1-1-2020

Teacher Perception of Inquiry-Based Teaching in Mathematics in Early Childhood

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College of Education

Dissertation submitted to the Faculty of the College of Education

in partial fulfillment of the requirements for the degree of

Doctor of Education in

Transformational Teacher Leadership

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Concordia University–Portland

2019

Abstract

Inquiry-based instruction has been pivotal in transforming classrooms into engaging student-centered learning environments. Utilizing inquiry-based instruction in mathematics in early childhood can help build a strong foundation in mathematics. This qualitative study examined the perceptions of teachers and administrators on inquiry-based instruction in early childhood mathematics. This study was guided by three research questions. This study took place at two public schools in NYC. Data was collected through a preinterview survey and interviews. The participants included nine teachers and three administrators. During the analysis process five themes were revealed: professional development, planning and preparation, student engagement, building foundational skills, and curriculum. Many participants felt strongly about the impact of inquiry-based instruction on student engagement and building foundational skills. Some of the participants revealed an increase in student achievement when inquiry-based instruction was implemented in math class. It was also revealed that professional development is vital for teachers to be successful in implementation of inquiry-based instruction. Working together teachers and administrators believe inquiry-based instruction can have a positive impact on students' success in mathematics. Inquiry-based instruction in early childhood mathematics can have a positive impact on student engagement and student achievement.

Keywords: inquiry-based instruction, mathematics, early childhood, student engagement, teacher perceptions, student centered

Dedication

Through love and support all things are possible. These people have been the guiding forces throughout this journey. My parents, gone but not forgotten, you have taught me to work hard and never stop learning. Your love and strength live on in me. My wife, you supported me each and every day, without you this would have never been possible. My two babies Arya and Ayan. May this be a symbol of the endless possibilities life can hold. My sisters, for always believing in me and provided that positive energy. My aunt and uncle for always being by my side. Lastly, my family and friends who have given me love and friendship to endure this process.

Acknowledgments

I would like to thank Dr. Kluth for all your support and positive energy during the entire process. Dr. Kluth has been a commendable force throughout this journey, he has helped me grow and learn. I would like to thank both Dr. Smith and Dr. Alford for sharing their knowledge with me. Their expertise has helped and guided me throughout this process. Their guidance has aided in my growth as a researcher and educator.

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Chapter 1: Introduction

Many educators are teaching a narrowed curriculum to meet the demands of high-stakes tests, which are used to make vital decisions regarding students for the accountability purposes in education (Bailey, 2018). Studies indicate that high-stakes testing is a major reason why teachers reduce the amount of student-centered instruction and interaction in classroom settings, thereby giving way to less time for inquiry learning and critical thinking (Bailey, 2018; Fickel, 2006). High-stakes testing has also been found to employ a high level of standardization to the point of yielding negative effects on students' skills for problem-solving and critical thinking (Ohanian, 1999; Ross, Mathison, & Vinson, 2014). The implications of such negative effects on students' skills for problem-solving and critical thinking is considerable, given that problem-solving and critical thinking skill sets are essential for students to excel academically and professionally in the future (Cooper & Murphy, 2016; Jensen, 2016; Mertler, 2014).

Prekindergarten and kindergarten students should be taught how to think critically and problem-solve given the demands of the Common Core state standards. Several researchers have delved into the study of effective methods of teaching and instruction to improve problem-solving and critical thinking skill sets for students (Dooley, Dunphy, & Shiel, 2014; Sumarna, Wahyudin, & Herman, 2017; Wu, 2014). Wu (2014) and Dooley et al. (2014) found that mathematics instruction under the Common Core state standards effectively moves the focus of teaching the material toward allowing students to develop problem-solving and critical thinking skills of their own. According to researchers, early childhood mathematics sets the foundation for becoming a critical-thinker and acquiring problem-solving skills (Dooley et al., 2014; Wu, 2014). A study conducted by Sumarna et al. (2017) indicated there is a significant correlation between critical thinking skills and mathematical skills acquired in elementary years. A

substantial difference is evident in the improvement of critical thinking ability of elementary students who receive more mathematical exercises and lessons compared to those students with less mathematical exercises (Sumarna et al., 2017). Critical thinking skills are proven to refine a student's capability to process analysis, evaluate, and synthesize solutions with the practice of solving a mathematical problem (Dooley et al., 2014; Sumarna et al., 2017; Wu, 2014). Mathematics is known to be a source of stress for young students, creating math anxiety, which contributes heavily to underachievement (Sorvo et al., 2017). According to Sorvo et al. (2017), students develop this stress early in their education and it is one of their greatest obstacles in comprehending the material itself.

Inquiry-based learning is one solution to decreasing the anxiety or fear of mathematics in early childhood students (Bailey, 2018). Inquiry-based learning also builds critical thinking and problem-solving in early childhood classrooms as students become more engaged in the act of learning (Sorvo et al., 2017). Addressing the need to increase student engagement in classrooms is important given that researchers argue a lack of student engagement results in the prevalence of lower academic achievement (Bailey, 2018; Schreck, 2011). Schreck (2011) stated that students learn best when they are highly engaged, and that student engagement in the classroom is most heightened when a positive student–teacher relationship exists. That is, learning occurs only when what is being presented is meaningful enough to the student that the student decides to actively engage in the learning experience (Caine & Caine, 1994). Rogers and Renard (1999) argued that a classroom driven by teacher–student relationships could encourage students to learn and achieve to the highest standard. The use of various teaching strategies such as inquiry-based pedagogy has paved the way to increase learner engagement. Inquiry-based instruction allows for the necessary shifts in teacher and student role to enhance learning (Eckhoff, 2017).

Buchanan, Harlan, Bruce, and Edwards (2016) stated that inquiry-based learning also allows students to make determinations about problems, challenges, and issues they investigate; inquiry-based learning moves the student into a more meaningful engagement and deeper learning (Buchanan et al., 2016). According to Eckhoff (2017) and Buchanan et al. (2016), inquiry-based lessons increase student engagement throughout the lesson by stressing the importance of critical thinking through questioning and discussion. Gaining the skills of inquiry is pertinent for students and their future as citizens in society (Eckhoff, 2017; Sorvo et al., 2017). Inquiry skills can have highly positive implications for students' academic and professional futures (Sorvo et al., 2017).

One important difference between inquiry-style classrooms and traditional classrooms is that in an inquiry-style classroom the educator facilitates students taking ownership of their own learning, whereas in a traditional classroom, students are passive receivers of learning. From the student's perspective, in a classroom applying inquiry-based instruction students will be engaged in inquiry-based learning. Students will be challenged to develop a unique way of thinking where their creativity will be developed in traditionally logic-based lessons (Minner, Jurist Levy, & Century, 2010). This is one of the greatest outcomes of inquiry-based learning, but it is also one of the biggest criticisms of the approach, with pedagogical research indicating creativity may be counter-intuitive to learning mathematics (Capps & Crawford, 2013; Kirschner, Sweller, & Clark, 2006). A problem educators struggle with in deciding on inquiry-based instruction is whether there is even such a thing as inquiry-based learning from the students' perspective (Capps & Crawford, 2013).

While some pedagogical researchers demonstrated inquiry-based learning to be ineffective, others have shown inquiry lessons foster student investigations, working with peers,

being cooperative within groups, and independence (Sorvo et al., 2017). These skills are vital for creating students who are college and career-ready in the 21st century (Sorvo et al., 2017). Twenty-first century skills are vital for today's students as they prepare for the global marketplace (Sorvo et al., 2017). Problem-solving, critical thinking, communication, and reasoning are important competencies for all students to build early in their educational careers as these skills, or the lack of them, can impact adult functioning. Inquiry-based instruction fosters such skills in early childhood (Eckhoff, 2017).

Conceptual Framework

Constructivism in education is a shift in the so-called "standard" or "traditional" teaching practices (Serafín, Dostál, & Havelka, 2015). It is derived from the broader concept of social constructivism, and when applied to pedagogical theory, constructivism shifts the educator's role from lecturer to facilitator (Wu, 2014). Student roles change as well, with the focus shifting from getting the right answer to being able to apply learned strategies in various situations (Serafín et al., 2015). The expectation for students in early elementary classrooms, according to the Common Core state standards, is to apply problem-solving and reasoning skills to solve problems (Serafín et al., 2015; Wu, 2014). For students to be able to accomplish this task, Wu (2014) underlined the importance of teachers' planning and preparing for how they will get their students to acquire the necessary information and to collaborate with peers. Using inquiry-based instruction is, therefore, a relatively intuitive method for information acquisition and learning how to work collaboratively in groups (Abdi, 2014; Ku, Ho, Hau, & Lai, 2014).

Within social constructivism in pedagogical theory, the concept of inquiry-based learning is of paramount importance (Ku et al., 2014; Serafín et al., 2015). Through the processes of inquiry-based learning, the educator creates an environment where the learners are encouraged to

review or reflect upon what they have learned. This does not mean students are simply providing comments on the experience of the task such as “that was fun,” or “that was difficult,” but rather, they are critically analyzing what was so engaging or challenging about the lesson (Costa & Kallick, 2008). According to Costa and Kallick (2008), the critical analysis sets the precedent for the next lesson as it provides the students themselves with an understanding of how they learn, work in groups, and solve problems. Getting to know oneself as a learner is an important outcome of reflective inquiry (Bailey, 2018; Dole, Bloom, & Kowalske, 2016).

Teachers can approach inquiry-based method through questioning students as a group or interviewing them on a one-on-one basis (Costa & Kallick, 2008). With inquiry-based methods, students are also encouraged to keep regular journals and then to periodically reread their journals and contemplate how they have developed over time in their understanding of the material (Abdi, 2014; Costa & Kallick, 2008). Teachers model reflection for students by asking themselves these questions as well and becoming reflective educators who can guide students in these processes of critical analysis (Costa & Kallick, 2008). Over time, as the process is assimilated into the overall inquiry-based instruction paradigm, its function will become clearer (Bailey, 2018; Costa & Kallick, 2008).

Educators who use inquiry-based instruction methods aim to create a risk-free environment where students can successfully take ownership of their own learning (Eckhoff, 2017). In an inquiry-style lesson, the teacher does not front-load information to the students; instead, the teacher’s role is to plan leveled questions to engage all students and bring the learning to a deeper level (Smith, Wenderoth, & Tyler, 2013; Wu, 2014). Questions must be tiered beginning with low-level questions and moving toward higher-order thinking questions to allow for discourse between the peers at wide-ranging levels (Wu, 2014). This is fundamental to

the concept of inquiry and forms the basis upon which a student comprehends progressively more complex lessons.

Inquiry-style lesson plans allow teachers to gradually release responsibility and ownership of learning to the students by providing prompts and supports (Smith et al., 2013). The most notable difference between traditional style lessons and inquiry lessons is that students derive the learning for themselves through play and exploration versus being told by the teacher (Anderson & Cohen, 2015; Minner et al., 2010). Inquiry nurtures students at their entry levels but brings their knowledge to a higher level by allowing them to interact with the material and other students. While the students are exploring and discussing, the teacher must use that opportunity to monitor, track and assess the students' progress (Anderson & Cohen, 2015; Minner et al., 2010). According to Graca (2012), this information will drive instruction and allow the teacher to create a plan for how to move each student to mastery of skills and standards. Through assessments and tracking of mastery, teachers can begin to close learning gaps and differentiate instruction (Graca, 2012; Minner et al., 2010). Inquiry-style lessons afford greater independence in the classroom especially with early elementary students (Graca, 2012).

Statement of the Problem

Inquiry-based instruction is not a new pedagogy. However, it is not extensively used across elementary grades in comparison with traditional paradigms (Marshall, Smart, & Alston, 2017). One concern often expressed by proponents of traditional classrooms is the pedagogies based on inquiry are insubstantial, lacking in research, and therefore too risky to impose on students (Kirschner et al., 2006). Much to the contrary, education theorists such as Vygotsky, Piaget, and Dewey wrote about this method of instruction since the early 20th century (Castronova, 2002). Inquiry gained momentum in the 1960s with the *discovery learning*

movement, which tasked students with learning on their own by using their prior knowledge as a basis for understanding (Matthews, 2014). The paradigms inquiry-based instructors use today are based on a derivation of this system. The theory that undergirds the discovery learning movement and its subdivisions (such as inquiry-based learning) is constructivism, which posits that learning occurs through ontological experience (Abdi, 2014). Constructivism promotes a communal learning experience because of how these experiences should ostensibly build on prior ones and allows students to use one another's experiences as resources (Abdi, 2014). Therefore, instead of learning as an individual, an inquiry-based teacher guides students in how to teach themselves as a group (Abdi, 2014).

Opponents of inquiry-based instruction have continuously expressed an overarching concern that when students lack the leadership of an adult educator, an inquiry-based instruction classroom can become chaotic and much time can be wasted (Kirschner et al., 2006). This concern demonstrates a misunderstanding of what the educator's role is with respect to inquiry-based instruction (Abdi, 2014). According to Abdi (2014), in inquiry-based instruction, educators are directors of lesson activities instead of dictators of those lessons. While there is no so-called standardized structure or roadmap in arriving at the aim of the lesson, this does not mean there is no structure to the classroom or that there is no teacher–student involvement (Abdi, 2014; Correia et al., 2016).

Teachers are pivotal in creating the aims of inquiry-based lessons (Capitelli, Hooper, Rankin, Austin, & Caven, 2016; Sorvo et al., 2017). Teachers are also responsible for clearly explaining expectations, acting as guides where input is needed, and assessing student comprehension (Abdi, 2014). The idea is that by applying constructivist theory, the contents of a lesson can be learned through the active processes of working on activities as a group (Capitelli

et al., 2016; Correia et al., 2016). By contrast, the more passive, traditional process of hearing a teacher's lecture naturally puts students in an isolating position to be lone learners who are summarily taught to think of themselves as such, even among a classroom of peers (Abdi, 2014; Capitelli et al., 2016; Correia et al., 2016).

A standard argument against inquiry-based instruction for math and science is that its premise is wrong for logic-based disciplines (Meijer, Geijsel, Kuijpers, Boei, & Vrieling, 2016). Reville (2015) stated that even though discoveries in math and science are found through the very processes that approximate those that are used in inquiry, inquiry-based methods are inappropriate for teaching basic concepts. Reville's argument was that the basic tenets of math and science are not ideas to be discovered; rather, they are concepts already known which must be conveyed and embraced. Therefore, as opponents of inquiry-based learning suggest, a form of supplying valuable tools for students is teaching concepts by means of front-loading material (Reville, 2015). According to traditionalists, deciding against front loading would be depriving students of critical tools they will need to master mathematics and science at higher levels (Reville, 2015).

Educators against inquiry tend to believe strongly in traditional paradigms, even if those paradigms did not work for them as students (Meijer et al., 2016; Sorvo et al., 2017). When it comes to math and science, educators who support traditional pedagogy believe that a traditional education gives students the capability to make new discoveries (Ku et al., 2014). The argument is students simply cannot make discoveries without formal math and science education where the teacher supplies the tools for students (Ku et al., 2014). For inquiry opponents, there is simply no precedent for students to discover the concepts on their own, particularly because such concepts are foreign to the everyday lives of students (Kirschner et al., 2006; Meijer et al., 2016). This

idea is one of the umbrella beliefs that tends to influence teachers when they decide against using inquiry in the classroom (Meijer et al., 2016).

A specific problem teachers face when creating a student-centered classroom is abandoning control to build student independence (Capitelli et al., 2016; Dole et al., 2016). Teachers do not know what will be expected of them in this kind of classroom and fear what the outcome will be of attempting this process of undoing what most undergraduate education classrooms taught them to do (Anderson & Cohen, 2015). Another aspect of this fear is about student achievement and whether inquiry-based instruction is rigorous enough to progress their students forward to the next grade (Bailey, 2018; Dole et al., 2016). Math teachers who are opposed to inquiry express a concern about achievement gaps more than teachers of other subjects (Bailey, 2018; Kirschner et al., 2006; Olver, 2013). Concerns are prompted mostly because of a prevailing belief the abstraction of mathematical concepts does not lend well to inquiry-based paradigms of learning (Kirschner et al., 2006). However, when early childhood teachers, specifically prekindergarten and kindergarten teachers, use inquiry-style lessons to teach mathematics to students they have a greater success rate, since students learn through play (Olver, 2013). Exposure to inquiry-based teaching increases teacher practice of this approach, and lack of that professional development can significantly impact the use of inquiry in the classroom (Olver, 2013). Through inquiry-based instruction, students develop a strong foundation in mathematical thinking and problem-solving (Kirschner et al., 2006; Olver, 2013).

Olver (2013) recommended further study in developing preservice programs and professional development that support inquiry-based instruction. Kirschner et al. (2006) pointed out research in the area of teacher understanding of inquiry-based instruction needs to be strengthen. Teachers struggle to understand the process of inquiry-based teaching (Kirschner et

al., 2006). Current research is lacking in identifying teacher perceptions of using inquiry-based instruction in early childhood classrooms. Through the presentation of data relating to the perceptions of teachers regarding inquiry-based learning, this would aid to increase the effectiveness of teaching methods to students, thereby effectively managing teachers and elucidating the process of inquiry-based methodology (Kirschner et al., 2006). Additionally, examining the factors that impact the use of inquiry-based instruction in early childhood may help school administrators, teachers, and parents to succeed in achieving an increase in academic performance for students in prekindergarten and kindergarten levels.

