J. (2011). Early childhood teacher education: The case of geometry.*Journal of Mathematics Teacher Education, 14*(2), 133–148. doi:10.1007/s10857-011-9173-0

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach*. New York, NY: Routledge.

Clements, D. H., Sarama, J., & DiBiase, A. (2004). *Engaging young children in mathematics: Standards for early childhood mathematics education.* Mahwah, NJ: Erlbaum.

Clements, D. H., Sarama, J., Wolfe, C. B., & Spitler, M. E. (2013). Longitudinal evaluation of a scale-up model for teaching mathematics with trajectories and technologies: Persistence of effects in the third year. *American Educational Research Journal, 50*(4), 812–850. doi:10.3102/0002831212469270

Copley, J. V. (2004). The early childhood collaborative: A professional development model to communicate and implement the stands. In D. H. Clements, J. Sarama, & A. M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 401–414). Mahwah, NJ: Lawrence Erlbaum.

Copley, J. V. (2010). *The young children and mathematics* (2nd ed.). Washington, DC: National Association for the Education of Young Children and National Council of Teachers of Mathematics.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches.* Los Angeles, CA: Sage.

Creswell, J. W. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (6th ed.). Upper Saddle River, NJ: Pearson.

Cross, C. T., Woods, T. A., & Schweingruber, H. (Eds.). (2009). *Mathematics learning in early childhood: Paths towards excellence and equity.* Washington, DC: The National Academies Press.

Cross, D. I. (2009). Alignment, cohesion, and change: Examining mathematics teachers' belief structures and their influence on instructional practices. *Journal of Mathematics Teacher Education, 12*(5), 325–346. doi:10.1007/s10857-009-9120-5

Crotty, M. (1998). *The foundations of social research meaning and perspective in the research process*. Thousand Oaks, CA: Sage.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8*(1), 1–44. doi:10.14507/epaa.v8n1.2000

Darling-Hammond, L. (2017). Teacher education around the world: What can we learn from international practice? *European Journal of Teacher Education, 40*(3), 291–309.

de Haan, A. K. E., Elbers, E., & Leseman, P. P. M. (2014). Teacher- and child-managed academic activities in preschool and kindergarten and their influence on children's gains in emergent academic skills. *Journal of Research in Childhood Education, 28*(1), 43–58. doi:10.1080/02568543.2013.851750

De Marco, A., & Veron-Feagans, L. (2015). Childcare subsidy use and childcare quality in low-wealth, rural communities. *Journal of Family and Economic Issues, 36*(3), 383–395. doi:10.1007/s10834-014-9401-8

Denzin, N. K. (2009). The elephant in the living room: Or extending the conversation about the politics of evident. *Qualitative Research, 9*(2), 139–160. doi:10.1177/1468794108098034

Denzin, N. K., & Lincoln, Y. S. (2013). *Collecting and interpreting qualitative materials* (4th ed.). Thousand Oaks, CA: Sage.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., . . . Brooks-Gunn, J. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428–1446. doi:10.1037/0012-1649.43.6.1428

Dunphy, E. E. (2009). Early childhood mathematics teaching: Challenges, difficulties and priorities of teachers of young children in primary schools in Ireland. *International Journal of Early Years Education, 17*(1), 3–16. doi:10.1080/09669760802699829

Dyson, N. I., Jordan, N. C., & Glutting, J., (2011). A number sense intervention for low-income kindergarteners at risk for mathematics difficulties. *Journal of Learning Disabilities*, *46*(*2*), 166–181. doi:10.1177/0022219411410233.

Early Childhood Learning & Knowing Center (2018). *Education requirements for center-based preschool teachers: Staff qualifications: Steps for programs to consider.* https://eclkc.ohs.acf.hhs.gov/sites/default/files/pdf/no-search/ed-reqs-preschool-teachers.pdf

Early, D. M., Iruka, I. U., Ritchie, S., Barbarin, O. A., Winn, D. M. C., Crawford, G. M., & Byrant, D. M. (2010). How do pre-Kindergartens spend their time? Gender, ethnicity, and income as predictors of experiences in pre-Kindergarten classrooms. *Early Childhood Research Quarterly, 25*(2), 177–193. doi:10.1016/j.ecresq.2009.10.003

Edmonds, W. A., & Kennedy, T. D. (2012). *An applied reference guide to research designs: Quantitative, qualitative, and mixed methods.* Thousand Oaks, CA: Sage.

Erikson Institute. (2014). *The early math collaborative. Big ideas of early mathematics: What teachers of young children need to know.* Boston, MA: Pearson.

Even, R., & Tirosh, D. (2002). Teacher knowledge and understanding of student's mathematical learning. In L. D. English (Ed.), *Handbook of international research in mathematics education* (pp. 219–240). Mahwah, NJ: Lawrence Erlbaum.

Fenstermacher, G. D. (1979). A philosophical consideration of recent research on teacher effectiveness. In L. S. Shulman (Ed.), *Review of research in education* (pp. 157–185). Itasca, IL: Peacock.

Ferrandino, V. L (2005). *Leading early childhood communities: What every principal should know and be able to do* (Executive Summary). National Association of Elementary School Principals.

Flick, U. (Ed.). (2018). *The Sage handbook of qualitative data collection.* Thousand Oaks, CA: Sage.

Frye, D., Baroody, A. J., Burchinal, M., Carver, S. M., Jordan, N. C., & McDowell, J. (2013). *Teaching math to young children: A practice guide* (NCEE 2014-4005). Washington, DC: National Center for Education Evaluation and Regional Assistance (NCEE), Institute of Education Sciences, U.S. Department of Education.

Fuson, K. C. (2009). Avoiding misinterpretations of Piaget and Vygotsky: Mathematical teaching without learning, learning without teaching, or helpful learning-path teaching? *Cognitive Development, 24*(4), 343–361. doi:10.1016/j.cogdev.2009.09.009

García, E., Weiss, E., & Economic Policy Institute. (2015). *Early education gaps by social class and race start U.S. children out on unequal footing: A summary of the major findings in Inequalities at the starting gate.* Washington, DC: Economic Policy Institute. Retrieved from https://files.eric.ed.gov/fulltext/ED560364.pdf

Gasteiger, H. (2014). Professionalization of early childhood educators with a focus on natural learning situations and individual development of mathematical competencies: Results from an evaluation study. In U. Kortenkamp, B. Brandt, C. Benz, G. Krummheuer, S. Ladel, & R. Vogel (Eds.), *Early mathematics learning. Selected papers of the POEM 2012 conference* (pp. 275–290). Berlin, Germany: Springer.

Ginsburg, H. P., & Amit, M. (2008). What is teaching mathematics to young children? A theoretical perspective and case study. *Journal of Applied Developmental Psychology*, *29*(4), 274–285. doi:10.1016/j.appdev.2008.04.008

Ginsburg, H. P., & Ertle, B. B. (2008). Knowing the mathematics in early childhood mathematics. In O. Seracho & B. Spodek (Eds.), *Mathematics, science and technology in early childhood education* (pp. 45–66). Charlotte, NC: Information Age.

Ginsburg, H. P., Inoue, N., & Seo, K. H. (1999). Preschoolers doing mathematics: Observations of everyday activities. In J. Copley (Ed.), *Mathematics in the early years* (pp. 88–99). Reston, VA: National Council of Teachers of Mathematics.

Ginsburg, H. P., Lee, J. S., Boyd, J. S., & Society for Research in Childhood. (2008). Mathematics education for young children: What it is and how to promote it. *Social Policy Report*. *Society for Research in Child Development, 22*(1), 3–23. Retrieved from https://files.eric.ed.gov/fulltext/ED521700.pdf

Glynn, S. J. (2012). *Childcare: Families need more help to care for their children.* Washington, DC: Center for American Progress.

Greenes, C., Ginsburg, H. P., & Balfanz, R. (2004). Big math for little kids. *Early Childhood Quarterly, 19*(1), 159–166. doi:10.1016/j.ecresq.2004.01.010

Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. *Early Childhood Education Journal, 35*(2), 181–188. doi:10.1007/s10643-007-0174-7

Griffin, S., & Case, R. (1997). Re-thinking the primary school math curriculum: An approach based on cognitive science. *Issues in Education, 3*(1), 1–65.

Grossman, P., Schoenfeld, A., & Lee, C. (2005). Teaching subject matter. In L. Darling-Hammond, & J. Bransford (Eds.), *Preparing teachers for a changing world – What teachers should learn and be able to do* (pp. 201–231). San-Francisco, CA: Jossey Bass.

Groth, R. E. (2008). Assessing teachers' discourse about the pre-K-12 guidelines for assessment and instruction in statistics education (GAISE). *Statistics Education Research Journal, 7*(1), 16–39. Retrieved from https://www.stat.auckland.ac.nz/~iase/serj/SERJ7(1)_Groth.pdf

Gubrium, J., & Holstein, J. (1997). *The new language of qualitative method.* New York, NY: Oxford University Press.

Hachey, A. (2013). The early childhood mathematics education revolution. *Early Education and Development, 24*(4), 419–430. doi:10.1080/10409289.2012.756223

Hamlin, M., & Wisneski, D. (2012). Supporting the scientific thinking and inquiry of toddlers and preschoolers through play. *Young Children, 67,* 82–88.

Hanushek, E. (2010). The economic value of higher teacher quality. *Economics of Education Review, 30*(3), 466–479. Retrieved from https://www.nber.org/papers/w16606

Harvey, H. A., & Miller, G. E. (2017). Executive function skills, early mathematics, and vocabulary in head start preschool children. *Early Education and Development, 28*(3), 290–307. doi:10.1080/10409289.2016.1218728

Hattie, J. (2012). *Visible Learning for teachers. Maximizing impact on learning*. New York, NY: Routledge.

Herron, J. (2010). An evolution of mathematical beliefs: A case study of three pre-K teachers. *Journal of Early Childhood Teacher Education, 31*(4), 360–372. doi:10.1080/10901027.2010.523771

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371–401. Retrieved from http://www.umich.edu/~lmtweb/files/hillrowanball.pdf

Hill, H. C., Sleep, L., Lewis, J., & Ball, D. (2007). Assessing teachers' mathematical knowledge: What knowledge matters and what evidence counts? In F. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 111–155). Charlotte, NC: Information Age.

Incikabi, L., & Kildan, A. O. (2013). An analysis of early childhood teacher candidates' digital stories for mathematics teaching. *International Journal of Academic Research, 5*(2), 77–81. doi:10.7813/2075-4124.2013/5-2/B.10

Joram, E. (2007). Clashing epistemologies: Aspiring teachers', practicing teachers', and professors' beliefs about knowledge and research in education. *Teaching and Teacher Education, 23*(2), 123–135. doi:10.1016/j.tate.2006.04.032

Kaartinen, S., & Kumpulainen, K. (2012). The emergence of mathematizing as a culture of participation in the early childhood classroom. *European Early Childhood Education Research Journal, 20*(2), 263–281. doi:10.1080/1350293X.2012.681136

Kena, G., Hussar W., McFarland J., de Brey, C., Musu-Gillette, L., Wang, X., . . . Dunlop Velez, E. (2016). *The condition of education 2016* (NCES 2016-144). Washington, DC: U.S. Department of Education, National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubs2016/2016144.pdf

Kilday, C. R., Kinzie, M. B., Mashburn, A. J., & Whittaker, J. V. (2012). Accuracy of teacher judgements of preschoolers' math skills. *Journal of Psychoeducational Assessment, 30*(2), 148–159. doi:10.1177/0734282911412722

Kilpatrick, J., Swafford, J., & Swindell, B. (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Klein, A., Starkey, P., Clements, D. H., Sarama, J., & Iyer, R. (2008). Effects of a Pre-Kindergarten mathematics intervention: A randomized experiment. *Journal of Research on Educational Effectiveness, 1*(3), 155–178. doi:10.1080/19345740802114533

Kliebard, H. (2004). *The struggle for the American curriculum: 1893-1958.* New York, NY: Routledge.

Kodagoda, T. (2014). Working mothers' gender ideologies on childcare and perception on existing childcare centres. *Gender in Management, 29*(7), 402–418.

Kontos, S. (1999). Preschool teachers' talk, roles, and activity settings during free play. *Early Childhood Research Quarterly, 14*(3), 363–382.

Kwon, Y.-I. (2002). Changing curriculum for early childhood education in England. *Early Childhood Research & Practice, 4*(2). Retrieved from http://www.peelearlyyears.com/pdf/Changing%20Curriculum%20for%20Early%20Childhood%20Education%20in%20England.pdf

Lamb, M. E., & Bornstein, M. H. (2011). *Social and personality development: An advanced textbook*. New York, NY: Psychology Press.

Lee, J. (2005). Correlations between kindergarten teachers' attitudes toward mathematics and teaching practice. *Journal of Early Childhood Teacher Education, 25*(2), 173–184. doi:10.1080/1090102050250210

Lee, J. (2010). Exploring kindergarten teachers' pedagogical content knowledge of mathematics. *International Journal of Early Childhood, 42*(1), 27–41. doi:10.1007/s13158-010-0003-9

Lee, J. E. (2014). A study of pre-Kindergarten teachers' knowledge about children's mathematical thinking. *Australasian Journal of Early Childhood, 39*(4), 29–36. Retrieved from https://www.researchconnections.org/childcare/resources/29624

Lee, J. S., & Ginsburg, H. P. (2007a). Preschool teachers' beliefs about appropriate early literacy and mathematics education for low- and middle-socioeconomic status children. *Early Education & Development, 18*(1), 111–143. doi:10.1080/10409280701274758

Lee, J. S., & Ginsburg, H. P. (2007b). What is appropriate mathematics education for four-year-olds?: Pre-kindergarten teachers' beliefs. *Journal of Early Childhood Research, 5*(1), 2–31. doi:10.1177/1476718X07072149

Lee, J. S., & Ginsburg, H. P. (2009). Early childhood teachers' misconceptions about mathematics education for young children in the United States. *Australasian Journal of Early Childhood, 34*(4), 37–45. doi:10.1177/183693910903400406

Leech, N., & Onwuegbuzie, A. (2007). An array of qualitative data analysis tools: A call for data analysis triangulation. *School Psychology Quarterly, 22*(4), 557–584. doi:10.1037/1045-3830.22.4.557

Leedy, P. D., & Ormrod, J. E. (2010). *Practical research: Planning and design* (9th ed.). Upper Saddle River, NJ: Merrill.

Leong, K. E. (2013). Factors that influence the understanding of good mathematics teaching. *Eurasia Journal of Mathematics, Science & Technology Education, 9*(3), 319–328. doi:10.12973/eurasia.2013.939a

Leong, K. E., Meng, C. C., & Rahim, S. S. (2015). Understanding Malaysian pre-service teachers mathematical content knowledge and pedagogical content knowledge. *Eurasia*

Journal of Mathematics, Science & Technology Education, 11(2), 363–370. doi:10.12973/eurasia.2015.1346a

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Linder, S. M. (2012). Building content and communities: Developing a shared sense of early childhood mathematics pedagogy. *Journal of Early Childhood Teacher Education, 33*(2), 109–126. doi:10.1080/10901027.2012.675837

Linder, S. M., Powers-Costello, B., & Stegelin, D. A. (2011). Mathematics in early childhood: Research-based rationale and practical strategies. *Early Childhood Education Journal*, *39*(1), 29–37. doi:10.1007/s10643-010-0437-6

Linder, S. M., & Simpson, A. (2018). Towards an understanding of early childhood mathematics education: A systematic review of the literature focusing on practicing and prospective teachers. *Contemporary Issues in Early Childhood, 19*(3), 274–296.

Ma, L. (1999). *Knowledge and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Mahwah, NJ: Lawrence Erlbaum.