Purpose of Study

The purpose of this study was to gain teacher perceptions on inquiry-based instruction in math with early childhood students, specifically in prekindergarten and kindergarten classrooms. The study revealed more insight regarding the details and perceptions about inquiry-based instruction and add to the existing literature in relation to this topic. The study was conducted to address a concern on how to increase student engagement in classrooms given there is a significant correlation between student engagement and academic performance (Dooley et al., 2014; Sumarna et al., 2017). In order to deliver an in-depth understanding of the teacher perceptions on inquiry-based math in early childhood classrooms, one-on-one interviews and preinterview surveys are methodologies that provided the researcher with necessary data to answer the research questions.

Research Questions

The research questions explored in this study are:

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

Nature of the Study

A qualitative case study was conducted to determine the impact of inquiry-based instruction in mathematics in prekindergarten and kindergarten classrooms in two New York City (NYC) schools. A case study allows for responses to questions about present-day issues (Yin, 2014). Case studies are effective research approaches, which use questions, analysis, connecting the data, and criteria for interpreting the findings (Yin, 2014). One reason the researcher chose to conduct a qualitative study is because the existing literature on inquiry-based learning is not often qualitative in nature or based on the perceptions of teachers (Abdi, 2014; Bailey, 2018). This qualitative study was an attempt to engage participants in thinking and experiences around inquiry-style lessons. The focus of this case study was to gain an understanding of teacher perceptions on inquiry-based teaching and learning in mathematics in early childhood. Gaining teacher perceptions' understanding of inquiry-based instruction is instrumental in delving into the factors on how inquiry-based instruction in early childhood could impact the development of mathematical skills, and consequently increase student engagement and improve academic achievement. With this study's objective, a qualitative method was the optimal choice that would allow more flexibility during data collection compared with quantitative methods. The qualitative method was useful in exploring participants' firsthand experiences and perspectives on inquiry-based instruction in educational

settings (Maxwell, 2012; Merriam & Tisdell, 2015; Ritchie, Lewis, McNaughton, & Ormston, 2015).

Several other research design options were considered for the current study such as the research designs of narrative analysis and phenomenology. However, phenomenology involves the process of gathering participants' perspectives based on their lived experience and consequently learning how participants interpret these experiences (Moustakas, 1994). The researcher did not choose the research design of phenomenology given that it was not the aim of the researcher to explore how teachers and school administrators interpret their experiences of teaching, making phenomenology inapplicable for the study. One of the other research design options considered was narrative analysis, which is the analysis of participants' life stories to answer the research questions (Bass & Milosevic, 2018). Given the extent of data gathering from participants, the researcher did not choose this type of research design given that the analysis of the participants' life stories was not necessary. Therefore, the qualitative research case study design was best fit to explore factors that produce teachers' perceptions on inquiry-based learning in mathematics in early childhood classrooms.

The goal of this dissertation study was to explore factors that produce teachers' perceptions on inquiry-based learning in mathematics in early childhood classrooms. This goal was accomplished using one-on-one interviews, preinterview surveys, and the examination of archival documents regarding NYC public schools. The researcher conducted open-ended interviews with nine teachers and three school administrators of NYC public schools. The study was conducted to explore the perceptions of teachers regarding the value of inquiry-based instruction and its effectiveness in early childhood mathematics.

Significance of the Study

The qualitative case study was conducted to gain more knowledge and understanding to teachers' perception of inquiry-based teaching. The purpose of using a qualitative method was to gather in-depth real world data of teacher perceptions (Creswell, 2013). Such knowledge may drive professional development opportunities both within grade bands and school-wide. School administrators who can influence and reach desired student outcomes will benefit from gaining an in-depth understanding of how inquiry-based-teaching is perceived and its value as an inquiry-based instruction. With this information, schools can then have more opportunities for peer coaching, intra-visitations, and collaboration among staff members. This information may also be informative for undergraduate education programs, giving student teachers an opportunity to learn inquiry-based instruction as an alternative method (Anderson & Cohen, 2015). By altering undergraduate programs to include inquiry-based instruction as an option, new teachers will not meet the same issues that seasoned traditional teachers do if teachers decide to employ this methodology of inquiry (Anderson & Cohen, 2015).

Through this study, the researcher was able to determine factors that contribute to teacher perception of using inquiry-based teaching of mathematics in the early childhood classroom. By collecting and analyzing data from surveys, responses to one-on-one interviews with teachers and school administrators, along with data gathered from observation and document reviews, this case study provided more insight into the topic at hand. Understanding how, why, or what is preventing the use of inquiry-based teaching in the early childhood classroom for mathematics is necessary in moving students toward mastery of standards as well as improvement of teaching practices and pedagogy.

Tenured teachers may be unwilling to shift their teaching method based on principle alone (Anderson & Cohen, 2015). As instructors generally become more educated on the research showing the efficacy of inquiry-based instruction, there may be a shift in consciousness that brings the benefits of inquiry-based learning into clearer focus (Bailey, 2018; Dole et al., 2016; Marshall et al., 2017; Sorvo et al., 2017). This study may provide evidence for the efficacy of inquiry-based learning in early childhood classrooms.

Definition of Terms

The following are definitions of terms used in this study:

Differentiated instruction: Differentiated instruction is tailored instruction to meet individual needs, whether content, process, products, or the learning environment (Tomlinson, 2014).

Direct teacher instruction: Direct teacher instruction is instruction led by the teacher with no real interaction with the students outside of asking questions (Kuhn, 2007).

Discovery learning movement: Discovery learning movement is a technique of inquiry-based learning that tasks students with learning on their own by using their prior knowledge as a basis for understanding (Matthews, 2014).

Explore: The concept of explore challenges student preconceptions by connecting new knowledge learned through exploration (Althauser, 2018).

Early childhood education: Early childhood education is a term used to identify programs that teach prekindergarten and kindergarten children.

Inquiry: Inquiry-based learning starts by posing questions, problems, or scenarios—rather than simply presenting established facts or portraying a smooth path to knowledge. A facilitator often assists the process. Inquirers will identify and research issues and questions to develop

their knowledge or solutions. Inquiry is defined to be the methodical process of diagnosing problems, critiquing experiments, and distinguishing alternatives. This also includes planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments (Linn, Davis, & Bell, 2004).

Inquiry-based learning: Inquiry-based learning is a strategy in the educational context in which students follow methods and practices similar to those of professional scientists in order to construct knowledge. This method is also known as a learning process concerning the discovery of new causal relations, with the learner formulating hypotheses and testing them by conducting experiments and/or making observations (Pedaste et al., 2015). According to Branch and Solowan (2003), inquiry-based learning is defined as a student-centered approach to learning focused on the asking of questions, critical thinking, and problem-solving that enables students to develop skills needed throughout their whole lives.

Traditional education learning: Traditional education learning is a method of learning in the educational context defined as a teacher-centered delivery of instruction to classes of students who are the receivers of information. Traditional schools employ this learning method by underlining basic educational practices and expect mastery of academic learning in the core subjects of math, reading, writing, science, and social studies (Minner et al., 2010).

Assumptions, Limitations, and Delimitations

All research involves interpretation. Researchers view and interpret meaning through their own viewpoint of how they understand the world to be (Creswell, 2013; Maxwell, 2012). This section discusses the assumptions, delimitations, and limitations that could have impacted the results of the study.

One key assumption identified is the nine teachers and three school administrators of NYC public schools interviewed for this study would be open about their viewpoints and experiences. Additionally, the researcher assumed the respondents would be honest in their answers even if, in some cases, it might be uncomfortable due to the questions asked. Being objective and having open discussions with least restrictive questions provided more objective data (Patton, 2014).

Patton (2014) pointed out that a researcher must also be aware of the limitations in order to find the best approach. One of the key limitations considered in this study was the sample population; this study was limited to the teachers who worked at the two schools. The limitation in terms of number of schools was due to the constraint in time to conduct this study. As such, these schools were selected because of the existing inquiry-based teaching incorporated in their educational system through professional development and curriculum. There was also the limitation of working under the Charlotte Danielson's framework given that the setting was in NYC, where teacher ratings are based on the Charlotte Danielson's framework. The framework consists of four domains (planning and preparation, classroom environment, instruction, and professional responsibility) and sets the foundation for teaching and learning in NYC's public schools.

Environment limitations play an important role in this study. One limitation includes lack of honesty and in some cases level of comfort with the questions being asked. Some participants might fear possible retribution for speaking negatively about the topic. This may yield some of the data as not credible. As Patton (2014) explains open questions in the participants own environment may provide more objective data. Additional limitations include observer biases in response to observational data.

Simon and Goes (2011) stated delimitations are the traits of a particular study that control and outline the study's parameters. In this case study the objective was to gain a deeper understanding of teachers' perceptions regarding the value of inquiry-based learning. One of the delimitations identified in this study was the fact it was conducted within NYC; therefore, it was not generalizable to other countries or regions in the world. Another delimitation in this study was participants interviewed were NYC public school teachers in prekindergarten and kindergarten and NYC public school administrators and all participants had at least three years of teaching experience. The sample population was delimited to nine teachers and three school administrators at two sites. This was done in order to keep the total data corpus at a manageable level. With this delimitation, the findings of this study are not generalizable to the larger population of teachers in various other school levels. Being aware of these assumptions, limitations, and delimitations is important to preserving the integrity of the research and the participants (Patton, 2014). Purposeful sampling was also used in this qualitative research study for the documentation and collection of case studies associated with a specific topic (Palinkas et al., 2015).

Summary

Research supports the use of inquiry-style teaching as one of the most effective approaches to engage students in learning and to build confidence among students in prekindergarten and kindergarten classrooms (Althauser, 2018; Anders & Rossbach, 2015; Lewis Presser, Clements, Ginsburg, & Ertle, 2015; Sorvo et al., 2017). Althauser (2018) explained how using inquiry-based lessons allows teachers to close learning gaps that affect how students learn and process mathematical concepts. Professional development and teacher training programs are crucial in implementing successful inquiry-based learning mathematics classrooms (Althauser,

2018; Anders & Rossbach, 2015; Haslip & Gullo, 2017; Lewis Presser et al., 2015; Meier & Khales, 2013). Sorvo et al. (2017) explained when teachers are well trained in the inquiry-based instruction process they are more confident in utilizing this method.

Chapter 2 provides a review of contemporary literature on inquiry-based learning paradigms and their efficacy in the classroom. The literature review builds a strong case for applying inquiry to mitigate the issue of math anxiety and looks at where this anxiety comes from, enabling the researcher to see how it is partially a result of the educators' own math anxiety. The research in Chapter 2 also explores math anxiety as a cycle between the students and the teacher, even stemming from the teacher's experience as a student. Special attention is given to the practical application of inquiry in math lessons and the ways those lessons can reduce achievement gaps for generations of students to come.

Chapter 2: Literature Review

Introduction

Mastery of skills and reinforcement through repetition has been the trend in teaching mathematics in the early childhood classroom. Students are taught to memorize numbers, shapes, and early computations through repetition (Sorvo et al., 2017). Math anxiety in both early childhood and childhood education is rooted in how students learn math early on (Sorvo et al., 2017). In order to raise the level of confidence in math and develop proficiency students need to deepen their mathematical thinking. Preparing students to meet the demands of the 21st century is at the core of educational reform. In the process of examining how educators can prepare students to meet these demands it is vital to evaluate the impact of mathematics on their future. In their research, Public Policy Forum (2009) found the significance of science, technology, engineering, and mathematics (STEM) education to the workforce. The jobs in highest demand during the 21st century will continually be those requiring STEM skills. Due to the rate at which technology is evolving, Public Policy Forum found that this trend is inevitable and therefore it is vital to ensure that the future workforce is prepared in STEM while in their childhood classrooms. This study was conducted to examine how inquiry-based lessons will make this possible by fostering critical thinking and deepening understanding of mathematical concepts in prekindergarten and kindergarten.

Inquiry-based teaching brings new light to traditional classroom settings (Eckhoff, 2017). Inquiry-based lessons involve student engagement throughout the lesson and greater emphasis on critical thinking and discussion. Through the inquiry process, educators facilitate students to become the drivers of their own knowledge acquisition. Inquiry lessons engender collaboration, critical thinking, discussion, problem-solving, and independence. These skills are vital in the 21st

century and will foster a growth mindset in all learners. As society continues to grow in a global interdependence culture, educators must look to foster the skills that humans need to succeed in such a climate. Using inquiry to drive instruction can help educators create successful classrooms of 21st century students.

In this chapter, a complete review of the literature begins with the importance of both teacher understanding and student achievement. The research questions addressed by this dissertation were,

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

The goal for this inquiry in math for early elementary public schools in NYC was to identify ways to help teachers release the responsibility and ownership of learning to the students. This will in turn increase student achievement with math skills and strategies specifically with students in grades prekindergarten and kindergarten. Fostering this growth in early childhood will set the foundation for deeper conceptualization in mathematics in elementary and secondary classrooms.

The search strategies used for collecting sources include keywords that were constantly refined. The key terms and phrases used in the literature search included *inquiry in the early childhood classroom, inquiry AND mathematics in early childhood, mathematics AND inquiry, teacher education in mathematics, discovery learning movement, kindergarten, prekindergarten,*

and *teacher training.* These searches were conducted using databases such as JSTOR, ERIC, ProQuest, and ProQuest Educational Journals. Through examination of the sources a confirmation was made that inquiry-style lessons impact student learning as well as their depth of understanding. There is evidence to support inquiry-style lessons also increase student engagement and achievement in the lower elementary grades (Eckhoff, 2017). These resources provide different perspectives and data, which will be useful for schools to successfully implement this approach, while also highlighting what needs to be considered for effective applications of the approach. This review also focused on the role of teacher's knowledge of teaching math with inquiry (Kubicek, 2005). Preservice programs are vital to teachers understanding and confidence of the inquiry-based learning paradigm. Through the literature search it was discovered that increasing student achievement through inquiry-based lessons should be advocated in preservice teacher preparation programs (Hourigan & Leavy, 2017).

Conceptual Framework

This study was completed using a conceptual framework positioned in constructivism that applies to a shift in teaching practices. The topic of study was inquiry in math for students in prekindergarten and kindergarten in elementary public schools in NYC. Inquiry-style lesson plans help teachers to release the responsibility and ownership of learning to the students. The most significant difference from traditional style lessons and inquiry-based lessons is students derive the learning for themselves versus being lectured to by the teacher. With inquiry-based lessons, the core principle is engagement through cooperation and problem-solving among peers. Direction from educators is certainly a requirement; however, dictation is not central as it is in traditional style lessons (Smith, Sheppard, Johnson, & Johnson, 2005).

One of the main dangers with traditional style and dictative pedagogies is that although there is a time and place for that type of instruction, student focus and differentiation is limited. When students lose interest in the topic or are frustrated because the material being presented is either too easy or difficult, they begin to misbehave (Skinner, Kindermann, & Furrer, 2009). This makes teaching and learning more difficult. Instructional time is wasted on re-teaching material in various ways. By contrast, engagement pedagogies such as inquiry-based learning are better able to address student comprehension issues as they arise in the moment so that students are less likely to fall behind (or feel bored). This is because the core idea to inquiry is student engagement (Smith et al., 2005).

Targeting student interest through engagement is indeed a foundational principle of the inquiry-based method. Educator Russ Edgerton defined inquiry-based learning in 2001 as one of several pedagogies of engagement that work by emphasizing student participation and deemphasizing traditional lecture-based teaching (Smith et al., 2005). These pedagogies of engagement are a compendium of education paradigms that focus on greater student-faculty cooperation as pivotal to lowering achievement gaps and preparing children for the challenges of being in the 21st century workforce (Smith et al., 2005). Among these paradigms, inquiry-based education has shown itself to be among the most efficacious for learners from early childhood through undergraduate university level (Smith et al., 2005).

One of the major advantages of inquiry is that it allows students to work at their own ability level and learn from one another through investigation. Kubicek (2005) made an argument for learning through investigation, especially with respect to science lessons, by describing how it is designed to stimulate the mind and make learners curious about the next lesson. The teacher's role in this type of lesson is to assess students' entry point and plan for how

to move students to the next level on the continuum of the learning standards and learning outcomes for a particular skill or unit of study. Teachers can then close the learning gaps by taking differentiating lessons, tasks, and questions to gain the missing understanding to fill those gaps. The student role in inquiry is to explore the learning and acquire it from a point of exploration versus from the teacher lecture.