Malik, R. (2019). *Working families are spending big money on child care.* Center for American Progress. Retrieved from https://www.americanprogress.org/issues/early-childhood/reports/2019/06/20/471141/working-families-spending-big-money-child-care/

Marzano, R. (2017). *The new art and science of teaching*. Bloomington, IN: Solution Tree.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Social Research, 11*(3), Article 8. Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1428/3028

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Kendall-Taylor, N., & Levine, M. H. (2017). *STEM starts early*: *Grounding science, technology, engineering, and math education in early childhood*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

McCray, J. S. (2008). *Pedagogical content knowledge for preschool mathematics: Relationships to teaching practices and child outcomes* (doctoral dissertation, Loyola University). Available from ProQuest LLC Dissertations and Theses database. (UMI No. 3313155)

McCray, J. S., & Chen, J. (2012). Pedagogical content knowledge for preschool mathematics: Construct validity of a new teacher interview. *Journal of Research in Childhood Education, 26*(3), 291–307. doi:10.1080/02568543.2012.685123

McFarland, J., Hussar, B., Wang, X., Zhang, J., Wang, K., Rathbun, . . . Bullock Mann, F. (2018). *The condition of education 2018* (NCES 2018-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2018144

Merriam, S. B., & Grenier, R. S. (Eds.). (2019). *Qualitative research in practice: Examples for discussion and analysis.* San Francisco, CA: Jossey-Bass.

Merriam, S. B. & Tisdell, E. (2016). *Qualitative research a guide to design and implementation*. (4th ed.). San Francisco, CA: Jossey-Bass.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis*: *A methods sourcebook* (3rd ed.). Thousand Oaks, CA: Sage.

Miller, B., Schiavo, N., & Busey, A. (2008). *Teacher leaders providing classroom support to teachers through demonstration lessons/modeling*. Retrieved from Math and Science

Partnership Knowledge Management and Dissemination website at http://www.mspkmd.net//index.php?page=03_1a

Mohan, L., Galosy, J., Miller, B., & Bintz, J. (2017). *A synthesis of math/science teacher leadership development programs: Consensus findings and recommendations* (Research Report No. 2017-02). Colorado Springs, CO: BSCS.

Moon, Y. S., & Lee, H. Y. (2011). A study on the early childhood mathematics teachers' perceptions and practices in support of the goals and contents of early childhood mathematics education. *Asia-Pacific Journal of Research in Early Childhood Education, 5*(2), 67–92. doi:10.1080/10409289.2015.994464

Moseley, B. (2005). Pre-service early childhood educators' perceptions of math-mediated language. *Early Childhood and Development, 16*(3), 385–396. doi:10.1207/s15566935eed1603_5

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage.

National Assessment of Education Progress. (2019). *The nation's report card: Mathematics.* Retrieved from https://www.nationsreportcard.gov/highlights/mathematics/2019/

National Association for the Education of Young Children. (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age eight.* Washington, DC: Author.

National Association for the Education of Young Children & National Council of Teachers of Mathematics. (2010). *Early childhood mathematics: Promoting good beginnings.* A joint position statement of NAEYC and the National Council of Teachers of Mathematics. Retrieved from https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/psmath.pdf

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

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

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics*. Reston, VA: Author.

National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.

Nelson, J., & Lewis, A. (2016). "I'm a teacher, not a babysitter": Workers' strategies for managing identity-related denials of dignity in the early childhood workplace. In *Research in the sociology of work* (Vol. 29, pp. 37–71). Emerald Group Publishing Limited.

Newton, K. J., Leonard, J., Evans, B. R., & Eastburn, J. A. (2012). Preservice elementary teachers' mathematics content knowledge and teacher efficacy. *School Science and Mathematics, 112*(5), 289–299. doi:10.1111/j.1949-8594.2012.00145.x

Nye, B., Konstantopoulos, S., & Hedges, L. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis, 26*(3), 237–257.

Pajares, M. F. (1992). Teachers' beliefs and education research: Cleaning up a messy construct. *Review of Education Research, 62*(3), 307–332. doi:10.3102/00346543062003307

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice* (4th Edition). Thousand Oaks: Sage.

Peisner-Feinberg, E. S., Mokrova, I. L., & Anderson, T. L. (2017). *Effects of participation in the North Carolina pre-kindergarten program at the end of kindergarten: 2015-2016* *statewide evaluation.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Perry, B., & Dockett, S. (2002). Young children's access to power mathematical ideas *Mathematics* In L. English (Ed.), *Handbook of international research in mathematics education,* (pp. 81–111). London, England: Lawrence Erlbaum.

Perry, B., Dockett, S., & Harley, E. (2007). Preschool educators’ sustained professional development in young children’s mathematics learning. [Special Issue]. *Mathematics Teacher Education and Development, 8,* 117–134. Retrieved from https://files.eric.ed.gov/fulltext/EJ836497.pdf

Phillips, B. M., & Morse, E. E. (2011). Family childcare learning environments: Caregiver knowledge and practices related to early literacy and mathematics. *Early Childhood Education Journal, 39*(3), 213–222. doi:10.1007/s10643-011-0456-y

Platas, L. M. (2008). *Measuring teachers’ knowledge of early mathematical development and their beliefs about mathematics teaching and learning in the preschool classroom* (Doctoral dissertation). Available from ProQuest LLC Dissertations and Theses database. (UMI No. 3367632)

Prasad, P. (2017). *Crafting qualitative research: Working in the postpositivist traditions.* New York, NY: M. E. Sharpe.

RAND Corporation. (2012). *Teachers matter: Understanding teachers’ impact on student achievement*. Santa Monica, CA: Author. Retrieved from https://www.rand.org/pubs/corporate_pubs/CP693z1-2012-09.html

Reinking, A. K. (2015). Increasing accountability measures for early childhood teachers using evaluation models: Observation, feedback, and self-assessment. *Current Issues in*

Education, 18(1). Retrieved from https://cie.asu.edu/ojs/index.php/cieatasu/article/view/1362

Ritchie, S., Weiser, B., Kraft-Sayre, M. E., Mason, E., Crawford, G., & Howes, C. E. (2010). *Snapshot codebook – FirstSchool.*

Rothstein, J. (2010). Teacher quality in educational production: Tracking, decay, and student achievement. *Quarterly Journal of Economics, 125*(1), 175–214. Retrieved from https://www.nber.org/papers/w14442

Roulston, K., & Shelton, S. (2015). Reconceptualizing bias in teaching qualitative research methods. *Qualitative Inquiry, 21*(4), 332–342.

Rudd, L. C., Lambert, M. C., Satterwhite, M., & Smith, C. H. (2009). Professional development + coaching = enhanced teaching: Increasing usage of math mediated language in preschool classrooms. *Early Childhood Education Journal, 37*(1), 63–69. doi:10.1007/s10643-009-0320-5

Rudd, L. C., Lambert, M. C., Satterwhite, M., & Zaier, A. (2008). Mathematical language in early childhood settings: What really counts? *Early Childhood Education Journal, 36*(1), 75–80. doi:10.1007/s10643-008-246-3

Rudd, L. C., Satterwhite, M., & Lambert, M. (2010). One, two, buckle my shoe: Using math-mediated language in preschool. *Dimensions of Early Childhood, 38*(2), 30–38. Retrieved from https://eric.ed.gov/?id=EJ945682

Ryan, G. W., & Bernard, H. R. (2003). Techniques to identify themes. *Field Methods, 15*(1), 85–109. doi:10.1177/1525822X02239569

Sackes, M., Flevares, L. M., Gonya, J., & Trundle, K. C. (2012). Preservice early childhood teachers' sense of efficacy for integrating mathematics and science: Impact of a methods course. *Journal of Early Childhood Teacher Education, 33*(4), 349–364. doi:10.1080/10901027.2012.732666

Samuelsson, I. P., & Carlsson, M. A. (2008). The playing learning child: Towards pedagogy of early childhood. *Scandinavian Journal of Educational Research, 52*(6), 623–641. doi:10.1080/00313830802497265

Saracho, O. N., & Spodek, B. (2008). *Contemporary Perspectives in Mathematics*. Vol X. Charlotte, NC: Information Age Publishing.

Saracho, O. N., & Spodek, B. (2009). Educating the young mathematician: The twentieth century and beyond. *Early Childhood Education Journal, 34,* 305–312. doi:10.1007.s10643-008-0293-9

Saracho, O. N., & Spodek, B (2014). *Handbook of research on the education of young children* / edited by Bernard Spodek, Olivia N. Saracho. (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Sarama, J., Clements, D. H., Starkey, P., Klein, A., & Wakeley, A. (2008). Scaling up the implementation of a pre-kindergarten mathematics curriculum: Teaching for understanding with trajectories and technologies. *Journal of Research on Educational Effectiveness, 1*(2), 89–119. doi:10.1080/19345740801941332

Schack, E., Fisher, M., Thomas, J., Eisenhardt, S., Tassell, J., & Yoder, M. (2013). Prospective elementary school teachers' professional noticing of children's early numeracy. *Journal of Mathematics Teacher Education, 16*(5), 379–397. doi:10.1007/s10857-013-9240-9

Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed.). Boston, MA: Pearson Education.

Schwartz, J. E., & Riedesel, C. (1994). *The relationship between teachers' knowledge and beliefs and the teaching of elementary mathematics.* Retrieved from https://files.eric.ed.gov/fulltext/ED366585.pdf

Seidman, I. (2019). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (5th ed.). New York, NY: Teachers College Press.

Şeker, P. T., & Alisinanoglu, F. (2015). A survey study of the effects of preschool teachers' beliefs and self-efficacy towards mathematics education and their demographic features on 48 - 60-month-old preschool children's mathematic skills. *Creative Education, 6*(3), 405–414. Retrieved from https://file.scirp.org/pdf/CE_2015031915464242.pdf

Sherin, M. G., Jacobs, V. R., & Philipp, R. A. (2011). *Mathematics teacher noticing: Seeing through teachers' eyes.* New York, NY: Routledge.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. Retrieved from http://www.jstor.org/stable/1175860

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–23. doi:10.17763/haer.57.1.j463w79r56455411

Silverman, D. (2013). *Doing qualitative research* (4th ed.). Thousand Oaks, CA: Sage.

Stake, R. E. (2014). *Qualitative research studying how things work*. New York, NY: Guilford Press.

Stebbins, R. (2011). *Exploratory research in the social sciences* (Qualitative Research Methods Series 48). Thousand Oaks, CA: Sage.

Stevens, R., Loudon, D., Wrenn, B., & Cole, H. (2012). *Concise encyclopedia of church and religious organization marketing.* New York, NY: Routledge.

Stoehr, K. (2017). Building the wall brick by brick: One prospective teacher's experiences with mathematics anxiety. *Journal of Mathematics Teacher Education, 20*(2), 119–139.

Suen, L., Huang, H., & Lee, H. (2014). A comparison of convenience sampling and purposive sampling. *Hu Li Za Zhi The Journal of Nursing, 61*(3), 105–111. doi:10.6224/JN.61.3.105

Summers, J. J., Davis, J. A., & Hoy, A. W. (2017). The effects of teachers' efficacy beliefs on students' perceptions of teacher relationship quality. *Learning and Individual Differences, 53,* 17–25. doi:10.1016/j.lindif.2016.10.004

Swars, S. L., Smith, S. Z., Smith, M. E., & Hart, L. C. (2009). A longitudinal study of effects of a developmental teacher preparation program on elementary prospective teachers' mathematics beliefs. *Journal of Mathematics Teacher Education, 12*(1), 47–66. doi:10.1007/s10857-008-9092-x

Swedberg, R. (2018). *On the uses of exploratory research and exploratory studies in social science.* Retrieved from http://people.soc.cornell.edu/swedberg/On%20the%20Uses%20of%20Exploratory%20Research%20and%20Exploratory%20Studies%20in%20Social%20Science.pdf

Taylor-Cox, J. (2016). *Math intervention: Building number power with formative assessments, differentiation, and games.* New York, NY: Routledge.

Thiel, O. (2010). Teachers' attitudes towards mathematics in early childhood education. *European Early Childhood Education Research Journal, 18*(1), 105–115. doi:10.1080/13502930903520090

Thomas, M., & Bainbridge, W. (2002). No Child Left Behind: Facts and fallacies. *Phi Delta Kappan Magazine, 83*(10), 781–782. Doi :10.1177/003172170208301014

Thornton, J. S., Crim, C. L., & Hawkins, J. (2009). The impact of an ongoing professional development program on prekindergarten teachers' mathematics practices. *Journal of Early Childhood Teacher Education, 30*(2), 150–161. doi:10.1080/10901020902885745

Tirosh, D., Tsamir, P., Levenson, E., & Tabach, M. (2011). From preschool teachers' professional development to children's knowledge: Comparing sets. *Journal of Mathematics Teacher Education, 14*(2), 113–131. doi:10.1007/s10857-011-9172-1

Upadyaya, K., & Eccles, J. S. (2014). How do teachers' beliefs predict children's interest in math from kindergarten to sixth grade? *Merrill-Palmer Quarterly, 60*(4), 403–430. doi:10.13110/merrpalmquar1982.60.4.0403

U.S. Congress. (2010). *The Obama Administration's Elementary and Secondary Education Act Reauthorization Blueprint* [electronic Resource] Hearing before the Committee on Education and Labor, U.S. House of Representatives, One Hundred Eleventh Congress, Second Session, Hearing Held in Washington, DC, March 17, 2010.

U.S. Department of Education. (2008). Learning processes. In U.S. Department of Education, *Foundations for success: The final report of the National Mathematics Advisory Panel* (pp. 25–34). Washington, DC: U.S. Government Printing Office. Retrieved from http://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf.

U.S. Department of Education. (2010). *A blueprint for reform: The reauthorization of the Elementary and Secondary Education Act*. Available: http://www2.ed.gov/policy/elsec/leg/blueprint/publicationtoc.html. Washington, DC: Author.

Vale, C. (2010). Supporting "out-of-field" teachers of secondary mathematics. *Australian Mathematics Teacher, 66*(1), 17–24.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2012). *Elementary and middle school mathematics: Teaching developmentally*. Boston, MA: Pearson.

van Oers, B. (2010). Emergent mathematical thinking in the context of play. *Educational Studies in Mathematics, 74*(1), 23–37. https://www.jstor.org/stable/40603185

Villa, E. (2017). *Using in-depth interviews as a primary source of data for developing case studies.* SAGE Research Methods Cases in Education. doi:10.4135/9781473958043

Whitebook, M., McLean, C., Austin, L. J. E., & Edwards, B. (2018). *Early childhood workforce index—2018.* Retrieved from https://www.fcd-us.org/assets/2018/07/Early-Childhood-Workforce-Index-2018.pdf

Wilkins, J. M. (2008). The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices. *Journal of Mathematics Teacher Education, 11*(2), 139–164. doi:10.1007/s10857-007-9068-2

Wong, K., & Sunderman, G. (2007). Education accountability as a presidential priority: *No Child Left Behind* and the Bush presidency. *Publius: The Journal of Federalism, 37*(3), 333–350. doi:10.1093/publius/pjm011

Yin, R. K. (2016). *Qualitative research from start to finish*. (2nd ed.). New York, NY: Guilford Press.

Yin, R. K. (2018). *Case study research design and methods* (6th ed.). Thousand Oaks, CA: Sage.

Youmans, A., Coombs, A., & Colgan, L. (2018). Early childhood educators' and teachers' early mathematics education knowledge, beliefs, and pedagogy. *Canadian Journal of Education, 41*(4), 1079–1104. Retrieved from http://journals.sfu.ca/cje/index.php/cje-rce/article/view/3442/2669

Young, J. L., & Young, J. R. (2016). Closing the gap or reaching the ceiling: An exploratory trend analysis of the Black White achievement gap in Texas. *Journal of Multicultural Affairs, 1*(1), Article 4. Retrieved from https://scholarworks.sfasu.edu/jma/vol1/iss1/4

Zambo, D., & Zambo, R. (2011). Teachers' beliefs about neuroscience and education. *Teaching Educational Psychology, 7*(2), 25–41. Retrieved from https://files.eric.ed.gov/fulltext/EJ955550.pdf

APPENDIX A

PRESCHOOL MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE INTERVIEW

451 North LaSalle Street
Chicago, Illinois 60654
312-755-2250 t 312-755-0928 f
www.erikson.edu

April 20, 2015

Raleta C. Summers
Old Dominion University
5115 Hampton Boulevard
Norfolk, VA 23529

RE: Permission to use PM-PCK Interview

Dear Raleta,

Thank you for contacting me in reference the *Preschool Mathematics PCK Interview*. I am delighted you are interested in utilizing this measure in your dissertation.