Theoretically, there is more possibility for inquiry-based lessons to make an impact on students in this manner because exploration positions them to make their own discoveries (Glassman, 2001). By contrast, learning from a teacher standing in front of a classroom and asking them to memorize facts does not compel learners in the same manner. As Kubicek (2005) explained, the reason for this has to do with the fact that exclusively lecturing to students and requiring them to memorize facts as the basis of their education "emphasizes teaching the conclusions of others" (p. 2). This does not give the student as much of an incentive to personally invest in the lesson, and there is a greater likelihood that the children will lose interest and fall behind (Kubicek, 2005).

To create positive reinforcement structurally within the inquiry paradigm, applying the concept of scaffolding can be highly useful (Glassman, 2001). Scaffolding is an education concept in pedagogical theory created by Lev Vygotsky in the early 20th century and is relatively intuitive for an inquiry classroom (Glassman, 2001). When using scaffolding in inquiry, a lesson is approached as a series of steps, and each step involves an activity that is interactive for the students (Hmelo-Silver, Duncan, & Chinn, 2007). Tapping into prior knowledge is essential, as every step builds on a previous level of knowledge, called a proximal zone of development (Hmelo-Silver et al., 2007).

Using proximal zones of development to "scaffold" learning allows students to relate the lessons to themselves in a way that is practical and assists them in building on their own knowledge base in a way that is intuitive. As such, applying scaffolding can be especially useful in inquiry when teaching the abstract mathematical concepts that math-anxious students do not easily assimilate into their knowledge base (Hmelo-Silver et al., 2007). Unlike in the traditional style, scaffolding through inquiry does not impose these seemingly foreign concepts on students in a way that can often be received as burdensome and irrelevant.

It is important to consider that every teaching method has pros and cons. One of the most critical articles about inquiry-based learning and paradigms of engagement was written by Kirschner et al. (2006). Toward the start of the 21st century pedagogical researchers Kirschner et al. published an article reviewing contemporaneous studies on applying nontraditional, constructivist pedagogies. Kirschner et al. found the practical application of these pedagogies (which included inquiry-based) results in classroom dysfunction, where there is little cohesion to the classroom at large. Disorganization results and students do not benefit from the lesson and can fall behind academically.

In addition to finding studies showing inquiry-based classrooms as prone to disorganization, Kirschner et al. (2006) found research where teachers trained in the traditional style can have a difficult time altering the structure of lessons for inquiry-based classrooms. To avoid this, it is imperative that teachers know how to set expectations and that these expectations be made clear to the students as well as the guidelines for how they will work collaboratively in the group with their peers. Expectations give the class a goal to reach so that they have an aim and a focus for the tasks they are doing together (Barron & Darling-Hammond, 2008).

In inquiry-based classrooms it is also important for teachers to ensure all students are actively engaged and participating in the task and that they are learning what is intended (Barron & Darling-Hammond, 2008). Teachers must be prepared with not only a well-developed lesson plan, but also with rubrics, checklists, monitoring systems, and behavior systems. In their lesson plans, teachers must group the students based on data and have leveled questions and roles for each student to ensure all students have access to the learning and are able to participate within the group. Lott, Roghaar, Price, and Wallin (2013) discussed how inquiry begins in science to draw students into the process and teaches them to think outside the box in early childhood classrooms.

The struggle for many progressive early childhood classroom teachers is not necessarily whether to choose inquiry, but how to begin developing inquiry-based lessons in math. There is a consensus among early childhood teachers that play and inquiry are vital components of the learning process (Lott et al., 2013). Research by Hourigan and Leavy (2017) has evidenced that early childhood students thrive on play. As such, using play as a framework for inquiry can perhaps develop better mathematical reasoning than modern pedagogy has considered thus far.

Engaging students in a process of exploration and inquisition builds a foundation that supports learning throughout their lifetime. Examining early childhood classrooms is essential to this present research because the foundation of learning in schools is in the early childhood classroom. The purpose of inquiry is to use data-driven instruction to decrease student-learning gaps and increase student achievement. The resources utilized confirm inquiry-style lessons do decrease learning gaps and increase both engagement and achievement in lower elementary grade students. The articles and resources not only break down the information for teachers as to

how to implement this approach, but also what to take into consideration in order to make the approach successful.

The variables that should be considered are demographics, school resources, teacher training, professional development, knowledge of support staff and administration, and teacher engagement. Research has demonstrated there is a vital link between teacher confidence in math instruction and student performance (Public Policy Forum, 2009). When that link is not made, it implicates student performance and creates greater issues as students move through elementary school. Math is more of a necessity today than it has ever been. To meet the demands of the 21st century students need a strong foundation in mathematical reasoning and concepts (Public Policy Forum, 2009).

Review of Research Literature and Methodological Literature

This section reviews the contemporary literature on kindergarten and Pre-K math education using the inquiry-based learning paradigm. For ease of understanding, the section is subdivided by concept into six smaller sections. These sections are titled as follows: (a) anxiety in mathematics, (b) student engagement, (c) student learning gaps, (d) student achievement, (e) teacher pedagogy, and (f) technology.

Anxiety in mathematics. Haslip and Gullo (2017) conducted a review of the literature to understand where exactly math anxieties stem from in the learning process. Haslip and Gullo found anxiety may come from the teachers themselves, many of whom feel unprepared in mathematics and lack confidence in teaching math concepts in the early childhood classroom (Haslip & Gullo, 2017). This lack of confidence transfers to students and the cycle continues. Math becomes a chore, a subject that must be taught because it is part of the curriculum rather than because it may interest or compel learners to greater intrigue (Wilson, 2014). The failure at

confidence in mathematics has been a problem in education for several decades (Wilson, 2014). Wilson (2014) made a secure case for the importance of educator training programs in teaching math. Foremost, to grow strong math thinkers, teachers need to have confidence in teaching math (Wilson, 2014). Confidence in teaching math requires training to deal with the math anxiety felt by many students that influence gaps in achievement (Haslip & Gullo, 2017).

Cultural ideas that math is difficult are another roadblock to achievement and contribute to math anxiety, but the inquiry method has been shown to help with this perception (Master, Cheryan, Moscatelli, & Meltzoff, 2017). Master et al. (2017) completed an empirical study in a traditional first grade classroom to determine the impact of using technology and inquiry to promote confidence in STEM among young learners. In the study, 98 first-grade students (49 girls and 49 boys) were interviewed to determine the kinds of stereotypes and biases they held regarding their ability in STEM. The researchers determined from the interviews that the subjects lacked confidence in solving math, science, and robotics problems. In the second part of the study, the students were given interactive STEM-related lessons in robotics and programming, analogous to those used in the inquiry method. At the end of the study the students reported greater self-efficacy, interest, and confidence in math, technology, and science (Master et al., 2017).

Master et al. (2017) concluded the hands-on approach made the learning significant and real to the students. Even more relevant to the overarching topic of inquiry-based learning, Master et al. also discovered the lack of motivation and confidence in the subjects could be traced to the traditional style learning classrooms in which they had been educated. As is the case in traditional, dictative style teaching, the students did not learn how to operationalize the concepts in their math class. When students are not motivated in the classroom the gaps in

mathematical achievement widen. As Master et al. found, using inquiry in the early childhood classroom may help educators increase the number of students entering STEM fields.

Addressing the issues of math anxiety can be a driving force in implementing inquiry-based lessons in the early childhood classroom. To ensure math anxiety is tackled early on, teachers need to be well trained and wield confidence in both math instruction and inquiry. Vartuli, Snider, and Holley (2016) argued professional development that is done right can equip teachers with the confidence they need to support inquiry-based classrooms. Vartuli et al. conducted a study with student teachers as they transition from college to the early childhood classroom. In the study, student teachers engaged in a teacher education program where they were trained using epistemic practice based methods to teach early childhood students. The results of the study were that student teachers were extremely confident in their ability to utilize inquiry-based teaching. The tracking of student teachers as they moved from college to early childhood classrooms was done over several months when classroom observations and teacher interviews were at the heart of the research. The study concluded with identifying the structures that need to be in place in order to secure teacher confidence and ability in teaching inquiry-based lessons in early childhood (Vartuli et al., 2016).

Student engagement. According to Kemple, Oh, and Porter (2015), fostering play in early childhood leads to higher levels of student engagement. Play increases problem-solving skills, creativity, and collaboration. Play allows for the development of both creativity and social skills. When students are engaged in play while learning, they are motivated to stay focused on the task at hand, increasing student engagement and performance (Kemple et al., 2015). Kroll and Meier (2017) added that students in preschool and kindergarten need hands-on learning that

approximates play. Using play in inquiry-based learning provides students greater opportunity to develop critical thinking skills (Kroll & Meier, 2017).

Using a mixed methods approach, Kroll and Meier (2017) collected data on the impact of inquiry-based methods on promoting critical thinking skills and increasing engagement in early childhood classrooms. Collecting data from four medium-sized schools in the greater San Francisco School District included understanding the demographics and faculty, which is similar to that of NYC. Through teacher observations, designed student work, evaluation of student work, surveys, comparison of schools, teacher feedback and interviews, the claim of inquiry increasing student engagement was validated (Kroll & Meier, 2017).

Graca (2012) discussed how the inquiry approach allows for greater independence in the classroom with early elementary students. Graca conducted a series of inquiry-based lessons with 14 kindergarten students over the course of two weeks to see how it would affect their critical thinking skills. Graca found inquiry gives students the opportunity to draw conclusions, come up with a plan, and problem solve on their own or in a collaborative setting with their peers. Students in the study used questioning to problem-solve and gain different perspectives on the material being explored, bringing learning to a deeper level of understanding (Graca, 2012).

At the end of Graca's (2012) study, subjects were given a science experiment and had to find a solution on their own. In this experiment students learned about inventors and inventions. Then students were given a problem and had to design an invention. Comparing the empirical data about the students' interactions and feedback from the beginning to the end of the study showed the inquiry method allowed students to generate questions, think independently, and solve real world problems. Data were collected through student monitoring, lesson planning, teacher observations, and student work. Graca pointed out classroom teachers should be well

educated in how to use inquiry to drive student thinking. Graca's research supports the value of inquiry in the early childhood classroom.

Lott et al. (2013) discussed how inquiry begins in science to draw students into the process, and how it teaches students to think outside the box during science in early childhood classrooms. Through student work, classroom observations, teacher planning, and professional development, early exposure to STEM will create both confidence and deeper understanding. This was the result of Lott et al.'s two-week case study, which was conducted in a kindergarten classroom of 18 students in the Midwest. Students engaged in STEM activities and then, through a survey, those students discussed their confidence in the various STEM subject areas.

Lott et al. (2013) used a descriptive analysis of student work. The survey results indicated students enjoyed completing the various STEM activities, which were hands-on and inquiry-based. Students reported feeling a great deal of confidence and motivation at the completion of these activities. The excitement from using technology and engaging in science experiments was evident in the student work and their discussions. Lott et al. explained early childhood students thrive on social interaction and play. Therefore, it is vital to create classroom environments that support inquiry. These classrooms will build lifelong learners who are well prepared for the 21st century.

Olver (2013) provided compelling research on how play-based inquiry fosters mathematical thinking in kindergarten, since students engage in assessments and play to build numerical knowledge. A total of 21 4-year-old children in a Toronto, Canada school completed a series of spatial skill, numerical knowledge, and visual-motor integration assessments. Patterns were then noticed in failure to achieve in specific STEM related skills and inquiry through play was applied to address closing the achievement gap. Through investigation, students were able to

build spatial skills, numerical knowledge, and visual-motor integration. Assessments were given before and after the study. Data from the subjects' numerical, visual-motor integration, and special skills tests were gathered and analyzed using number line estimations (NLEs). The NLEs showed that between December and May the students performed 1.5 times better on tests for these skills, which can be attributed to the alteration in their style of learning to play-based inquiry (Olver, 2013).

Bequette (2009) added to the discussion on how math-talk drives investigative learning and the ways teacher-training programs create successful inquiry-based teachers. Math-talk is a newer pedagogical concept adapted for engagement theories (such as inquiry) where the students engage in peer-to-peer conversations about a math problem. Bequette claimed that when students are engaged in math-talk they build inquiry skills through collaboration and realize that there are several ways to examine the same problem. Using qualitative research methods Bequette found evidence to support how math-talk engages students in collaborative discourse. To accomplish this, Bequette used both classroom observations and audio recordings of two kindergarten classrooms in a Queens school district. The students engaged in math-talk during their mathematics class time for 14 school days, during which time their activities were monitored and tracked by the researcher. Studying these recording and observations it was found that students became more organized and functional in groups over this time (Bequette, 2009).

Early childhood students have short attention spans. In the early childhood classroom, students are bombarded with massive amounts of information all day. Therefore, activities that support growth should be strategic and well planned. In order to support the thinking process, early childhood educators should examine the efficacy of their lessons. Cook and Borkovitz's (2017) research provided evidence that traditional lessons are not effective. Cook and Borkovitz

evaluated student attitudes about math learning from a kindergarten classroom of 20 students via interviews. Students spoke poorly of math and math classes. Math was highlighted in a negative manner and students expressed fear toward learning math. Cook and Borkovitz used thematic content analysis to make improvement to their educational programs. Cook and Borkovitz highlighted that teachers need to understand the needs of their students in early childhood in order to build foundational appreciation for mathematics. Furthermore, if teachers view mathematics to be a dreaded subject or have a clear lack of interest toward math it will be reflected in how they prepare and how they teach. Cook and Borkovitz emphasized the need to have inquiry-based math programs in early childhood to support learning, which will create a more flexible learning environment. This environment will move at the students' pace with a focus on hands-on activities.

Student learning gaps. According to Sorvo et al. (2017), many primary school children struggle with math anxiety, which can lead to several gaps in learning. Sorvo et al. conducted a massive study on 1,327 children spanning 20 schools, ages 5–11, where 48% were girls and 52% were boys. The study was conducted in Finland and focused on math anxiety both in terms of failing math tests in the classroom and facing day-to-day situations requiring math. An assessment for math anxiety was given using a 6-item Math Anxiety Questionnaire (MAQ). The questions on the MAQ pertained to relative interest and enjoyment in math, feelings surrounding tests, and feelings when being asked questions by teachers in front of the class. A separate 3-item questionnaire was used regarding day-to-day situations, where the questions were more about confidence in those types of situations. The researchers were also given permission to see the students' math grades to compare possible correlations with math fluency and math anxiety (Sorvo et al., 2017).

Sorvo et al. (2017) found the leading cause of math anxiety is arithmetic fluency because it affects a student's understanding and computation of basic arithmetic skills. Sorvo et al. concluded that early arithmetic skills are core components of early childhood curriculum. However, many students continue to fall short of understanding and computation. Math anxiety begins as early as kindergarten, where students are under of pressure to perform and keep up with rigorous standards (Sorvo et al., 2017). Sorvo et al. demonstrated that math anxiety is linked to understanding of basic arithmetic skills in primary schools. Children's math anxiety, especially related to arithmetic, should be addressed in early childhood. The gaps in mathematics can be addressed in the early childhood classroom. Addressing these gaps early on will help alleviate a great deal of math anxiety in primary and secondary school. Sorvo et al. explained that to decrease learning gaps it is imperative to design lessons that will support a deeper understanding of arithmetic. When the foundation is weak the building will have cracks. This is the case for weak mathematical learning in early childhood (Sorvo et al., 2017).

Hitt and Smith (2017) conducted a literature review to find out the efficacy of teaching scaffolding techniques to teachers within an inquiry-based model. Hitt and Smith focused on studies involving science teachers with little or no experience. The purpose of this review was twofold. First, Hitt and Smith sought to find out how well preservice teachers could assimilate the technique into their teaching method. As Hitt and Smith found, preservice teachers were less resistant to learning and applying the new techniques as opposed to teachers who had gone through training into their career. Secondly, Hitt and Smith found that using scaffolding through inquiry lessons was efficient in engaging students in science content. Scaffolding allows for students to access the learning in various stages and inquiry allows for ownership of that learning. Student ownership of learning allows teachers to differentiate the lessons to meet the

needs of all students. Many educators believe their role is minimal in an inquiry-based lesson (Kirschner et al., 2006). However, preparation and planning are key to successful inquiry lessons. To close the gaps in learning scaffolding will allow students to work at their own pace. The benefits of scaffolding during inquiry lessons are that teachers can meet the students at their individual levels and help move them through the learning. Scaffolding supports learning for all students especially those with disabilities and English language learners (Hitt & Smith, 2017).

Hourigan and Leavy (2017) researched the connection between math curriculum, teacher knowledge of inquiry, and math comprehension. Hourigan and Leavy reported on a case study conducted in Dublin with 25 prospective primary teachers who designed, taught, and reflected upon inquiry lessons over the course of a month. The participants were 4- and 5-year-old children in two elementary classrooms who were falling behind in their math lessons. The aim was to find a way for the students to work collaboratively in groups and relate the content to the lessons to something familiar to them. The comparison of pre and posttests for basic numerical concepts showed most of the students who had been falling behind were now testing at grade level. Improvement was attributed to how the lessons worked to help the students connect abstract math concepts with practical situations. Hourigan and Leavy examined the interviews the researchers conducted with teachers, finding the inquiry method helped teachers identify the source and nature of their students' errors.