This letter serves as my official notice granting you, Raleta C. Summers, permission to administer the measure in your dissertation study. Please continue to keep me abreast of your progress and findings throughout your journey.

Sincerely,

Jennifer S. McCray, Ph.D.
Assistant Research Scientist and
Director, Early Math Collaborative

graduate school in child development
erikson institute

Different Kinds of Math

- NUMBER SENSE
- PATTERNS
- OPERATIONS
- MEASUREMENT
- SHAPE
- SPATIAL RELATIONSHIPS
- CLASSIFICATION

This is an interview about how you think about preschool math. It has two classroom scenes. I'm going to ask you to read each scene to yourself, then I'll read it with you, and then I'll ask you some questions about it. OK?

In these two scenes, children are doing free play. I want you to read through them and see if you can see any math in their play. When I say math, I mean things like:

- Number sense (for example, counting, number use, 1-to-1 correspondence)
- Patterns
- Operations (like combining, taking away)
- Measurement (like comparing, estimating, using units)
- Shape
- Spatial relationships
- Classification (for example, sorting, matching)

Let's start with Scene One now. Please read it through to yourself looking for math, and then I will read it with you before I ask you any questions about it.

(TEACHER READS.)

Now let's read it together.

<u>Scene One</u>

Brittany and Jacob are playing in the dramatic play area and want to put their 5 babies to bed. There are no doll beds, so they make "cribs" out of three shoeboxes. Jacob says "but there aren't enough cribs." Brittany responds, "these babies are younger" picking out the three babies with no hair and setting them near the shoeboxes. She picks up the two babies with thick hair, says "these babies don't need to nap anymore," and sets them aside. Jacob says "OK, but this baby needs the most room" and puts the biggest bald baby in the biggest shoebox. Brittany watches him and then puts the medium-sized bald baby in the medium-sized shoebox and the smallest bald baby in the smallest shoebox. Jacob says "now go to sleep, babies."

<u>Scene One</u>: Brittany and Jacob Play with Babies

<u>VOLUNTEERED RESPONSES</u>

Where do you see any math in this play? [**Probe**: What part of the children's play has math in it?] Some people see only one example of math, while some people see more. Can you see any other math in this play? [**Probe**: What *other* math do you see in this play?]

PLAY EXAMPLE [+1] Where do you see any math in this play? **[Lead to Example]**: What is it the kids are doing that makes you think of (content mentioned)?]	HOW IS IT MATH? **[+2 when tied to example]** **[From Example]**: How is that mathematical? **[From List]**: Why is it an example of (content mentioned)?	LIST **[+2 when tied to ex]** If you had to describe this math using these terms (provide list), how would you describe it?	SCORES
☐ Baby to shoebox by size order	☐ rule that repeats ☐ order by size ☐ monotonic seriation	☐ PATTERNS	[0-5]
☐ Shoebox crib	☐ shape/space match	☐ SHAPE	[0-5]
☐ Babies INSIDE shoebox	☐ "crib" encloses ☐ relationships of location/ btwn objects	☐ SPATIAL RELATIONS	[0-5]
☐ Babies/shoeboxes differ in size	☐ comparison by size	☐ MEASUREMENT	[0-5]
☐ Sort by hair age	☐ logic / similarity ☐ grouping / which go together	☐ CLASSIFICATION	[0-5]
☐ 3 cribs hold 3 babies	☐ counting, number use ☐ 1 to 1 correspondence	☐ NUMBER SENSE	[0-5]
	☐ compare/see amount/number	☐ MEASUREMENT	[0-4]
☐ Put two babies aside	☐ take away right amount/number	☐ OPERATIONS	[0-5]
☐ Other [0 points possible]		**TOTAL VOLUNTEERED**	[0-39]

PROMPTED RESPONSES

[For those content areas *not selected previously*]…

Do you see any use of (content area) in this play? Please answer either yes, no, or not sure.

[If "yes" to above]…
Where do you see (content area) in this play?

[If "not sure" to above]…
Where do you think you might see (content area) in this play?

Prompted?	Content Area	Response	Specific Play Example	Score
☐	NUMBER SENSE	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] 3 cribs hold 3 babies	[0 2]
☐	PATTERNS	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Baby to shoebox by size order	[0 2]
☐	OPERATIONS	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Put two babies aside	[0 2]
☐	MEASUREMENT	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Babies/shoeboxes differ in size	[0 2]
		[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] 3 cribs hold 3 babies	[0 2]
☐	SHAPE	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Shoebox crib	[0 2]
☐	SPATIAL RELATIONSHIPS	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Babies INSIDE shoebox	[0 2]
☐	CLASSIFICATION	[ ] yes/not sure **[+2 with corresponding ex only]** [ ] no	[ ] Sort by hair age	[0 2]
			TOTAL SCORE PROMPTED	[0 16]

ELABORATIONS

Can you think of a *comment you could make* to help the children see some of the math in their play? [**Probe**: What could you say about what the kids have done to help them understand that there is math in their play?]

□ MATH FOCUSED
□ PLAY RELATED

[+2 if both checked above]: ______________

(Show list) Which *math topic* on this list do you believe this comment would help the children see or think about? [**Probe**: What specific math ideas would your comment help the children think about?]

[+2 if connects to comment above]: ______________

Can you think of a *question you could ask* to help the children find out more about the math in their play? [**Probe**: What could you ask the kids that would encourage them to think further about or experiment with the math in their play?]

□ MATH FOCUSED
□ QUESTION

[+2 if both checked above]: ______________

(Show list) Which *math topic* on this list would this question help the children explore? [**Probe**: What math ideas would this question help the children work on?]

[+2 if connects to comment above]: ______________

TOTAL ELABORATIONS (0-8): ______________

Now let's do Scene Two. Please read it to yourself first.

(TEACHER READS.)

Now let's read it together.

<u>Scene Two</u>

Brandon and Tyra are playing with unit blocks and want to build a cage for a mama elephant and her two babies. Tyra builds the first two sides of the cage, set up at a right angle to each other, and using two unit blocks for each side. Brandon sets up the third cage side, but uses one unit block and a half unit block instead of two full units. When Brandon tries to finish the cage by building the 4th side, he sees that it doesn't hit the 1st side exactly at the corner. He says, "hey, it doesn't work…I'll fix it." He adds another half unit block to his 3rd side and he and Tyra finish the cage together. Tyra and Brandon place the three elephants inside.

Scene Two: Brandon and Tyra build a cage

VOLUNTEERED RESPONSES

Where do you see any math in this play? [**Probe**: What part of the children's play has math in it?.] Some people see only one example of math, while some people see more. Can you see any other math in this play? [**Probe**: What *other* math do you see in this play?]

PLAY EXAMPLE **[+1]** Where do you see any math in this play? **[Lead to Example]**: What is it the kids are doing that makes you think of _________ (content mentioned)?]	HOW IS IT MATH? **[+1 when tied to example]** **[From Example]**: How is that mathematical? **[From List]**: Why is it an example of _______ (content mentioned)?	LIST **[+1 when tied to ex]** If you had to describe this math using these terms (provide list), how would you describe it?	SCORES
☐ two blocks each side	☐ repetition of number	☐ PATTERNS	(0-3)
	☐ counting blocks used	☐ NUMBER SENSE	(0-2)
☐ Cage – rectangle	☐ seeing/matching shapes	☐ SHAPE	(0-3)
☐ Can make rectangle	☐ rt angles/parallel lines ☐ ends/corners meet	☐ SHAPE	(0-3)
☐ Select rectangular blocks	☐ best for building wall ☐ match to wall shape	☐ SHAPE	(0-3)
☐ **Elephants INSIDE cage**	☐ relations in space/btwn objects ☐ "cage" encloses	☐ SPATIAL RELATIONS	(0-3)
☐ 3^{RD} side is shorter	☐ compare length	☐ MEASUREMENT	(0-3)
☐ Combine 2 sm = 1 lg	☐ estimate difference/relation ☐ unit use	☐ MEASUREMENT	(0-3)
	☐ adding makes more	☐ OPERATIONS	(0-2)
☐ Size of cage fits elephants	☐ size/space estimate	☐ MEASUREMENT	(0-3)
☐ types of blocks	☐ seeing diff types of blocks ☐ matching block types	☐ CLASSIFICATION	(0-3)
☐ Other [0 points possible]		**TOTAL VOLUNTEERED**	(0-31)

Scene Two: Brandon and Tyra build a cage

PROMPTED RESPONSES

[For those content areas *not selected previously*]…

Do you see any use of ____________ (content area) in this play? Please answer either yes, no, or not sure.