Wagh, Cook-Whitt, and Wilensky (2017) argued that inquiry-based lessons with a focus on technology can support student growth. Using technology as a learning tool support and fosters student understanding of mathematical concepts. Wagh et al. highlighted the value of teaching students to learn computer coding, which is the means by which websites, applications, and software are made. Coding involves mathematics and lends itself well to any math

curriculum. Coding engages students and allows students to work at their own pace. When teachers utilize technology as a learning tool it can have remarkable benefits (Wagh et al., 2017). Inquiry-based classrooms help prepare students to meet the demands of the 21st century (Wagh et al., 2017). Students are equipped in communication, technology, problem-solving, and critical thinking. When students learn how to use technology as tool in their learning, they will secure the means to use technology in everyday life. As the global marketplace relies more and more on technology, students need to be equipped with the skills to be successful in the 21st century.

Student achievement. According to Eckhoff (2017), inquiry allows students to develop greater investigation skills in science and it makes teachers more self-efficacious to apply this paradigm. Inquiry can be used by both prekindergarten and kindergarten teachers to support critical thinking in science**.** Eckhoff (2017) applied a multiple-method research style approach, which included a meta-analytic review of qualitative research about using inquiry in kindergarten science classrooms. The research additionally included data from Eckhoff's own classroom observations, as well as transcripts taken from prelesson planning with preservice teachers. Teachers supplied answers to questionnaires to find out if their opinions would change from using inquiry for science lessons in their kindergarten classrooms. Analysis of the meta-analytic review and Eckhoff's research showed teachers were more self-efficacious after using inquiry. Furthermore, Eckhoff demonstrated students saw greater improvement in creativity, independent thinking, and problem-solving during science. The application of inquiry in the science class also increases student motivation towards science. Eckhoff explained that inquiry also involves discovery. Discovery can help students develop essential skills such as problem-solving and critical thinking.

Wu (2014) discussed how to build early numeration skills in kindergarten and first grade students. Using inquiry to build number sense is the key to strengthening math success in early childhood classrooms. The observational research study by Wu (2014) consisted of 55 children ages 4–6 years in a Beijing school. Through teacher observations, student work, and lesson plans, Wu found evidence to support that students were engaged in learning and the teachers took a great deal of effort to plan for inquiry. Wu stated that when students are highly motivated in early childhood, they will build a strong number sense foundation. In the research teachers spent time in planning and preparation. Lessons that built early numeracy skills had to be engaging, hands-on, and rigorous. Wu's study lends itself to a vast body of work because it proves that inquiry in the early childhood classroom can create a strong mathematical foundation in numeracy.

Aldemir and Kermani (2017) examined the benefits of STEM in head start programs. Researchers used mixed methods research to collect and analyze data from four prekindergarten classrooms for a total of 72 students in North Carolina. Through lesson planning, student monitoring, collection of student work, observations, professional development and teacher feedback, results showed students can be successful in STEM subjects. Constant exposure to well planned, stimulating, and developmentally appropriate activities increased student engagement and increase student performance (Aldemir & Kermani, 2017). Student performance on STEM activities was supported using discovery and inquiry. When students completed the various tasks, they engaged in meaningful discussions. Aldemir and Kermani stated when students worked collaboratively, they moved quickly through the tasks. Students were better able to solve problems and explain their thinking. Aldemir and Kermani demonstrated the value of inquiry in Pre-K classrooms appears to be truly remarkable. Students appreciated playing and

saw play as a normal everyday activity. Aldemir and Kermani concluded from their results that when inquiry-based lessons were presented to the four prekindergarten classes, it seemed like play to the students. As Aldemir and Kermani discussed, inquiry and play engage young learners in the classroom.

According to Vartuli et al. (2016), using inquiry to train teachers can make them more likely to apply the same paradigm in the classroom. Vartuli et al. hypothesized that early childhood student teachers need authentic classroom experience where they can learn how to apply inquiry to their lesson plans by experiencing it themselves as undergraduates. Structures are needed in teacher education programs for teacher success in the classroom. The study was conducted at one university and examined one teacher education program. The participants were engaged in the program for several months in their last year of their teacher preparation program. Through a mixed methodology of observations, surveys, and designed teacher education programs, Vartuli et al. tracked student teachers as they moved from university to the classroom. During the study, the relationship of teaching practices to one another was explored using the transformer approach. Vartuli et al. examined three transformers as they worked to revise a teacher education program. The transformation process included practices centered on inquiry rather than direct teaching. Monitoring student teachers who were pursuing careers in early childhood occurred over a period of several months. The study proved to be successful because of the changes made to the teacher education program, which included incorporating inquiry methods into its own paradigm for educating teachers in training (Vartuli et al., 2016).

Gilbert, Bloomquist, and Czerniak (2016) discussed how cross-curricula studies of math and science thinking leads to innovation. Gilbert et al. communicated that early math computation in science supports scientific thinking and increases student performance and

success. Gilbert et al. explains that teaching mathematical and computational thinking in early science classrooms has evidenced success in preparing students for inquiry and investigation. Gilbert et al. also points out that teachers need to assess teacher efficacy and professional competency with using inquiry for math. Gilbert et al. also explained the ways inquiry increased student engagement, finding that teachers were more inclined to report higher student engagement from using inquiry paradigms.

Teaching pedagogy. Hollingsworth and Vandermaas-Peeler (2017) communicated how strategies for preschool teachers foster inquiry-based learning in the classroom. Additionally, professional development will train teachers on how close the gaps in learning using inquiry. Hollingsworth and Vandermaas-Peeler's survey provided enough data to validate that teachers in early childhood are not well trained in teaching science. In the study, 51 teachers participated in a survey regarding their professional efficacy for administering science lessons using the inquiry method. Through an examination of their responses, Hollingsworth and Vandermaas-Peeler found that one quarter of all respondents knew of the inquiry method prior to the study and were familiar with at least one inquiry technique. The teachers then participated in a training program to learn more inquiry techniques. Through a follow-up portion to the study Hollingsworth and Vandermaas-Peeler interviewed some participants who had not been familiar with the method prior to the research. The participants said they had begun to use the basic inquiry steps, such as questioning and observing through interactive activities. However, they did not do the next steps, such as evaluating the evidence and making predictions. Their reason for this was mainly scheduling, a lack of adequate supplies, and time restrictions (Hollingsworth & Vandermaas-Peeler, 2017).

Piasta, Logan, Pelatti, Capps, and Petrill (2015) connected how professional development can help teachers drive inquiry. Piasta et al. used quantitative data collection to track students' progress in math and science in 65 classrooms, showing that professional development in the area of science inquiry in early childhood had growth. After 10.5 days of training, teachers were tracked through students' work in math and science. Only growth in science was evident, with little improvement in math (Piasta et al., 2015).

Haslip and Gullo (2017) also examined how professional development is the key to inquiry success. Information was collected via a literature review to determine many variables such as demographics, funding, and teacher training were taking into consideration. Haslip and Gullo concluded that professional development has proven to be a successful strategy in training teachers in 21st century skills. The study demonstrated the need for policy makers to be on board with practices and policies that aid teacher preparation programs. Haslip and Gullo encouraged effective professional development to support teacher success in the inquiry process. The study highlighted the work of professional development in engaging teachers in meaningful conversations. One issue identified was the policies and practices of school and local leaders. Many teachers felt that current policies and practices do not always support the inquiry process (Haslip & Gullo, 2017). It is a difficult task to begin preparing teachers to change years of standardized teaching practices. However, if school leaders and administration are on board, quality support and professional development can yield far-reaching results (Haslip & Gullo, 2017).

Meier and Khales (2013) discussed using inquiry to foster classroom community and how teacher-training programs can help strengthen inquiry-based learning in the classroom. Data were collected from following 12 student teachers whose progress was tracked through portfolios

during their first years in the classroom. The hypothesis of the research was that professional development and teacher education programs can train teachers to use the inquiry approach, partly by building confidence in using inquiry-based model in the classroom (Meier & Khales, 2013). Anders and Rossbach (2015) as well as Lewis Presser et al. (2015) argued that teacher training, understanding of social-emotional development and standards, and state and local curriculum increases teacher preparation in early childhood students. This is done through fostering an environment of play, which allows for greater inquiry in math and building fluency. Lewis Presser et al. (2015) explained that early childhood teachers need to have a strong background in curriculum and clear understanding of social-emotional development. These components are vital in working with young children.

Erfjord, Hundeland, and Carlsen (2012) also supported the use of professional development as a tool to increase effective math instruction. Teacher confidence in math instruction has a direct impact on student learning. Training is a necessity for teachers to develop effective math practices. Erfjord et al. explained professional development that supports inquiry-based lessons will help teachers prepare students for success in mathematics. Moving teachers from traditional methods of teaching math to inquiry-style needs support for quality professional development (Erfjord et al., 2012). Von Renesse and Ecke (2017) suggested inquiry-based teaching pivots from curiosity. Lessons should be engaging and lead through a lens toward curiosity. This type of learning not only captures student interest but also increases knowledge. Specific teacher moves were highlighted in the study conducted by Von Renesse and Ecke, where teachers of Grades kindergarten through 12 were involved in a year-long workshop to teach them inquiry. Teachers' application of the techniques was monitored; Von Renesse and Ecke found teachers became most adept at staging disagreement and creating a safe space. The

feedback from the teachers was that curiosity and inquiry are deeply connected. Professional development will deepen thinking about inquiry-based teaching by considering curiosity as one of the starting points of inquiry.

The process of allowing students to be in control of their learning takes planning and preparation for educators. However, the results have a greater impact than traditional methods of direct teacher instruction. The process begins with training teachers in educational training programs. Betts, McLarty, and Dickson (2017) explained teachers need to be well equipped in teaching inquiry even before they enter the classroom. Betts et al. used an action research project to learn about the relations between theory and practice. Eight teacher candidates were taught how to use inquiry for their math classes in a three-week workshop taking place three times a week. The objective was for the teacher-candidates to build self-confidence and increase early numeracy skills in their students. Teachers successfully learned how to apply inquiry skills in teaching mathematics to kindergarten students and reported that they would proceed to use these skills as they proceed in their teaching careers. Betts et al. claimed a success to the study and proved their outcome by following the teacher candidates as they transitioned into teaching.

Technology. Levin and Tsybulsky (2017) assessed the impact of using technology to build STEM for students in their early years of formal education. Levin and Tsybulsky explored how digital tools help drive inquiry in STEM learning and how computer programming promotes inquiry solutions among these students. Levin and Tsybulsky conducted a study of 13 children in Israel ages 5 and 6 to monitor student use of technology in STEM subjects; student progress was tracked for eight weeks. Levin and Tsybulsky also looked at contemporary literature on the use of technology in inquiry-based paradigms for STEM subjects. In both their own research and their review of the literature, Levin and Tsybulsky focused on how engagement would lead to

student improvement in retaining science concepts by applying them to programming. The study was extensive and demonstrated a tangible impact of technology in the classroom, where students are more focused on the work when they are using computers. Levin and Tsybulsky posited that since the children of the 21st century are growing up with computers as part of their daily lives, they are more drawn to engage with lessons involving computers. Combining computers with the tasks of inquiry-based lessons, which ask the students to work collaboratively, makes lessons both relatable and communal (Levin & Tsybulsky, 2017).

Using programs to move students through STEM subjects has yielded positive results. However, digital resources need to be carefully selected and schools need to work with IT departments to best design programs for student success. Wager and Parks (2016) discussed how teacher planning, classroom resources, and use of technology, specifically programs for teaching mathematics within inquiry yields positive impacts on student achievement in the area of mathematics. Although students need to have a conceptual understanding of how to solve problems, technology allows for that practice, engagement, and simulation.

Technology is a component that cannot be left out of any classroom (Wagh et al., 2017). Moving students ahead and closing gaps in learning is essential in any classroom. Today smart boards, iPads, laptops, and computers allow students to learn the benefits of technology in the learning process. Wagh et al. (2017) highlighted the value of coding. Coding can advance the use of technology in the classroom. Students are utilizing critical thinking and problem-solving in computer programming (Wagh et al., 2017).

Any discussion about college and career readiness must include attention on STEM. Levin and Tsybulsky (2017) stated the jobs of the future will primarily be in the fields of STEM.

For students to have a passion towards STEM subjects there must be motivation and passion from early childhood (Levin & Tsybulsky, 2017).

Love, Hodge, Corritore, and Earnst (2015) explained that blended learning should be utilized to build technology into lesson planning. Blended learning is the integration of digital tools and computers with traditional classroom tools for learning, where the student and teacher do not always necessarily have to be physically present with one another (Staker & Horn, 2012). With blended learning, more remote learning takes place where the students have added control over where, when, and how they learn than they do in classrooms (Staker & Horn, 2012). Blended learning also inherently involves an inquiry-style approach to teaching (Staker & Horn, 2012).

In a study conducted by Love et al. (2015), students in two classrooms in a central California school district used technology as a resource to discover, solve problems, communicate, build skills, and design. Students were testing below grade average and the flipped classroom model was applied as an intervention. From the four-monthlong study Love et al. found the model supports inquiry-based learning as students improved in their retention of concepts. It was hypothesized that the success of inquiry with technology was because of how it promotes greater student independence and problem-solving (Love et al., 2015). Love et al. stated the traditional methods of teaching math do not prepare students for a deep understanding of key mathematical concepts because those methods do not relate the concepts in a way that makes those concepts seem useful to students. Students cannot assimilate the concepts in their knowledge base in a way that is intuitive through the traditional methods. Instead, the traditional style is counter-intuitive, asking students to first grasp abstract concepts before seeing the

practical application. Inquiry is the inverse of this, drawing the student in with practicality first and teaching concepts second (Love et al., 2015).

Teacher confidence and ability has a direct correlation with student performance. The self-efficacy of educators and how it relates to their ability to effectively teach STEM subjects to early childhood classrooms was explored. While the exploration of teacher self-efficacy clarified where the underachievement gap is generated from, none of the studies gave an in-depth analysis of how teachers perceive inquiry. The studies did not look too closely at teacher beliefs with respect to pedagogical theory, and thus, it is unclear whether there is a bias towards traditional methods among educators. Furthermore, the studies that did assess teacher perceptions of inquiry tend to do it through quantitative methods. However, a qualitative study such as the one carried out here can better connect beliefs, values, and motivations. Through this research we can close the gap on the reason for possible resistance to inquiry, finding common themes that thread those reasons together. Once these threads are found researchers can begin to devise interventions that will successfully clarify the meaning and function of inquiry for early childhood educators.

Review of Methodological Issues

This review unearthed the benefits of inquiry-based instruction in early childhood mathematics. It was discovered that gaps in mathematical reasoning and understanding stem from foundational work in early childhood classrooms. Many researchers who studied preservice programs and professional development went directly to the source–the teachers. Most of the studies used in this review were mixed methods in nature. The researchers conducted interviews, surveys, classroom observations, questionnaires, case studies, and action research. In examination of the methodological issues throughout this literature review, mixed method research seems to be the most common form of study used to gather and prove data.

Teacher interviews. In order to evaluate teacher confidence in the classroom it was vital for many of the researchers to conduct teacher interviews. Gilbert et al. (2016), Erfjord et al. (2012), Althauser (2018), Little (2017), and Piasta et al. (2015) interviewed teachers to evaluate teacher confidence and gauge how teachers felt about professional development and preservice programs. Piasta et al. interviewed teachers to determine how professional development can help drive inquiry in the classroom. In the process of the interviews open-ended questions were utilized to understand past and present professional development and its impact. During the interview process respondents had time to reflect and discuss. The interview process lent itself well to opening meaningful conversations. In the interviews, teachers were able to be candid about how professional development has either helped or hindered their practices. It was discovered that many early childhood teachers lack confidence in teaching math (Haslip & Gullo, 2017). Teachers explain that professional development must be meaningful and supportive of teacher practices (Haslip & Gullo, 2017).

Haslip and Gullo (2017) interviewed several teachers explaining that in order to prepare students to meet the needs of the 21st century, school leaders, policy makers, and administration should be on the same page regarding the presentation of instruction and best practices. In the interview process teachers expressed their concern with current policies and practices in regard to professional development, teacher practices, curriculum, and teacher support. Interviews allowed teachers to explain why they felt low self-confidence regarding math instruction. Meier and Khales (2013) pointed out that teachers felt their lack of confidence in math instruction was part of the reason why their students had a lack in confidence in math. Meier and Khales (2013) explained that interviews capture human emotion and feelings. This type of measure can prove to

be a great benefit to researchers rather than teachers rating themselves in a survey or questionnaire.

One disadvantage in using interviews is that they are time consuming. Kroll and Meier (2017) explained that interviews can elicit emotion, which can be difficult to code, a negative in this style of research. Tracking information and gathering data then becomes a more challenging task. Finding time to meet and having enough time to gather enough data also proves to be a challenge (Kroll & Meier, 2017). The interview process can also be affected by the relationship of the interviewer and interviewee. If the interviewer and the interviewee know each other, there is a level of comfortability, which could lead to researcher bias. Some people know each other but dislike or distrust each other, or one of them dislikes or distrusts the other. This can also lead to bias. If the relationship is unknown, there may be some distrust or resistance to being honest. For instance, some teachers are hesitant to be honest in interviews due to the culture or climate in their school. Non-tenured teachers, and teachers who have lower ratings, may often feel reluctant to be honest due to their current situation in the school. This may affect the data gathering process and the authenticity of the data (Kroll & Meier, 2017).

Student interviews. Student interviews were utilized in gathering data in several of the studies conducted in this literature review. The purpose of the student interviews was to evaluate math confidence, understanding of the inquiry process, and determine results of inquiry-based lessons. Wu (2014), Kemple et al. (2015), Graca (2012), and Wu and Lin (2015) utilized student interviews to evaluate inquiry-based mathematical teaching. In the interviews, students discussed their confidence in math and how the inquiry process works. Wu and Lin interviewed students after the completion of various mathematical inquiry-based tasks. The students were between the ages of 3 and 6 years old. The interviews revealed what students liked and disliked about the

tasks. The evidence used in the research set the basis for curriculum development (Wu & Lin, 2015).

The benefit of conducting student interviews is to gain an insight into their learning ability. During the interview process both open-ended and closed-ended questions are utilized. To gauge insight into the impact of STEM and technology in the classroom Levin and Tsybulsky (2017) asked students specific questions. Student responses demonstrated whether inquiry-based learning through technology had an impact on student growth. Like teacher interviews, student interviews provide researchers with a personalized experience. Student interviews provide a substantial amount of data (Graca, 2012). When students explain their learning process, researchers are able to understand the value of inquiry-based learning. Data collection from student work does not give the researcher the same information and thus can yield to gaps in the research. Student interviews provide first-hand accounts of the learning. One major problem that arises with this methodology is the students' willingness to be truly honest with researchers. This is one of the most obvious issues considering what is known about how even discussing the subject of math produces anxiety. Furthermore, the issues might be out of the children's scope of intellectual understanding. In this case, students would not provide meaningful answers via interviews. Scheduling and student attrition can also affect the interview process with some students dropping out before all data is collected.

Surveys and questionnaires. Surveys and questionnaires are the most common method of gathering information used by the researchers in this literature review. Both student and teacher surveys were utilized to gather information about the inquiry process in classrooms. The surveys were used to understand how the inquiry process would support mathematical instruction. Several surveys given to teachers examined preservice programs, professional

development, confidence in teaching math to early childhood students, and understanding STEM.

Hollingsworth and Vandermaas-Peeler (2017) utilized a survey to gain insight into teacher confidence. In the first part of the study, 52 Pre-K teachers were given a survey about confidence in teaching science, inquiry process, and the science curriculum at their school. The survey was quick, and the researchers discovered more professional development was needed to support the inquiry process and science instruction. The survey formed the basis of the study and discovered that teachers need greater support in the inquiry process to feel confidence in their abilities. Hollingsworth and Vandermaas-Peeler designed the bulk of their argument around the survey data.

Another survey used in the research was the Teacher Education Evaluation Survey used by Meier and Khales (2013). This survey was utilized to gain insight into an early childhood teacher education program in Palestine (Al-Qus University). This survey provided information regarding how the curriculum supported inquiry-based teaching in the classroom. The survey was used to demonstrate that teachers need training in inquiry-based teaching in order to have greater success in the classroom. The survey provided a support of Meier and Khales' argument.

One of the disadvantages to surveys is that many participants fail to answer or complete the survey, especially if the survey is conducted electronically. Teachers and students taking surveys did not have the opportunity to explain why they rated a specific question with a rating. Wilson (2014) used a survey to understand teacher practices. Some of questions in the survey pertained to teacher confidence. The questions did not have explanations in the rating. The teachers did not have an opportunity to explain the reasoning behind their lack of confidence. Wilson surmised that lack of confidence might stem from the environment, professional

development, educational training programs, or a specific curriculum. Regarding students, if the survey is done as a whole class, students may share answers, copy, or just complete the survey to move on to the next task. Students may see the survey as a menial task and rate all items on the farthest scale. Kindergarten students may struggle with reading the survey or interpreting the questions. In preparing surveys for early childhood students, it is vital to use kid-friendly language, pictures, and or have the facilitator read the survey (Wilson, 2014).

Surveys provide the platform for understanding what teachers know and how they feel about inquiry in mathematics. Drawing conclusions from the various surveys examined in this literature review highlighted the gap between teacher confidence in both math and inquiry and student performance. The disadvantage to surveys and questionnaires is the lack of understanding with the choices provided for survey response. There is nobody to explain how or why participants rate a specific question, so the subjects might interpret prompts differently than the researchers had intended for them to be understood. Even though both surveys and questionnaires provide a glimpse into topic and experiences they lack the story behind the individual and their experiences. This can leave gaps and misinformation in the analysis of survey data. A follow up survey or questionnaire can allow the researcher to examine reasons behind original choices and or explanations and provide a better supply of data.

Action research. Action research was utilized in some studies to demonstrate that when teachers engaged in professional development and quality preservice programs, they were more successful in designing inquiry lessons in mathematics. McCullough (2016) used action research to investigate the change in professional development model in the acquisition of content knowledge for fourth grade math teachers. The study reported many elementary school teachers are not trained and prepared with the necessary skills and knowledge needed to properly deliver

math instruction to students (McCullough, 2016). The action research study showed that when teachers have a direct input into the learning model during a professional development setting, it is possible that the acquisition of knowledge in teachers could increase. In this study the teachers had a hands-on approach of acquiring new knowledge that directly affects their delivery of instruction to students. Using inquiry in professional development solidified the learning and fostered new learning. McCullough's action research was part of a mixed methods research that monitored teacher acquisition of content knowledge over the course of several hands-on professional developments. The teachers reported a positive feeling about the process and results. The study used both surveys and teacher observations to evaluate research success. However, the control group was small and focused on one school in which professional development had been unsuccessful in impacting teacher practices (McCullough, 2016).

Betts et al. (2017) also used an action research project to report on using math inquiry with a focus on learning about relations between theory and practice. In this action research teachers learned to apply the 4-D Cycle Model of Inquiry, interpret what it means for inquiry to be flexible, and to build a theory of teaching with inquiry-based on non-linear and community-based dispositions of teachers toward learning. The model could constitute a developmental pathway by teacher candidates for experiencing the linkages between theory and practice. The process included the 4-D Cycle Model of Inquiry, which describes three modes for teacher candidates to learn about teaching. The first mode is applying theory to practice. The second is interpreting theory and practice and the third is building personal, practical, and professional theories. The action research study highlights the process by which preservice teacher candidates can prepare for success in using inquiry in the classroom and gave credibility to fostering an inquiry-based mindset before educators enter the classroom (Betts et al., 2017).

Classroom observations. Another common methodology used by many of the researchers examined in this literature review is classroom observations. Classroom observations include teacher and student observations. Davis (2016), Bequette (2009), Olver (2013), Graca (2012), and Koomen (2016) used classroom observations to monitor and track student progress. Classroom observations provide qualitative data that explain student behaviors, thinking, and processing. Various studies had different foci in their observations. Researchers visited classrooms and monitored student and/or teacher behaviors and practices. The study completed by Davis (2016) involved students engaging in a sparse but logically ordered and scaffolded sequence of problems that supported inquiry to the heart of big mathematical ideas. The observer monitored student discussions, student engagement in the task, student collaboration, and student work. Students were highly motivated, and discussion moved them to develop an action plan to tackle the problems. The observation allowed the observer to also interact with students and ask open-ended questions (Davis, 2016).

Classroom observations can be a useful tool in determining the success of a given study or research. These classroom observations provided a clear picture of how inquiry-based learning supports growth in early childhood classrooms. Essential to this growth are discussion and play. Stone and Hamann (2012) used classroom observations to examine how games and inquiry can raise math achievement in American Indian students. The study was conducted in three fifth-grade classrooms in various K–5 schools. According to Stone and Hamann, inquiry-based math supports a deep conceptual understanding of mathematical concepts. During classroom observations, Stone and Hamann witnessed students engaging in games to build core mathematical concepts. Through first-hand accounts they documented the benefits of inquiry, play, and math (Stone & Hamann, 2012).

A struggle with classroom observations is time, planning, and scheduling. Classroom observations take time to complete and must be thorough. The variables in the class need to be considered and the school needs to be on board. It is also crucial to have enough time in the classroom. Spending a few minutes observing only a couple of students will not provide adequate data. However, scheduling with teachers and administration can be a challenge. Curriculum and programs are tightly monitored and deviating for research purposes may not always be supported by administration or school leaders. The disadvantage to classroom observations is that the activity needs to be monitored across days, possibly weeks, to gain a true recording. In the case of Stone and Hamann (2012), the study was only conducted in three classes and classroom observations were not conducted daily. Much of the data were student work and teacher observations of students. If observations are not consistent and well planned, they yield little success, as data can be inclusive.

Case study. Various case studies were utilized to support the researcher's framework and discussion. Stone and Hamann (2012) conducted a case study on Native American fifth grade students. Henderson-Rosser and Sauers (2017) conducted a case study on three teachers to examine one-on-one inquiry-based learning on the iPad in an all-girls STEM focused school. Both studies targeted specific groups to examine math and inquiry-based learning. The case studies consisted of a variety of research methods including interviews, pre and posttest, classroom observations, and student work. Henderson-Rosser and Sauers explained the impact of technology on one-on-one inquiry-based learning has a great success in the elementary classroom. Even though the case study may be the best plan for answering the research question it does come with limitations. The disadvantage to the case study is that it focuses on one unit and the issue of generalization clouds over the research. Even though the case studies, as in the

two explained above, provided evidence in support of the overall body of research, some researchers may argue they are just too specific.

Synthesis of Research Findings

The literature review relied solely on the impact of inquiry-based lessons to close the gaps in mathematical learning in early childhood. In this review of literature, the research identified several key factors indicating the benefits of inquiry-based lessons and the necessity for this type of learning in early childhood mathematics. Davis (2016) pointed out the value of using inquiry-based teaching to build a mathematical foundation in early childhood. Wilson (2014) explained that failure to develop critical thinking and problem-solving in early childhood can have lifelong repercussions in learning math. Inquiry-based lessons are fostered through play and socialization. Children in prekindergarten and kindergarten classrooms are now setting their roots in socialization. Althauser (2018) explained teachers of early childhood students need to have a sense of balance between inquiry and traditional teaching in the classroom and how through inquiry students are highly engaged, proactive, and motivated.

In analysis of the literature on the benefits of inquiry-based teaching in early childhood the issue of teacher readiness was highlighted. Many researchers believe lack of teacher training in mathematics and inquiry has created gaps in mathematical achievement (Althauser, 2018). It was discovered in the research that many early childhood teachers feel unprepared in the field of math education. Meier and Khales (2013) examined the value of teacher training in mathematics instruction. Based on the literature reviewed here, many of the issues in using inquiry in the classroom stem from a lack of teacher knowledge and training. Althauser (2018) explained to build strong foundations in mathematics, teachers need to be trained in using inquiry.

The literature reviewed here led the researcher to conclude that using inquiry-based teaching will create lifelong learners. Inquiry is at the core of STEM and building the foundation in mathematical thinking (Levin & Tsybulsky, 2017). Based on this literature review, fostering an inquiry-based classroom will promote a greater love for math and other STEM subjects. Inquiry allows students to discuss, think critically, problem solve, analyze, and build valuable social skills. In early childhood classrooms, students use play to inquire how numbers work, how mathematical thinking helps solve real world problems, and make sense of early numeracy (Aldemir & Kermani, 2017). This style of teaching improves educational outcomes and fosters a thriving learning environment. Inquiry-based lessons give students greater voice in their learning. Students become the drivers in mathematical thinking. As Kroll and Meier (2017) stated, inquiry in the early childhood classroom will help close the gaps in learning that are evident in childhood and secondary students.

Critique of Previous Research

To understand the impact of inquiry-based teaching in early childhood it is vital to examine teacher readiness. Preservice programs that support inquiry-based lessons and teaching methods yield far greater teacher readiness than ones that do not. The value of play in the early childhood classroom has been the topic of debate for many years. Mantzicopoulos, Patrick, and Samarapungavan (2011) stated that inquiry-based programs involving play in kindergarten and prekindergarten classrooms motivate students to appreciation learning. The foundation of play not only builds essential social skills but also sets the foundation for problem-solving and critical thinking. Mantzicopoulos et al. (2011) conducted a federally funded science literacy project to examine the impact of inquiry in kindergarten. Two separate control groups were selected to evaluate the impact of traditional teaching versus inquiry-based lessons. Through before and

after performance assessments and various other measures of learning it was discovered that inquiry-based learning developed critical thinking, scientific inquiry, socialization, increase rates of literacy development, increase in vocabulary, and problem-solving skills. Through scientific inquiry students had open discussions, took their time, and worked as a group. The resulting atmosphere felt more like a playground than a classroom (Mantzicopoulos et al., 2011).

White (2012) further explained the power of play in the early childhood classroom. White conducted extensive research at the Minnesota Children's Museum and demonstrated that hands-on learning experiences create far better learning activities for children. White stated that research supporting play has been utilized for decades. Play builds confidence and yields socio-emotional growth necessary for human development (White, 2012). Play fosters creativity, physical development, mental development, and happiness. Using play to foster inquiry can begin the stage for higher order thinking and critical analysis. As children move through exploration and inquiry-based lessons they begin to set the framework for lifelong learning. Play also fosters social-emotional learning. Children learn how to share and respect one another during play. Monitoring student behavior on a playground is an effective way to understand how play builds social-emotional learning (White, 2012).

The challenges educators face in the path of utilizing inquiry in the classroom is lack of understanding of designing inquiry-based lessons, methodology, usage in science and math, and planning and preparation. Teacher preparation programs are at the heart of teacher readiness. It is vital that preservice programs begin to prepare teachers for inquiry-based teaching (Eckhoff, 2017). When teachers are not trained properly in the process of inquiry the methodology is both misunderstood and misused. The data highlighted that when preservice teachers are trained in inquiry-based teaching there is greater confidence and success in their practices (Eckhoff, 2017).

Previous research indicates that inquiry-style teaching helps students build deeper understanding of various content knowledge bases. Chi (2010) explained that teacher mastery of the inquiry process will secure the effectiveness of the methodology as a teaching tool. Research on the impact of inquiry has done extensively in both secondary and college classrooms. However, it was not until recently that researchers began examining the practice of inquiry in elementary classrooms. Inquiry is targeted primarily in content areas such as science and social studies. The work in mathematics is low and at times dismal.

In critically analyzing the research reviewed in the previous section, there are ways in which the studies have helped forward a conversation about what professional development means for teachers in inquiry-based classrooms. Vartuli et al. (2016) established the importance of beginning professional development in inquiry when student teachers are still undergraduates. Vartuli et al. affirmed the belief that it can be easier to incorporate inquiry into a paradigm before students begin their career rather than once they are deeply established. However, to this end, Vartuli et al. only studied subjects who were student teachers as they went through inquiry training. Vartuli et al. did not look at established professionals as a comparison. There remains a question about the challenges that exist in professional development with teachers who have already been using traditional methods. Meier and Khales (2013) similarly failed to look at how already-established teachers learn inquiry. Unlike Vartuli et al., Meier and Khales followed student teachers through their first year. Meier and Khales demonstrated how student teachers took their training, applied it in the field, and the ways they adjusted it to meet the needs of their classrooms. Meier and Khales provided insight into how inquiry-based theories can be more properly geared towards practical application so the needs of student teachers can be anticipated better in the training stage.

In contrast to Vartuli et al. (2016) and Meier and Khales (2013), Hitt and Smith (2017) did provide empirical research on the differences between training student teachers and established teachers. Hitt and Smith found concrete evidence that established teachers are far more resistant to inquiry, even if it does increase self-efficacy, as Eckhoff (2017) also found. Kirschner et al. (2006) offered some clarity on why established teachers are more likely to resist inquiry, explaining how teachers believe their role within inquiry lessons is too ambiguous to make a difference. Although Kirschner et al. (2006) did not offer their own research, their analysis of the literature on the negative outcomes of inquiry is compelling.

Wilson (2014) delivered well-rounded research about how teacher training programs for inquiry can be highly efficacious in both closing math achievement gaps and improving teacher confidence. Wilson's research is useful as a resource for creating interventions to combat this issue. By contrast, the research article by Haslip and Gullo (2017), which also argued that math anxiety in teachers is correlated to student underachievement, gave only partial suggestions as to how to intervene with the issue of teacher confidence. Haslip and Gullo did not operationalize a definition for "teacher confidence." However, it is important to note that Haslip and Gullo did offer an insightful way to view math anxiety as a cycle between low self-efficacy among teachers and math anxiety. This perspective helps to expand the perspective on the genesis of the problem on a school-wide level.