[If "yes" to above]…
Where do you see _____________ (content area) in this play?

[If "not sure" to above]…
Where do you think you might see _______________ (content area) in this play?

Prompted?	Content Area	Response	Specific Play Example	Score
☐	NUMBER SENSE	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ two blocks each side	[0-1]
☐	PATTERNS	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ two blocks each side	[0-1]
☐	OPERATIONS	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ combine 2 sm = 1 lg	[0-1]
☐	MEASUREMENT	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ combine 2 sm = 1 lg	[0-1]
		☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ 3rd side shorter	[0-1]
		☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ cage size fits elephants	[0-1]
☐	SHAPE	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ cage = rectangle	[0-1]
		☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ can make rectangle	[0-1]
		☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ select rectangular blocks	[0-1]
☐	SPATIAL RELATIONSHIPS	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ Elephants INSIDE cage	[0-1]
☐	CLASSIFICATION	☐ yes/not sure **[+1 with corresponding ex only]** ☐ no	☐ 2 types of blocks	[0-1]
			TOTAL SCORE PROMPTED	[0-11]

Scene Two: Brandon and Tyra build a cage

ELABORATIONS

Can you think of a *comment you could make* to help the children see some of the math in their play? [**Probe**: What could you say about what the kids have done to help them understand that there is math in their play?]

□ MATH FOCUSED
□ PLAY RELATED

[+2 if both checked above]: ______________

(Show list) Which *math topic* on this list do you believe this comment would help the children see or think about? [**Probe**: What specific math ideas would your comment help the children think about?]

[+2 if connects to comment above]: ______________

Can you think of a *question you could ask* to help the children find out more about the math in their play? [**Probe**: What could you ask the kids that would encourage them to think further about or experiment with the math in their play?]

□ MATH FOCUSED
□ QUESTION

[+2 if both checked above]: ______________

(Show list) Which *math topic* on this list would this question help the children explore? [**Probe**: What math ideas would this question help the children work on?]

[+2 if connects to question above]: ______________

TOTAL ELABORATIONS (0-8): ______________

APPENDIX B

MATHEMATICAL DEVELOPMENT BELIEFS SURVEY

SAN FRANCISCO
STATE UNIVERSITY

2 October 2014

Ms. Raleta C. Summers
Old Dominion University
5115 Hampton Boulevard
Norfolk, VA 23529

Dear Ms. Summers,

Thank you for contacting me in reference to the *Knowledge of Mathematical Development Survey* and the *Mathematical Development Beliefs Survey*. I am delighted you are interested in utilizing both measures in your dissertation.

This letter serves as my official notice granting you, Raleta C. Summers, permission to administer both measures in your dissertation study. Please continue to keep me abreast of your progress and findings throughout your journey.

Sincerely,

Linda M. Platas

Linda M. Platas, Ph.D.
Child and Adolescent Development Department
San Francisco State University
1600 Holloway Avenue, SCI 389
San Francisco, CA 94132

Check the box that best describes your agreement/disagreement with the statement (check only one box).

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	1. Math is an important part of the preschool curriculum.
☐	☐	☐	☐	☐	☐	2. It is better to wait until kindergarten for math activities.
☐	☐	☐	☐	☐	☐	3. Mathematical activities are an inappropriate use of time for preschoolers; because they aren't ready for them.
☐	☐	☐	☐	☐	☐	4. Preschoolers are capable of learning math.
☐	☐	☐	☐	☐	☐	5. I am knowledgeable enough to teach math in preschool.
☐	☐	☐	☐	☐	☐	6. Math flashcards are appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	7. Math activities are good opportunities to develop social skills in preschool.
☐	☐	☐	☐	☐	☐	8. Preschoolers learn mathematics *without* support from teachers.
☐	☐	☐	☐	☐	☐	9. Math activities are a very important part of the preschool experience.
☐	☐	☐	☐	☐	☐	10. The teacher should play a central role in preschool mathematics activities.
☐	☐	☐	☐	☐	☐	11. Teaching mathematics to preschoolers is/would be uncomfortable for me.
☐	☐	☐	☐	☐	☐	12. Supporting development in academic subjects such as math is the *primary* goal of preschool education.

Strongly Agree	**Agree**	**Somewhat Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**	
☐	☐	☐	☐	☐	☐	13. Preschoolers learn mathematics *best* through direct teaching of basic skills.
☐	☐	☐	☐	☐	☐	14. I am unsure how to support math development for young children.
☐	☐	☐	☐	☐	☐	15. Most preschoolers are ready for participation in math activities.
☐	☐	☐	☐	☐	☐	16. Social and emotional development is the *primary* goal of preschool and time spent on math takes away from this goal.
☐	☐	☐	☐	☐	☐	17. Math is/would be a difficult subject for me to teach in preschool.
☐	☐	☐	☐	☐	☐	18. Teachers can help preschoolers learn mathematics.
☐	☐	☐	☐	☐	☐	19. In preschool, children should learn *specific* procedures for solving math problems (i.e., 2 + 4).
☐	☐	☐	☐	☐	☐	20. Preschool math will weaken preschoolers' self-confidence.
☐	☐	☐	☐	☐	☐	21. I can think of many math activities that would be appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	22. Children are ready for math activities in preschool.
☐	☐	☐	☐	☐	☐	23. In preschool, children construct their mathematical knowledge *without* the help of a teacher.
☐	☐	☐	☐	☐	☐	24. I don't know enough math to teach it in preschool.

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	25. Teachers should help preschool children memorize number facts (for instance, 2+3).
☐	☐	☐	☐	☐	☐	26. Preschool children are *not* socially or emotionally ready for math activities.
☐	☐	☐	☐	☐	☐	27. Math would be easy for me to incorporate into preschool curricula.
☐	☐	☐	☐	☐	☐	28. If a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected.
☐	☐	☐	☐	☐	☐	29. Math is confusing to preschoolers.
☐	☐	☐	☐	☐	☐	30. I can create effective math activities for preschoolers.
☐	☐	☐	☐	☐	☐	31. Academic subjects such as mathematics are too advanced for preschoolers.
☐	☐	☐	☐	☐	☐	32. Preschool teachers are responsible for making sure that preschoolers can learn the right answer in mathematics.
☐	☐	☐	☐	☐	☐	33. Math worksheets are appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	34. I don’t know how to teach math to preschoolers.
☐	☐	☐	☐	☐	☐	35. Mathematical activities are age-appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	36. Teachers should show preschoolers the correct way of doing mathematics.
☐	☐	☐	☐	☐	☐	37. Very *few* preschoolers are ready for math in preschool.

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	38. Before kindergarten, preschool teachers should make sure preschoolers memorize verbal counting numbers.
☐	☐	☐	☐	☐	☐	39. Math is a worthwhile and necessary subject for preschoolers.
☐	☐	☐	☐	☐	☐	40. I know how to support math learning in preschool.

APPENDIX C

CONSENT FORM

INFORMED CONSENT DOCUMENT

PROJECT TITLE: A Comparative Case Study Exploring the Nature of how Prekindergarten Teachers' Mathematics Instruction Decisions Relate to MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE

INTRODUCTION
The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES.

RESEARCHERS
Academic Degree of Responsible Principal Investigator: Dr. Melva Grant
College: Darden College of Education, **Department**: Teaching and Learning
Ms. Raleta Summers Dawkins, Doctoral Student, Department of Teaching and Learning, Old Dominion University, Darden College of Education

DESCRIPTION OF RESEARCH STUDY
The study aims to explore early childhood teachers understanding of the components of mathematics pedagogical content knowledge and mathematics pedagogical content knowledge level. If you decide to participate, then you will join a study involving research of early childhood mathematics. If you say YES, then your participation will include: three interview sessions and three classroom observations.