Master et al. (2017) further expounded on the problem of math anxiety by looking at cultural notions of math as an inherently challenging subject. Master et al. demonstrated that inquiry can help to reframe these notions, especially when technology is incorporated into lessons. Children in Master et al.'s study, like those in Lott et al.'s (2013) investigation, were better able to understand math through collaborative efforts and an incorporation of technology

into their lessons. Both studies showed how technology can be efficacious in teaching children STEM subjects. By comparison, Master et al.'s study was slightly more impactful because it looked at 98 students, whereas Lott et al. studied only 18 students. However, Lott et al. did conduct their study over a 2-week period, whereas Master et al. only a provided a day long workshop.

In terms of scope, Sorvo et al. (2017) offered research about math anxiety with the largest participant base of any other study reviewed. Sorvo et al. looked at math anxiety from two distinct and interconnected ways: (a) math as a school subject, and (b) math as a tool of practically engaging and negotiating with the world. Due to the scope of the research and the simple and poignant questions it sought to answer, Sorvo et al.'s results (which showed that math anxiety and fluency are inextricably linked) were somewhat more general than that of Lott et al. (2013) or Master et al. (2017).

One of the most efficacious tools within the inquiry paradigm was using play within lessons. Kroll and Meier (2017) added substantial research on the successes of teaching math through play, studying a large participant body in a diverse region. To make their study more impactful, Kroll and Meier should have considered doing a follow-up on participants, and to this end it may have been better for them to conduct a longitudinal study. This would have been beneficial for teachers who resist the principles of inquiry. Lewis Presser et al. (2015) supported the notion that teachers cannot simply apply those principles without understanding their theoretical underpinnings. Lewis Presser et al. gave a cogent explanation about the socio-emotional development of children and why using play with inquiry fits more fluidly into this development than the traditional paradigm. Olver (2013) certainly supported this idea, as Olver's study on play within inquiry not only demonstrated efficacy but gave real support to students in

Toronto who were falling behind in their math lessons. Olver found that applying play to math lessons improved student learning; students were testing at grade-level by the end of the research. Hourigan and Leavy (2017) had a similar outcome for underachieving students in Dublin, both finding support for inquiry and helping the students at the same time.

Throughout all these studies there was little mention of how teachers see themselves with respect to their schools and school districts. Teachers' perceptions of themselves both within and without the education system were not explored. In this research I hoped to find out more about these two views teachers may hold as a means to understand their perception of inquiry. It was found that new teachers who want to try inquiry do not feel supported or feel established teachers, in which the literature has shown are more resistant to it, would treat it with derision. There is a need for research into the gap between (about teaching) what teachers believe and how they teach (in practice). This would also highlight teacher motivations for applying the paradigms they chose, which underscores values, especially when teachers' values are given insight through interviews. To understand the impact of inquiry-based teaching in early childhood it is vital to examine teacher readiness. Preservice programs that support inquiry-based lessons and teaching methods yield far greater teacher readiness than ones that do not. The value of play in the early childhood classroom has been the topic of debate for many years.

Summary

The literature review supported the argument that inquiry-based lessons support early numeracy in the prekindergarten and kindergarten classrooms. The review of the research identified various areas to be considered in evaluating inquiry-based teaching in early childhood mathematics. Both teachers and students experience math anxiety. Math anxiety has been a burden in the development of lifelong mathematicians. When teachers feel a great deal of anxiety

it is replicated in student confidence in math. The second point to be considered is the closing of the achievement gaps in mathematics. One of the reasons for this is the anxiety and lack of conceptualization in early childhood. Using inquiry in the early childhood classroom can close the gaps in learning. Teacher training and teacher preparation is another area that needs to be considered when examining the impact of inquiry in early childhood mathematics. Teachers need to be well trained through professional development or teacher training programs. Another aspect of inquiry that needs to be considering is fostering play and inquiry to both challenge and move students in the learning process.

The research supports the use of inquiry-style teaching to drive motivation and increase confidence among students in the both prekindergarten and kindergarten classrooms. When students engage in inquiry-style lessons, they build a level of passion for math that stays with them if this type of learning is supported in the future. The research opened the doors to a larger problem facing many early childhood educators. There is a math anxiety and lack of confidence that appears to discourage an embrace of inquiry-style teaching. Teachers do not feel secure in their mathematical reasoning and therefore lack the skill to build inquiry-style lessons.

Many of the researchers explained that professional development and teacher training programs are vital to building confidence and understanding of inquiry in math. As Sorvo et al. (2017) explained, when teachers are well trained in the inquiry process, they yield far greater results. For classrooms to facilitate inquiry-based teaching school leaders need to work with educators in the training process. When professional development is done right it can have a great impact on change. If a school or school district is moving toward an inquiry approach to learning, effective professional development is the key to having confident and well-trained teachers. This should reduce the gap in math anxiety and help teachers in the planning and

preparation. Though the task may be daunting transitioning from traditional teaching methods to inquiry-style yields far greater results. The research also showed that the skills students need in order to be successful in the 21st century are to be fostered in the early childhood classroom. Effective planning and preparation can foster skills that support inquiry and problem-solving. Through this body of literature review, an argument for the research is developed taking a deeper look at studies on instructors' opinions on inquiry. As such, there is more exploration of the most common causes for resistance to inquiry from instructors at varying levels of experience. This chapter, therefore, helped bring a better understanding of how to approach teaching the inquiry method to teachers and the kinds of issues that can be expected as inquiry-based instruction and learning are adopted. The next chapter presents a discussion of the process for this study, the collection of data, and the analysis of that data in relation to the research questions. The next chapter explains the case study design used to the study. The case study included a presurvey, teacher interviews, and analysis of archival documents.

Chapter 3: Methodology

Introduction

Inquiry-based teaching in early childhood supports growth and creativity. Early childhood mathematics sets the foundation for critical thinking and problem-solving (Wu & Lin, 2015). When early childhood teachers (i.e., prekindergarten and kindergarten teachers) use inquiry to teach mathematics they have far greater success in conveying the fundamental concepts of the subjects than when they use traditional methods. Olver (2013) stated how play through inquiry yields greater success in math-foundational learning.

Eckhoff (2017) explained how when teachers are exposed to inquiry-based teaching during preservice programs, there is a greater chance of using those paradigms in practice. Lack of professional development can have a significant impact on how and when teachers utilize inquiry-based teaching in their classrooms (Olver, 2013). Even though inquiry-based teaching has a great deal of research behind its success, many districts, schools, and school leaders prefer traditional methods (Haslip & Gullo, 2017). The purpose of this qualitative case study was to examine teacher perceptions of using inquiry-based teaching in mathematics in early childhood education classrooms.

Research Questions

The research questions for this study were:

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

Purpose and Design of Study

The purpose of this study was to discover what is creating or affecting teacher perceptions of inquiry-based instruction in math in early childhood. Using a case study, the researcher provided answers to questions about inquiry-based learning. When conducting a case study, it is vital to include questions and analysis connecting the data, as well as criteria for interpreting the findings (Yin, 2014). This case study focused on kindergarten and prekindergarten teachers and school administrators. This qualitative study was conducted to explore participants' thinking and experiences. The teachers and school administrators were from two schools in NYC. Five kindergarten teachers and two school administrators were from school A, a prekindergarten-5 school. The other four teachers and school administrators were from school B, a prekindergarten school.

The case study was focused on understanding what affects or creates teacher perceptions on inquiry in math in early childhood. After the interviews, the researcher analyzed whether the school, administration, leadership, teacher knowledge, professional development, preservice programs, school culture, and/or experience create their perception. The interviews provided information on teachers' understanding of inquiry-based teaching and allowed the interviewer to gauge a deeper personal understanding of the teacher's perception. This case study was conducted to uncover various teacher perceptions of inquiry in math in early childhood and factors that affect those perceptions.

The review of current literature on using inquiry-based teaching in early childhood classrooms offered insight into the benefits of using inquiry (Kemple et al., 2015; Kroll & Meier,

2017), impact of professional development on inquiry-based teaching (Erfjord et al., 2012; Piasta et al., 2015;), and pedagogy (Althauser, 2018; Chiatovich & Stipek, 2016; Erfjord et al., 2012; Vartuli et al., 2016). However, many of the studies reviewed used a quantitative or mixed method design. This study focused on a gap in the literature in early childhood teachers' perception of inquiry-based teaching using a qualitative case study. The purpose of using a qualitative method was to gather in-depth, real-world data of teacher perceptions. A quantitative approach would utilize a more statistical approach that would not yield the same results as the exploration of teacher interviews.

Data were gathered from preinterview surveys (see Appendix A), interviews (see Appendix B), and archival document review. The preinterview survey served as a preassessment of teachers' understanding of inquiry-based instruction in mathematics in early childhood and implementation in their school. The preinterview survey was brief and distributed before the interviews. The teacher and school administrator interviews provided a platform for uncovering teacher perceptions on inquiry in math in early childhood. The researcher anticipated gaining deeper insight into various factors impacting teachers understanding and utilization of inquiry-based teaching. The preinterview survey and interview questions were piloted on a small sample population prior to researcher use. The purpose of the pilot was to validate the questions utilized in the study.

This research design was selected because a case study centered on teacher interviews could provide a more generalizable collection of data to assist in bringing value to the study. Action research was not utilized because the purpose of the study was to examine what is creating teacher perceptions. Action research is a systematic inquiry that involves the collection and analysis of data (Masters, 1995). However, understanding teacher perceptions takes a more

intricate approach. One-on-one interviews provided a platform for teachers to be less stressed and less apprehensive about disclosing their personal thoughts. In other words, teachers who wanted to discuss perceptions of administration involvement or a lack of understanding may have been more willing to discuss them with an interviewer rather than in a group or survey (Evald, Freytag, & Nielsen, 2018). Therefore, a quantitative study and survey-only methodology were deemed less effective means of data collection. As Creswell (2013) explained, the case study allows the researcher to observe and engage in conversation that may shed light and/or open new perceptions or ideas. According to Baxter and Jack (2008), it is best to use a case study when the research wants to answer how and why. Studying human perception in which boundaries are not clear between the phenomena and the context was also relevant to this case study. This study was conducted to explore the perceptions of teachers and the context is inquiry-based instruction in early childhood mathematics.

The case study was executed to explore factors that produce teachers' perceptions on inquiry-based learning in mathematics in early childhood classrooms. The factors explored were the school, administration, teacher knowledge, professional development, preservice programs, school culture, and experience. With this objective, this case study utilized teacher one-on-one interviews, observations, and archival document review in order to garner each teacher's perceptions. During the data gathering process, the researcher examined what specifically contributed to each teacher's perspective on inquiry-based teaching and learning.

The one-on-one teacher interviews allowed the researcher to identify the level in which teachers understand inquiry-based teaching. Teacher interviews allowed the researcher to become aware of the different teachers' perceptions. Archival document reviews were conducted as supplementary data collection methods/approaches. The additional methods to obtain and

gather supplement data allowed the researcher to triangulate across data sources in the analysis stage. In order to provide effective understanding on teacher perceptions in inquiry-based mathematics in early childhood classrooms, a case study with this set of methodologies gave the researcher valuable data to answer the questions set forth in Chapter 1. As such, archival documents for review were selected based on the written material's relevance to the research questions pertaining to inquiry-based learning, early childhood teaching methods, and learning mathematics in early childhood classrooms. The resulting transcripts were useful for data analysis as analysis incorporated substantial notes and reflective journal entries. As such, both deductive and inductive approaches were used in the process of analysis.

In qualitative research, one way to ensure validity is by using triangulation. Triangulation is important for decreasing bias when reporting and analyzing data (Creswell, 2013). In this study the topic was teacher perceptions of inquiry-based instruction in mathematics in early childhood. Preinterview surveys and one-on-one interviews with teachers and school administrators were used to collect data on teacher perceptions regarding inquiry-style lessons in early childhood classrooms. The inclusion of school administrators as respondents in the interviews provided relevant data needed to compare this study's findings from interviews with teachers. Preinterview surveys provided a preassessment of teachers' understanding of inquiry and implementation in their school. The survey was brief and was analyzed before the researcher conducted the interviews. The teacher and school administrator interviews provided a platform for uncovering what is creating teachers' perceptions on inquiry-based instruction in mathematics in early childhood. The researcher's focus was to determine the various factors impacting teachers understanding and utilization of inquiry-based instruction in mathematics in early childhood.

Research Population and Sampling Method

Population. The participant sample for this case study was a pool of nine elementary school teachers and three school administrators in two public schools with prekindergarten and kindergarten classes located in NYC. Five kindergarten teachers and two school administrators were from school A. The other four teachers and school administrator were from school B. School A is an elementary school with students in grades prekindergarten through fifth grade. School A has an instructional focus of differentiated instruction and is constantly looking for new ways to customize learning for student success. The second school, school B, is a prekindergarten school. It has only prekindergarten classes and is part of a network of prekindergarten centers in the district. The student body numbers fewer than 100. School B adheres to the core curriculum for NYC Pre-K.

Sampling method. Purposeful sampling is often used in qualitative research for the documentation and collection of case studies associated with a specific topic (Palinkas et al., 2015). In this case study the topic was inquiry-based teaching in mathematics in early childhood. For this study, the sample group was nine NYC public school teachers in grades prekindergarten and kindergarten and three NYC public school administrators. Each teacher has at least three years' experience in teaching the grade. There is a total of 14 teachers in both grades in both schools. Both schools utilize Pearson math programs for math instruction. Some teachers are new to the field or in a substitute position; those teachers were not included in the sampling method. The teachers and school administrators in the sample group participated in one-on-one interviews and a preinterview survey. The researcher selected the study population from those teachers and school administrators who consent to participate in preinterview survey and interviews.

Appendix A contains the invitation used in this study for teacher participation. The invitation outlined the components and timeframe for the study to ensure teachers and school administrators were comfortable and all expectations of the process were made clear. This type of teacher and school administrator selection is known as self-selecting, since the teachers had a choice in participation within the study (Berg, Lune, & Lune, 2004).

Instrumentation and Data Collection

A case study was employed to examine teacher insights, obstacles, knowledge of, and practice regarding inquiry-based learning in early childhood mathematics. This case study allowed teachers to reflect on their practices, professional development, preservice training, and pedagogy. The pedagogical practice was inquiry-based teaching. Information was gathered using a preinterview survey and one-on-one interviews. This method of research provided valid data that were consistent and relevant for the case study (Leung, 2015).

The total number of contributors participating in this study was nine teachers and three school administrators. Appendix C contains the text of the email that was used to invite teachers and school administrators to participate in this research. The first nine teachers and first three school administrators to accept the invitation received a presurvey that provided the research with adequate background information.

Yin (2014) explained using an interview method is critical to gain insight into participants' perceptions and views. During the interview process, the researcher was able to gain in-depth analysis of the participants' points of view and attitudes. Error in the interview process can come with poorly selected questions, interviewer bias, and information participants believe the interviewer wishes to hear (Yin, 2014).

Identification of Attributes

The elements defining this study included inquiry-based teaching, teacher pedagogy, foundational mathematical skills and concepts, and early childhood education. The attributes important to teaching that defined these elements of the study are motivation, consistency, attitude, professional development, and preservice training. Motivation refers to the amount of energy and effort people wish to expend to achieve their goals (Albrecht & Karabenick, 2018). Consistency refers to ongoing practices and routines that are put into place and monitored over the course of time (Hamilton, 2017). Attitude can refer to a person's feeling or emotion. It can also refer to how a person regards certain issues, people, and environments (Hamilton, 2017). Professional development is the ongoing support of administration and leaders to increase teaching staff skills and efficacy in the classroom (Erfjord et al., 2012). Professional development provides teachers with opportunities to better their craft, raise the quality of instruction, acquire new skills or strategies for specific content (such as new standards), and build school community (Erfjord et al., 2012). Lastly, preservice training refers to the experiences, training, and coursework done before a teacher enters the classroom (Althauser, 2018).

A key component of the study was the reflection on pedagogical practices implemented in the classroom. This reflection took place through the interview questions, which touched upon inquiry model lessons and inquiry-based teaching in mathematics. The researcher expected the results of this reflection will help to guide the practice of using inquiry-based teaching in early childhood mathematics.

Data Analysis Procedures

According to Baxter and Jack (2008), the process of analyzing case study data can be difficult as there are no clear rules for the researcher to follow. Yin (2014) recommended focusing on the theoretical propositions that guide a study and connect the data across common themes. This study focused on the practices, procedures, trends, variables, and patterns that impact the use of inquiry-based teaching in mathematics in early childhood classrooms.

It was expected that interviews, preinterview survey questions, and archival document review would provide a deeper analysis of teacher perceptions of inquiry-based instruction in mathematics in early childhood. It was also expected that a variety of perceptions would be gathered from the interviewees for a diversified set of data. Looking for patterns and trends was important to the analysis of the data. The software program NVivo was utilized during the analysis process. Recognition and critique of patterns in a qualitative study is the preferred method of decoding the data (Yin, 2014).

During the process of analysis, it was important to pay close attention to themes that emerged from the interviews (Berg, 2004). Through inductive analysis the data gathered from interviews, observations, and archival document review assisted the researcher in exploring patterns and themes (Berg, 2004). The transcripts of data gathered were reviewed several times before uploading to NVivo. The researcher examined key themes through extensive coding of all documents.

Limitations and Delimitations of the Research Design

Limitations. Limitations of the study are factors outside the control of the researcher (Berg, 2004). The environment was considered a limitation. The study was limited to the teachers and administrators who worked at these two NYC public schools. Although the

demographics represented a diverse population, the study was limited by comparisons to other schools with different populations of students and teachers. The limitation of the environment played a key role in this study. Patton (2014) stated the researcher must be aware of the limitations in order to find the best approach in gathering data and reporting findings.

In terms of environmental limitations, the teachers may not have been honest or in some cases comfortable with the questions asked because they might have feared possible retribution for speaking negatively. In that case, some of the data may not have been as credible. Being objective and having open discussions with least restrictive questions may have provided more objective data (Patton, 2014). The case study focused on only nine teachers and three school administrators. Limitations to this study included lack of generalizability, as the study was only nine teachers and three school administrators at two particular sites in NYC. Additional limitations included observer biases in response to observational data. Patton (2014) stated that observational data may constrain data due to observer biases. There was also the limitation of working under the Charlotte Danielson's Framework. In NYC, teacher ratings are based on the Charlotte Danielson's Framework. That framework consists of four domains (planning and preparation, classroom environment, instruction, and professional responsibility) sets the foundation for teaching and learning in NYC's public schools.

Delimitations. Delimitations are the traits of a particular study that control and outline the study's parameters (Berg, 2004). This study had delimitations, as it was restricted to NYC teachers in prekindergarten and kindergarten. The sample population was delimited to nine teachers and three school administrators at two sites. This study's aim was to explore the perceptions of teachers on their use of inquiry-based teaching in mathematics in the early childhood classroom. The case study design focused on a small population.

Validation

Credibility. The credibility and dependability of a case study validate the information offered (Cohen, Manion, & Morrison, 2002). Validation involved the use of multiple sources of data including teacher interviews and presurvey questions (Cohen et al., 2002). Credibility in this study involved triangulation of data using the preinterview survey questions and interview data, which assisted the researcher in controlling biases. According to Noble and Smith (2015), data triangulation is important for the credibility of a case study by yielding inclusive and wide-ranging data. The research participants were invited via email. Once accepted, the participants were allocated a preinterview survey (see Appendix A). An interview protocol (see Appendix B) was used in developing the semistructured questions and interviews. Each participant had an equal time of 30–45 minutes. If more time was needed the researcher scheduled a second interview with the participant. Each participant was able to review the interview transcripts and the draft case study report as recommended by Patton (2014).

Dependability. Dependability is marked with results that are constant and reliable. The researcher analyzed the data by recognizing patterns, themes, and trends as recommended by Patten and Newhart (2017). In order to ensure the study has dependability, the researcher must keep detailed records of each interview. As Noble and Smith (2015) explained, when examining the dependability of research, it is vital to examine both reports and data collection through the same lens. The process of reliability was constructed through a case study protocol and semistructured interview questions and the collection and formal organization of data (Yin, 2014).

Expected findings. The review of the literature found inquiry-based teaching has a positive effect on student growth and achievement (Althauser, 2018). The literature review also

highlighted the use of inquiry to teach mathematics with enhanced-instruction and provided students with the platform to build 21st century skills (Olver, 2013). Inquiry-based teaching in early childhood mathematics supports building critical thinking, problem-solving skills, and communication (Althauser, 2018). Few researchers have approached inquiry-based teaching in early childhood mathematics through teacher perceptions. This study used a qualitative methodology to examine inquiry-based teaching in early childhood mathematics.

Participants completed one-on-one interviews. Interviews lasted 30–45 minutes and provided insight into teacher perspective on using inquiry-based teaching in early childhood mathematics. The interview questions (see Appendix B) allowed participants to share their views and experiences on the topic. The researcher expected the interviews to provide information on the struggles, successes, adversaries, complications, and usage of inquiry to teach early childhood mathematics.

Ethical Issues

In order to maintain validity in research it is essential to identify the ethical issues and create procedures for decision-making (Patten & Newhart, 2017). Some of the potential issues that can arise are conflicts of interest, assessment, and researcher's bias. It was critical for the researcher to remove any personal bias from the study itself by monitoring personal prejudices with objectivity on a regular basis. This aided in preserving the credibility and validity of the study. The researcher provided all participants an invitation and equal documentation. There was no discrimination based on age, gender, gender identity, race, ethnicity, culture, religion, sexual orientation, disability, or socioeconomic status. There was no conflict of interest for the researcher.

The detailed invitation (see Appendix C) outlined the study and expectations. Informing the participants of the process, purpose, and procedures aided in negating any conflict of interest participants might have after agreeing to participate (Ngozwana, 2018). All participants had time to decide whether they would consent to all parts of the study. In all parts of the study, participant identity was protected, and participants' personal information was kept on record in digital media format. The information was encrypted on a server in a computer database so that a username and password are necessary to access it. Data will remain on record for three years after publication of dissertation. When the retention period ends, the information will be sent for disposal as per Concordia University's guidelines. Once permission is granted for the information to be destroyed, software will be used to permanently erase the data from the server. No hard copies of material will be stored.

The researcher's position or bias was another ethical issue that could arise during the study. This included the researcher's bias and ability to secure the privacy of all the participants. All participants had the opportunity to choose the time for the interviews. Each participant was made aware of the location and time in writing. The researcher informed the participants that all recordings and data would be kept confidential throughout the study. The recording of each teacher was given a participant code rather than the use of the participant's actual name.

The process of the Concordia's Institutional Review Board (IRB) was smooth and done in a timely manner. Communication between researcher and the review board was often. However, the school district's IRB had a very lengthy process. The IRB committee meets once a month and the process was very long. The lengthy process delayed the start of the research. However, the closure process was smooth for both the NYC IRB and Concordia IRB.

Summary

In every study the methodology is vital in obtaining a credible and valid data set. Through this study, the researcher examined teacher perception of using inquiry-based teaching of mathematics in the early childhood classroom. Data were collected and analyzed through a case study approach including a presurvey and teacher interviews, and archival document reviews. Understanding how and why teachers are using, or what prevents teachers from using, inquiry-based teaching in the early childhood classroom for mathematics, was fundamental to the study. The next chapter presents an analysis of the data collected and findings. Eleven codes and five themes emerged from the collection of data. The next chapter also discusses the themes in relation to the research questions.

Chapter 4: Data Analysis and Results

Introduction

The purpose of this qualitative case study was to explore teacher perceptions of the benefits of inquiry-based instruction in early childhood mathematics. Olver (2013) highlighted that hands-on learning and play yield success in early childhood mathematics. When early childhood teachers, i.e., prekindergarten and kindergarten teachers, use inquiry-based instruction to teach mathematics students deepen their problem-solving and critical thinking skills (Sumarna et al., 2017). Early childhood mathematics sets the foundation for problem-solving and critical thinking. However, the subject of mathematics creates considerable anxiety and stress in many students (Sorvo et al., 2017). Inquiry-based instruction is one solution that can be utilized to decrease anxiety in students related to early childhood mathematics (Bailey, 2018). Increasing student engagement and fostering environments that promote student independence are pivotal in building young children's early foundational skills in mathematics.

The researcher selected a qualitative case study to examine teachers' knowledge and perceptions of inquiry-based instruction in mathematics in early childhood classrooms. Nine teachers and three administrators participated in the qualitative case study. Three research questions guided the study:

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

Description of Sample

The study took place in two NYC public schools. The researcher provided the principals of both schools with a description of the study, IRB approval (see Appendix D), informed consent form, and a permission to conduct research letter. Both principals offered permission to contact teachers at their respective schools. Creswell (2013) explained the need for purposeful sampling to gain an in-depth understanding of a specific, unique, or emerging phenomenon. In this study the researcher employed a purposeful sampling method to carry out data collection related to teacher perception of inquiry-based instruction in mathematics. After gaining permission to conduct research from the site principals, the researcher sent invitations to 15 teachers and two principals (see Appendix C). The researcher contacted the invitees via email and provided each with a background to the study, invitation, and an IRB consent form (see Appendix B). Nine of the 15 teacher invitees agreed to take part in the study. The study also included both site principals and one assistant principal, henceforth referred to as "administrators." The researcher included the administrators in the study to gain background knowledge related to the research topic.

A total of 12 participants took part in the study. The study sample included four prekindergarten teachers, five kindergarten teachers, and three administrators. All 12 participants were females. All participants except for one administrator, had at least three years of experience teaching. All nine teachers were considered effective instructors based on their most recent evaluations by administration. In NYC teachers, teachers are rated through Charlotte Danielson's framework. The evaluation examines teacher practices with a rating system of ineffective, developing, effective, and highly effective. Participants' experience in teaching and/or administration ranged from 3–18 years. Participants were given a letter number code to ensure

privacy and member checking. The number 1 represents all prekindergarten teachers, the number 2 represents all kindergarten teachers, and the number 3 represents all administrators.

Teacher 1a was a prekindergarten teacher in her third year of teaching this grade. She had utilized inquiry-based approaches for the last two years. Teacher 1a had 3 years of teaching experience in education in NYC schools.

Teacher1b was a prekindergarten teacher in her third year of teaching this grade. She had utilized inquiry-based approaches for one year. Teacher 1b had 3 years of teaching experience in education in NYC schools.

Teacher 1c was a prekindergarten teacher in her fifth year of teaching this grade. She had utilized inquiry-based approaches three years. Teacher 1c had 5 years of teaching experience in education in NYC schools.

Teacher 1d was a prekindergarten teacher in her sixth year of teaching. She taught prekindergarten for 2 years and kindergarten for 4 years. Teacher 1d had utilized inquiry-based approaches two years. Teacher 1d had 6 years of teaching experience in education in NYC schools.

Teacher 2a was a kindergarten teacher in her 10th year of teaching kindergarten. She had utilized inquiry-based approaches for 3 years. Teacher 2a had 10 years of teaching experience in education in NYC schools.

Teacher 2b was a kindergarten teacher with 18 years' experience; she had taught kindergarten, first grade, and second grade. Teacher 2b had utilized inquiry-based approaches for four years. Teacher 2b had 18 years of teaching experience in NYC schools.

Teacher 2c was a kindergarten teacher with 6 years of experience in kindergarten and second grade. She had utilized inquiry-based approaches for one year. Teacher 2c had 6 years of teaching experience in education in NYC schools.

Teacher 2d was a kindergarten teacher with 4 years of experience. She was new to the school and the district. Teacher 2d had utilized inquiry-based approaches during the current school year for the first time. Teacher 2d had 1 year of teaching experience in education in NYC schools.

Teacher 2e was a kindergarten teacher with 8 years of experience in the district but was new to the school. Teacher 2e had utilized inquiry-based approaches during the current school year for the first time. Teacher 2e had 8 years of teaching experience in education in NYC schools.

Administrator 3a was a principal at one study site. Administrator 3a had been a principal for 4 years; however, she had been in the field of education for 12 years. Administrator 3a had worked in the district office for 2 years and as a prekindergarten program director for 6 years.

Administrator 3b was a principal at one study site. Administrator 3b had been in leadership for 5 years. She had taught early childhood for 7 years in her current district for a total of 12 years in the field of education.

Administrator 3c was working with Administrator 3a at one study site. Administrator 3c had been an assistant principal for 3 years and had previously taught for 3 years in her current district. Administrator 3c had 6 years of experience in the field of education.

Table 1

Participant Demographics

Participant ID	Years Taught/Admin	Grades Taught	Years of Inquiry-based Teaching	Professional Development in Inquiry-based Teaching	Years in NYC Schools
School A					
T1a	3	PreK	2	Yes	3
T1b	3	PreK	1	Yes	3
T1c	5	PreK	3	Yes	5
T1d	6	PreK; K	2	Yes	6
School B					
T2a	10	K	3	Yes	10
T2b	18	K, 1, 2	4	Yes	18
T2c	6	K, 2	1	No	6
T2d	4	K	1	No	1
T2e	8	K	1	Yes	8
School C					
A3a	0/4	0	0	Yes	4
A3b	7/5	K, 1	2	Yes	12
A3c	3/3	2, 4	0	Yes	6

Upon confirmation of participation, each participant received background information about the study, ethical procedures for confidentiality, participant rights, and a timeline for setting up and conducting interviews via email. Participants were notified that individual interviews would be conducted to collect data and participants would have the opportunity to select the time and place for the interview. Participants returned the signed informed consent to the researcher at the beginning of the interview.

Research Methodology and Analysis

The researcher used a qualitative case study design to understand teacher experiences and perceptions of inquiry-based instruction in mathematics in prekindergarten and kindergarten. The

goal of this study was to obtain information from prekindergarten and kindergarten teachers regarding inquiry-based instruction in mathematics. Three research questions guided the collection of data. The data collection instruments for this study included preinterview surveys (see Appendix B), archival documents and artifacts, and one-on-one interviews guided by a set of open-ended questions (see Appendix C). The researcher collected data in multiple stages over the course of nine weeks.

Pilot sessions. The interview questions were piloted prior to use to ensure questions were clear and purposeful. In the pilot session the researcher presented the interview questions to 10 teachers who were not included in the study population. The 10 teachers included in the pilot sessions were all prekindergarten and kindergarten teachers. The pilot sessions took place several weeks prior to teacher interviews. The results of the pilot sessions yielded that the questions were clear; therefore, no questions were deleted or modified. The pilot session data confirmed the interview questions were well defined and would yield dependable results.

Preinterview surveys. The researcher emailed preinterview surveys (see Appendix A) to all participants to gather information on the participants' experiences with inquiry-based instruction. All participants took part in the survey. The survey results indicated that 100% of participants had experience with inquiry-based instruction. The survey results also revealed that 83% of participants had received professional development in inquiry-based instruction.

Interviews. The researcher conducted interviews at the two study sites in secure locations of the participants' choice. Each participant scheduled a time and location for the interview. After confirmation of interview time and location, the researcher scheduled all interviews. Interviews took place over the course of nine weeks. The interviews were recorded using voice memo and a digital recorder. The transcripts were saved on the researcher's personal

computer and a back-up digital copy was saved on a flash drive and locked in a secure location. The researcher used NVivo to transcribe all recordings. All participants were made aware of and consented to the use of audio recordings. Interviews lasted 30–45 minutes. Three participants provided a follow-up interview so the researcher could obtain clarification about statements made in the first interview.

Archival documents and artifact collection. During the process of data collection, the researcher collected and analyzed several artifacts. Artifacts included the core curriculum math program for all prekindergarten classrooms, curriculum maps, professional development agendas, Everyday Math kindergarten teacher's guide, reciprocal math teaching protocol, and Metamorphosis math. The artifacts provided a background of the math curriculum and highlighted the professional development teachers had in inquiry-based instruction.

Member checking. Member checking provided validity and triangulation to the study. After the first round of interviews, three participants required a follow-up interview of additional questions to assist with data collection. Upon completion of the data collection, the researcher transcribed the participants' responses. Participants received copies of their transcripts to review before the data-analysis process for member checking. Participants reviewed their transcripts to ensure the data were accurately recorded. None of the participants requested changes to the transcripts. Once member checking was completed, the data was then analyzed for common themes and patterns.

Data analysis procedures. Interviews were recorded and transcribed. Data were transcribed immediately following interviews using NVivo. The researcher completed six phases of analysis outlined by Braun and Clarke (2006). The phases included familiarization, generating initial codes, seeking themes within the codes, reviewing codes, uncovering themes, and naming

final selective themes (Braun & Clarke, 2006). The researcher reviewed the codes, trends, and themes outlined by NVivo's transcription of the data. Data will be stored in a software-protected folder for three years following the study as outlined in the Concordia University IRB protocol.

Summary of Findings

The purpose of this qualitative case study was to examine teachers' and administrators' perceptions of inquiry-based instruction in mathematics in early childhood. The goal of the study was to uncover themes and patterns related to those perceptions in response to three research questions. Initially eleven codes emerged. These codes were (a) inquiry-based instruction, (b) obstacles, (c) support, (d) scaffolding, (e) time on task, (f) student engagement, (g) student-centered, (h) reflection, (i) ownership of learning, (j) collaboration, and (k) monitoring. Five themes and six subthemes emerged from the coding and analysis of data. The themes that emerged from coding the data were (a) professional development, (b) curriculum, (c) planning and preparation, (d) student engagement, and (e) building foundational skills. The subthemes that emerged were (a) resources, (b) preservice training, (c) math talk, (d) group work, (e) time management, and (f) problem-solving skills. The presentation of findings is organized by Braun and Clarke's (2006) phases of analysis.

Phase 1: Familiarization of data. During the first phase of data collection the researcher read the interview transcripts several times. During this process, the researcher also read through the artifacts several times in order to ensure accurate transcription of the study data. This process also allowed the researcher to determine patterns and trends by identifying repetition of words and phrases to later create codes (Creswell, 2013). As words or phrases appeared in the transcriptions, the researcher assigned an identifying code to each (Saldaña, 2016).