EXCLUSIONARY CRITERIA
You should be a lead pre-Kindergarten teacher at a learning center who works with students between the ages of three and five years old.

RISKS AND BENEFITS
RISKS: There are no foreseeable risks associated with participating in this study
BENEFITS: The main benefit to you for participating in this study is: understanding your participation may advance the field of early childhood mathematics.

COSTS AND PAYMENTS
The researchers want your decision about participating in this study to be absolutely voluntary. Yet they recognize that your participation may pose some inconvenience of time if the interview runs over the projected 30 minutes it is estimated. The researchers are unable to give you any payment for participating in this study.

NEW INFORMATION

If the researchers find new information during this study that would reasonably change your decision about participating, then they will inform you.

CONFIDENTIALITY

All information obtained about you in this study is strictly confidential unless disclosure is required by law. The results of this study may be used in reports, presentations and publications, but the researcher will not identify you.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of negative consequences arising from this study, neither Old Dominion University nor the researchers can give you any money, insurance coverage, free medical care, or any other compensation for such injury. If you suffer injury as a result of participation in any research project, you may contact Dr. _______________ 757-683-3460 at Old Dominion University, who will be glad to review the matter with you.

VOLUNTARY CONSENT

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later, then the researchers should be able to answer them:

Investigator(s): Dr. Melva Grant and Raleta Summers Dawkins
Phone number: 757.683.6263 336.259.5252
Email: mgrant@odu.edu rsumm002@odu.edu

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should contact Dr. _____________, Chair of the Darden College of Education Human Subjects Review Committee, Old Dominion University, at ______________@odu.edu. And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study.

Participant's Printed Name & Signature	**Date**
Parent / Legally Authorized Representative's Printed Name & Signature (If participant is a minor or incapacitated adult)	**Date**

INVESTIGATOR'S STATEMENT

I certify that I have explained to this participant the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the participant's questions and have encouraged him/her to ask additional questions at any time while this study. I have witnessed the above signature(s) on this consent form.

Investigator's Printed Name & Signature	**Date**

APPENDIX D

RESEARCHER DOCUMENT FOR CLASSROOM OBSERVATIONS

<u>Key Math Ideas</u>
Counting and Cardinality
Operations and Algebraic Thinking
Number and Operations in Base Ten
Measurement and Data
Geometry

Time	**Activity Setting** Whole Group, Free Choice Centers (specify), Teacher Mandated Stations, Small Groups, One-on-One, Meals/Snacks, Outside, or by Chance	**CCSSM Domain** Counting and Cardinality, Operations and Algebraic Thinking, Number and Operations in Base Ten, Measurement and Data, Geometry	**Actions Observed** Direct Instruction or Indirect (be specific with actions: Integrated Curriculum, Reading, Vocabulary Building, Technology, Gross Motor Activities, Fine Motor Activities, Informal Conversation)	**Context of Teacher** Behavior Reflecting, Scaffolding	**What element of** mathematics pedagogical content knowledge does the observed behavior reflect knowledge of (M P C) Was it Intentional/ of Unintentional mathematic interaction?

APPENDIX E

SEMI-STRUCTURED INTERVIEW PROBES

Opening Script: Good (morning, afternoon, evening) _________, my name is Raleta Summers Dawkins and I would like to thank you for agreeing to participate in this interview relating to teachers' perspectives and beliefs towards their mathematic teaching in pre-K. This interview should take about 30 minutes. I am very appreciative of your time. Before we get started, please take a moment to review the consent form we discussed during our initial meeting. Do you have any questions about the consent form, or the purpose of this study? Please be assured that the confidentiality of your identity and the responses that you provide will be kept strictly confidential. If at any time during the interview you choose to opt out, I will respect your prerogative to do so. May I record this interview? Do you have any questions for me before we begin this interview?

Major question 1 (**first interview**): How do pre-K teachers describe the personal life experiences that have impacted your mathematical teaching beliefs and instructional decisions?
Supportive probes if necessary.

1. What experiences guided your career choice?
2. What do you remember about your school experiences, former teachers that shaped your understanding of and your affect for mathematics?
3. What do you remember about experiences that made you feel in such a way?
    a. Would you share some specific examples?
4. Think for moment, how would you describe the impact pre-K has on students?
5. How would you describe your philosophy of education?
6. Based on your philosophy, how would you describe your pedagogical practices?
7. Can you share how you craft your lesson plans?
    a. Do you use a specific curriculum?
    b. What is that?
    c. Do you use state or national standards?
8. Tell me your thoughts on early childhood mathematics.
9. Would you describe your most recent experience with mathematics in your classroom?
10. How has that above experience impacted your facilitation of mathematics instruction?
11. Would you share some examples of mathematics experiences you have observed where your students were engaged in mathematics?
12. Thinking about your knowledge of mathematics, please share content knowledge you are comfortable with teaching?
    a. What shaped this?
    b. Could you be more specific or share more details?
13. From your experiences, what do you think is appropriate mathematics for pre- students?
14. Using five words or less, how would you describe your feelings about mathematics?

We are nearly at the end of our interview. I have just a few final questions.

1. Is there anything about preschool mathematics you find interesting?

2. Is there anything that I did not ask you that you think may be important>
3. Is there anything else you would like to add, share, or questions you ever wanted to ask about pre-K mathematics?

Thank you kindly for spending part of your afternoon with me. I truly enjoyed hearing about your experiences with mathematics.

Major Question 2 (**Second Interview**): **In today's interview, we will talk about your knowledge of mathematics pedagogical content knowledge, and how yours has evolved since entering the classroom.**

Probes to consider if necessary:

1. Do you know what mathematics pedagogical content knowledge is?
    a. What makes it up?
    b. How it develops?
2. What domains, strands, and processes of mathematics are taught in your classroom?
    a. What type of math is taught in your classroom?
3. Tell me about how students learn mathematics.
4. What do you think your role is in helping them learn these skills or concepts?
5. Would you share experiences where you have facilitated learning of mathematics domains, processes, and strands in your class?
6. Have you taken any courses or gone through professional development that focused on mathematics for early teachers or mathematics in early childhood environments?
    a. **If yes:** Please tell me about those experiences/
    b. **If no:** did you take any math methods courses in your degree program that focused on early childhood mathematics, how to teach, assess, extend or integrate math with other subjects for young students?
7. Can you tell me what you know about CCSSM?
    a. How has CCSSM impacted your mathematics instructional decisions?
8. What grades, if any, have you taught aside from pre-K?
9. What are your thoughts and beliefs about young students; capability in understanding and mastering math concepts?
10. Does your center use a specific math curriculum?
    a. **If yes**: what curriculum?
    b. **If no**: What guides what types of math you teach?
11. What are the three most important math concepts young students should master by the end of preschool to be successful in kindergarten?
12. Please share your examples
13. What are some approaches you take to facilitate math development in young students?
14. Do you incorporate mathematics into the children's daily routine? How so?
15. Do you use learning centers?
16. What learning centers are available during free play to your students?
17. What concepts of mathematics are available in each of those centers?

Centers	Concepts	Is this observed during the 1st observation?

18. Describe your rationale or what guides your decision to embed math-focused activities into your centers?
19. Can you share other instructional methods, strategies, or activities that you used to integrate mathematics into other content areas such as language arts, science, social studies, art, music, and movement?

We are nearly at the end of our interview. I have just a few final questions.

1. Where there any aspects of our conversation that surprised you today?
2. Is there anything that I did not ask you that you think may be important>
3. Is there anything else you would like to add, share, or questions you ever wanted to ask about pre-K mathematics?

Thank you kindly for spending part of your afternoon with me. I truly enjoyed hearing about your experiences with mathematics.

APPENDIX F

DEMOGRAPHIC QUESTIONNAIRE

1. How many years have you been an early childhood teacher? _____

2. Current work setting (please check all that apply):

3. _____ Private preschool _____ Public preschool

Housed in a:

_____ religious facility _____ commercial facility _____ home facility

4. What is your race/ethnicity? ___________________________________

5. What is your gender? _____ Female or _____ Male

6. What is your age? _____

7. What is your yearly household income?

   _____ Below $21,000 _____ $21,001 - $35,000 _____ Above $ $35,001

8. Highest degree attained? _____ Associates Degree _____Bachelors _____ Masters _____ Advanced certificate/degree _____ Doctorate _____ Other (please list): _______________

9. Have you received prior early childhood mathematical professional development, teacher preparation, other training? _____ **Yes** or _____ **No**

10. Please list the early childhood mathematical professional development, teacher preparation, other training you have participated.

    ____

    ____

APPENDIX G

RESEARCH TIMELINE

Research Timeline

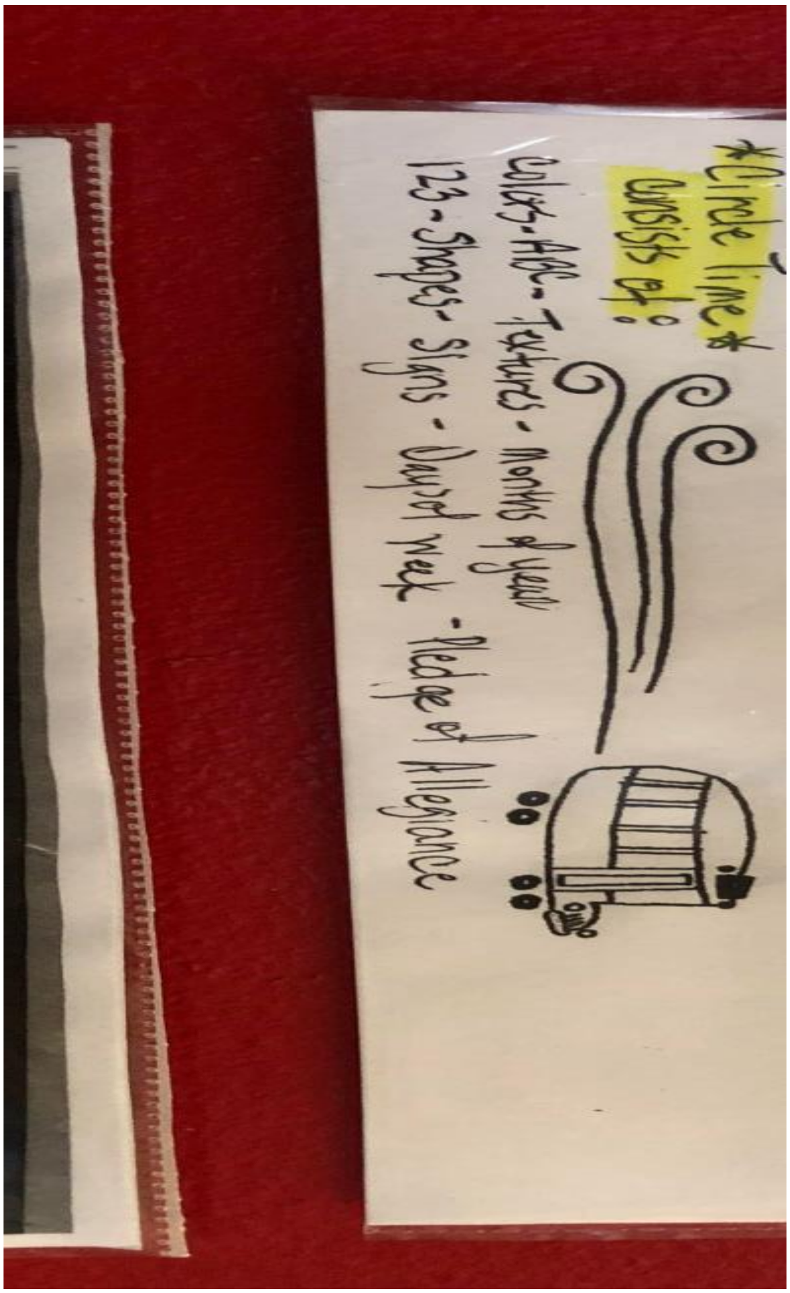
Month (time estimate)	Research Task
August 2018	Prepare IRB application Proposal approved by dissertation committee Revise IRB application based on DC recommendations Submit and receive IRB approval
August/September 2018	Reconfirm permission still granted for research to take place at targeted pre-K facilities Schedule meetings with potential participants Describe the study and expectations verbally and in writing to interested participants ● Have participants complete consent forms ● Describe study, expectations, and answer questions for ● Center directors and interested teachers ● Leave copies of signed consent forms for center directors and teachers ● Collect teacher information forms ● Schedule site visits for classroom observations, post-pre interviews, and survey collection dates.
September - December 2018	Data Collection: 3 classroom instructional observations per teacher ● Observations: 3 – 4 hours each visit 3 weeks of mathematics instructional lesson plans to review following each observation 2 Post-Pre-Interviews per teacher ● 30 – 45 minutes each Collection and review of any available mathematics curriculum
November 2018	Collect the *Mathematical Development Beliefs Survey* from participants
December 2018	Administration of the *Preschool Mathematics Pedagogical Content Knowledge Interview*
September 2018 – February 2019	<u>*Validity Testing*</u> Member checking at follow-up interviews with teachers
Repeat multiple times as data corpus grows	<u>*Qualitative Data Analysis*</u>

Month (time estimate)	Research Task
	● Create field notes based on analysis ● Draw preliminary conclusions based on data and reflections ● Make data collection adjustments based on preliminary findings ● Listen to teachers' audio taped interviews and selectively transcribe ● Create field notes based on audio and transcriptions ● Draw preliminary conclusions based upon data, theory, and ● Reflections ● Make data collection adjustments based on preliminary findings
	Data Analysis ● Listen to interview audio tapes, transcribe, and code using the conceptual framework ● Review and code surveys using the conceptual framework ● Create field notes based on audio and transcriptions ● Draw preliminary conclusions based upon data, theory, reflections, and preliminary findings
	Data Collection ● Schedule additional data collection cycles as needed to fill data collection/analysis gaps
January 2019	*Preliminary Write Up* Begin preliminary write up of findings
August 2019	*Final Draft Write Up* ● Continue preliminary write up of findings ● Begin final report write up of findings using dissertation format ● Review earlier chapters of report and adjust as needed
April 2019	*Final Data Analysis* ● Review findings and warrants ● Critically reflect on the strength of claims and warrants ● Identify additional warranting data examples as needed to strengthen analysis
September 2019	*Final Write Up* ● Submit initial dissertation draft to the committee for review

Month (time estimate)	Research Task
	● Revise per feedback and resubmit as needed ● Schedule Dissertation Defense
November 2019	*Dissertation Defense* Meet with the committee to defend dissertation (1st or 2nd week of June)

APPENDIX H

REGINA'S PLANNING NOTE



VITA

Raleta Summers Dawkins
Department of Teaching and Learning, Old Dominion University
3101 Education Building
Norfolk, VA 23529

Education

MASTER OF ARTS in EDUCATION	North Carolina A&T State University, Greensboro, NC *Elementary Education* **2008** *National Board Certification* **2011**
BACHELORS of SCIENCE	North Carolina A&T State University, Greensboro, NC *Elementary Education* **2004**

International (Refereed) Presentations

Austin, N., & **Summers, R**. (2014). Early childhood development & play therapy: Socio-emotional implications for supporting young children with behavioral issues. *Play Therapy Institute*, Reggello, Italy.

Crompton, H., Burgin, S., De Paor, D., Gregory, K., & **Summers, R**. (2014). A qualitative study to investigate the use of mobile learning to facilitate student questioning in a large university classroom. *The World Conference on Mobile and Contextual Learning*. Istanbul, Turkey.

Presentations (Refereed)

Summers, R. (2014, October). Are you good math? *North Carolina Council of Teachers of Mathematics*, Greensboro, NC.

Lester, A., **Summers, R**., Pettiford, L., & Cherry, S. (2010). Mathematics in pre-kindergarten classrooms. **Presentation** for Guilford County Schools' Pre-Kindergarten Professional Development Day.

Summers, R. (2007). Integrating manipulatives in pre-K–2nd grade. **Presentation** for Guilford County Schools' Professional Development Day.

Presentations

Crompton, H., Burgin, S., De Paor, D., Gregory, K., & **Summers, R.** (October, 2014). Questions and answers in large undergraduate classrooms. *Provost Conversation*, Old Dominion University, Norfolk, VA.