The researcher followed the inductive data analysis method presented by Hatch (2002). Data were collected through preinterview surveys, one-on-one interviews, artifacts, and member-checking meetings with participants. Before the researcher uploaded the data into NVivo, the researcher began the initial coding process as described using Saldaña's (2016) analysis method. This entailed open coding (Saldaña, 2016), a process by which the data from the interviews, surveys, and artifacts were analyzed for repetitive words and phrases. Those words and phrases were then sorted and classified to form common themes and patterns using pattern coding (Saldaña, 2016). The researcher employed NVivo to identify and then confirm supplemental themes and patterns that may have escaped the attention of the researcher. The researcher also used NVivo to decrease the potential for researcher bias in reporting the findings. This process showed there were words and phrases used frequently by both the teachers and the administrators.

Phases 2 and 3: Generating initial codes and patterns. Saldaña's (2016) coding method and Hatch's (2002) inductive analysis method provided the framework for the creation of initial codes and patterns. The identified codes and patterns were confirmed with analysis generated through NVivo. The research questions that guided this study were:

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

When rereading each survey and interview response for each participant, the researcher used the research questions as a vehicle to constantly guide the coding process. The practice of constant comparison with the research questions allowed the researcher to reduce researcher bias. Additionally, keeping the research questions in mind aided the researcher in finding key terms for establishing themes, classification groups, and subgroups. Five themes emerged from the analysis of data: (a) professional development, (b) curriculum, (c) planning and preparation, (d) student engagement, and (e) building foundational skills. The researcher developed 11 classification groups or codes: (a) inquiry-based instruction, (b) obstacles, (c) support, (d) scaffolding, (e) time on task, (f) student engagement, (g) student-centered, (h) reflection, (i) ownership of learning, (j) collaboration, and (k) monitoring.

As terms and words were used, the researcher identified which category the words belonged under and terms were recorded (Saldaña, 2016). Transcriptions were then input into NVivo to confirm researcher-analyzed themes and codes. According to Saldaña (2016), a code is allocated for each repeated word or phrase appearing in the transcriptions and datasets. For example, one phrase consistently used in the one-on-one interviews was *student-centered*. Therefore, *student-centered* became one of the codes. In some instances, there were words or phrases that belonged to more than one code, such as inquiry-based instruction, student engagement, time on task, and monitoring. Participant T1c provided a statement that fell into these four mentioned codes:

> Inquiry-style lessons let me be able to assess what prior knowledge students are already coming into a lesson with and how much they are able to apply from the learning. I can also see how students follow directives and work with each other to complete tasks. Do

they shy away from participating or do they insert themselves? Are they able to organize their own thoughts from those of the group members?

Table 2 provides an overview of the research questions with themes and related codes.

Table 2

Research Questions and Associated Themes/Codes

Research Question	Themes	Codes
RQ1	• Professional Development	• Inquiry-based instruction • Reflection
RQ2	• Planning & Preparation • Student Engagement • Building Foundational Skills	• Scaffolding • Time on task • Student engagement • Student-centered • Ownership of learning • Collaboration
RQ3	• Curriculum	• Obstacles • Support • Monitoring

The reoccurrences of each word and phrase was documented both manually by the researcher and through the use of NVivo. The 11 key terms that developed from the themes from the participant transcriptions included: (a) inquiry-based instruction, (b) obstacles, (c) support, (d) scaffolding, (e) time on task, (f) student engagement, (g) student-centered, (h) reflection, (i) ownership of learning, (j) collaboration, and (k) monitoring. The 11 codes were then assessed based on the researcher's interpretation of the meanings (Creswell, 2013). The participants verified the interpretations during the member-checking meetings.

Code 1: Inquiry-based learning. All nine teachers who took part in the study articulated that from their perspective, inquiry-based learning is vital to early childhood students' ability to access information at their pace in the content area of mathematics. The elements of inquiry-based learning directly referred to including task cards, focusing prompts, grouping of students, and choice in demonstration of learning. During a one-on-one interview, T1c stated, "inquiry-based learning is crucial if you want students to work together collaboratively and to come to the learning on their own versus them just listening to us talk." Similarly, T2d stated:

> When I was first told about inquiry-based learning, I thought it was going to be a disaster. I questioned how my five-year-olds were going to be able to engage in a discussion and figure out a math problem all by themselves without me. Then when I saw it modeled, I realized I was not giving my students enough credit and that they could do more than I realized. So, I tried it. I put a math problem on the board, handed out counters, counting bears, and unfix cubes. I had a task card with step-by-step directions and matching pictures that served as a checklist for my little ones. I could not believe the conversations and arguments that they were having. Of course, there are times I have to step in or redirect the conversations, but overall, they do enjoy it and respond well to working together with the structures in place.

All of the participants spoke about the adaptability of inquiry-based learning for large class sizes. Participants stated they found it more manageable to group the students and have them work on a task with others to provide alternative ways of looking at the problem or to deepen the conversation, even at age five. Participant A3a, verbalized:

> When visiting classrooms, students [who] are in inquiry-based learning tasks seem to be more engaged in the task at hand. Another great aspect is when teachers give students the

> opportunity to demonstrate their learning in any way they want. It is always fun for me to see how the little ones show off their work.

Code 2: Monitoring. The process of monitoring learning is different for each teacher and the types of inquiry-based learning that are happening in the classroom. Participants spoke about monitoring the students' progress though tracking systems, monitoring students' time on tasks, and students' ability to reach the learning goal for the lesson; however, the methods teachers employed for monitoring were different. During the one-on-one interviews, participants repeatedly mentioned monitoring learning. Participant T1d said:

> Inquiry-based learning lets me monitor more than just students' completed work. It lets me into the child's head by listening in on the conversations that are happening in the groups. I can get an idea of what [the children] are thinking and how they are processing the information. I can then look for strengths and next steps that I need to work on with each child. This time also gives me the opportunity to confer with students and jot down notes on their ability to grasp the content.

Similarly, T2b said, "monitoring learning is crucial if we are going to make sure each child in the classroom learns and meets the learning target for each math lesson." T1a said,

> I turn the task cards into checklists with all the individual steps and an example to help [the students] if needed as a tool, then through the monitoring process I can assess the students' prior knowledge and performance level with the specific content.

Code 3: Scaffolding. The teachers spoke about scaffolding in a variety of ways throughout the one-on-one interviews; scaffolding was also demonstrated in the curriculum-based artifacts collected by the researcher. Participant T1b referred to scaffolding as "ways to get the student to be able to understand and apply a skill or strategy by providing [the student] steps

or tools." T2c said she used "scaffolding tools like individual checklists and procedure charts." T2b summarized:

> I scaffold the learning for the students by showing students a finished product before they do the task on their own, so that they have a model to use. In addition, I give the student their own step-by-step procedural chart for the specific strategy they are applying. If necessary, I also front load math terminology or give them a vocabulary bank to aid the students in understanding the math terms used.

Strategies for scaffolding and the math "hallmarks" are clearly stated in the math curriculum and curriculum maps to assist teachers with how to scaffold learning. Participants mentioned strategies such as "think aloud," modeling, leveled questioning and discussion techniques, number talks, and the use of manipulatives. Participant A3a stated:

> Scaffolding is imperative, especially for the struggling students. Scaffolding can be done in so many ways and can be as easy as providing discussion stems to start conversations or to provoke conversations. Another example could be providing students with a reference guide with vocabulary or examples to use as guides.

***Code 4: Time on task*.** All 12 participants discussed how they perceived inquiry-based learning to directly affect time on task. Generally, students in groups have an equal amount of time to work on a task. If a group finishes early there is a second task assigned usually kept in the group's folders. Some participants have technology assignments on Google-classroom or various other sites for students to complete if done early. There was improvement on the amount of time students were able to work on a task. Specifically, participants noticed an increase in the amount of time students were able to sit and focus on the task at hand. Participant T2a shared,

> Inquiry-based learning lessons provide students with time to talk and move around during the task; therefore, inquiry-based learning reduces the amount of time students need to be sitting and focused on just listening and provides students with an opportunity to move, manipulate, and talk, making them more interested in the task and in doing the work.

T2e said:

> I started setting a timer for each part of the lesson to gradually increase the time on task, so that the students had an opportunity to get used to focusing on one task for 5 minutes, then 7, 10, and now they can focus on one task for a minimum of 15 minutes, which is impressive for 5-year-olds.

As stated in curriculum maps and lesson plans, school expectations require a time allotment for each component of the lesson plan. This is the school's way of making sure that instructional time is maximized for each content area. Additionally, all 12 participants reflected on how monitoring time on task directly correlates to maximizing learning time. Participant A3c expressed:

> The more time students spend applying the skills and strategies learned through inquiry-based learning, the more learning and retention is happening. I see teachers actively walking [around] the room and listening to student responses to the prompts, which drives their instruction during conferring time and small group instruction. I have noticed a substantial growth in the amount of time students are applying a skill or strategy learned with blended learning versus traditional methods. [Students] also get more time to work when teachers are using inquiry-based learning versus the traditional teaching methods.

Code 5: Engagement. The term, engagement, occurred frequently in participant responses. Engagement was directly related to interview questions 9 and 10 and to participants' perceived increases in time on task. Each participant used the word engagement several times throughout the interviews. Participant T2a said,

> Student engagement comes from students spending more time on task and having the ability to apply the learning in a way that is appropriate for them. The more engaged the student is in the task, they more they are motivated and interested in doing the actual work I have assigned.

T1b stated:

> For me, with the class I have this year, one way to increase student engagement was to give them a menu of choices for what part of the task they wanted to do and how they were going to present it. The students got so excited to have a part in making the decision that they were focused on the task and completed it.

A3b said, "I have seen great success in classrooms where the teachers have the [students] do some work independently, some in groups, and some on the SMART boards; the movement seems to keep [students] engaged and on task longer."

Code 6: Student-centered. Student-centered in this study refers to a classroom environment that promotes interactions among peers within a task and allows students to navigate their classroom environment without the teacher. The teacher in a student-centered classroom is the facilitator and gives over control to the students but provides support. Participant T1c said,

> I believe my classroom is an example of a student-centered classroom because in my class we do a lot of collaborative assignments within the inquiry-based learning

approach. What I mean by that is that my students sit in clusters not rows, which makes it easier for them to have discussions and work together in groups. I also don't lead the lesson with a lecture. Instead, I present a math problem, give students the tools and materials they will need with the task cards that have the procedure and prompts to guide them through, and let them figure it out in their group. I walk around and ask questions or correct misconceptions as they arise, but [I do] not tell the students what they need to know.

T2d said:

> The reality is that we have to prepare our students for 21st-century learning, which is fixated on the ability to use critical thinking skills, not on being to solve a problem and get the right answer. It is about the process and procedure. Teachers who began teaching before Common Core are used to lecture style lessons; however, our students live in a world where they don't need us to tell them how to find 4 + 2 = 6; they can do that on their phones, iPads, or [they can] Google it. Teachers today are needed to deepen understanding and make connections so that skills and strategies can be applied in various situations. Learning is about problem-solving and reasoning. We must shift our thinking and methods to empower our students, not hold them back because we want to control what they learn, how they learn it, and how they apply it. A teacher's way is not the only way; I have learned so much from my students' strategies and ways to represent learning that I would never have thought of.

A3b, shared,

> From a leadership position, it is difficult to find ways to keep students on task for long periods of time, even with teachers who have the best plans. Making assignments and

> tasks led by students and providing them with choices has seemed to increase that engagement and time on task. Getting teacher buy-in is sometimes a challenge, but that is where we, the administration, need to provide more of that professional development and modeling for teachers to see and experience the benefits for themselves. Then we, the administration, can support the teachers in their implantation process.

***Code 7: Reflection*.** Reflection was a word that reoccurred often in the one-on-one interviews and in the curriculum-based artifacts, as a school-wide expectation is for students to reflect on their learning. Reflections were mentioned both by the teachers in reference to their own teaching practices and in relation to students' learning. All 12 participants discussed how teachers incorporated some form of reflection, whether student-driven or teacher prompted T1a said:

> I incorporate student reflection as a daily component of my classroom instruction at the end of each math lesson. In prekindergarten we reflect as a whole class and keep a whole class reflection chart so we can use it as a reference. Every Friday, as a class, we devote 5–10 minutes reflecting on the week and what we learned and how we applied the learning. I do my own reflecting as well on Fridays to assess what went well and what changes I need to make based off of the whole class reflection responses.

Teacher 2a said,

> In kindergarten we have the choice of keeping a class reflection chart or having the students reflect in their notebooks; because of the various performance levels of learners in the classroom I do both. In the beginning of the school year, we kept a whole class reflection chart; now the students are given the choice of which they prefer. One group will write on the chart and reflect together, while the other students reflect in their

> notebooks. Then I allow them 3–5 minutes to share out their reflections. The responses from their reflections guide my reflection on what skills or strategies I still need to work on, when and how to plan, deepening that understanding, and for which students I will do what.

The curriculum maps contained suggested reflection prompts such as:

1. What did you learn this week?
2. What strategy or skill did you learn?
3. How did that skill or strategy help you to learn?
4. What activity did you find engaging or interesting?
5. What questions do you still have?

A3b said, "Student reflections are needed to drive instruction for the teacher and guide planning and preparation when used as an assessment tool."

***Code 8: Collaboration*.** Collaboration in this study was twofold. Collaboration was viewed from the perception of the teachers in terms of working together for professional development. Collaboration was also viewed as the students' ability to work together in collaborative groups. A3c said,

> I just recently read somewhere that "students need a reason to collaborate." It went on to explain that if teachers assign work that is easy, students will just do it themselves and then share what they did with the group members, but then there is no collaboration. If the task is too hard, the struggling students do not have an entry point into the conversation; therefore, teachers must find tasks that are rigorous enough to push the thinking with prompts that can allow students to access the desired learning without turning them off to [learning] completely. That is not an easy task.

Teacher 2e said:

> I can assign students to groups and give them a task, but that doesn't mean the students will collaborate. Collaborative groups have to be taught and modeled for students especially in early childhood classrooms, where students don't have any prior experiences with collaboration. Students need to learn how to work with other students and what it means to be part of a team. Not one person does all the work and the rest talk; it is equal participation, utilizing individual strengths they don't know they have.

Teacher 2c stated, "I began by assigning roles to each student within the groups in order to make sure each child had a role and participated; now the students choose their roles." Regarding teacher collaboration, A3c said:

> Teachers are given planning time that is the same on each grade band to provide opportunities for collaboration. In addition, there are opportunities for school-wide planning sessions to align curricula vertically between grades. This aids in making decisions on curriculum refinements.

***Code 9: Ownership of learning*.** All 12 participants discussed ownership of learning and the transition from placing ownership of learning on the students rather than the teacher. T2b stated:

> I know every teacher at one time or another has had a student or group of students that seems to be unmotivated and no matter the rewards or systems in place, they don't ever seem to engage in the learning. Inquiry-based learning helps engage students because they see it as play and time to talk with their friends, but are actually learning, while they are "having fun." Not only do they engage in the learning task, but [they] take ownership of that learning and are proud to show what they can do.

T1a said:

> One way that gives ownership of learning to the students is by creating an environment where I seek information from the students rather than just tell them the information. I do this by asking questions throughout the inquiry-based learning lesson like, "How did you get to that? What were you thinking? What kinds of things did you discuss with the group? How did that help your thinking? How did that help your understanding?" Then I give them suggestions in writing as feedback for them to try in the next task.

Code 10: Obstacles. The obstacles in this study as identified in the responses to the interview questions referred to reasons why teachers find it difficult to incorporate inquiry-based learning approaches. T1d said, "one challenge with inquiry-based learning is keeping students on track with the conversation and making sure the students will be able to meet the learning outcome, especially with prekindergarten students." T2b said, "A challenge for me when it comes to inquiry-based learning is finding new ways to keep students engaged and building stamina with five-year-olds." T2e said,

> Inquiry-based learning is great, and I see my students making progress, but monitoring what they are doing both individually and in the group is challenging. What part did they contribute, how much did they know, and how much did they learn are questions I ask myself and have been trying to find a monitoring system for, but I haven't quite got one that answers all those questions.

Code 11. Support. In this study, the term support referred to the assistance teachers receive from each other and from administration, school leaders, or both. A3a said:

> Support can look differently for each person, based on the individual strengths and needs. Our approach at this school is to give teachers options of how they will receive support

and how they can support each other. For example, there is a menu of various "lunch and learns" and afterschool professional development opportunities that teachers hold for their peers to share information learned and implemented. These opportunities provide a platform for teachers to share their best practices and for other teachers to seek help in being able to implement a concept in their own classrooms with the support of their peers. The information sessions may then lead to intra-visitations and lab sites that are initiated by the teachers. I support this process. My part in that is to find teachers that have a best practice and bring it to light by highlighting them in meetings or setting up opportunities for them to share their practices.

Phases 4, 5, and 6: Theme development. During the final phases, the researcher combined similar terms to find themes. Initially, the researcher combined similar terms to find broad themes then narrowed the overarching themes into five final themes. Through the evaluation of the data key themes emerged through the identification of commonalities in words and phrases from the participants' responses. During the process of transcribing the data, the researcher analyzed the recurring codes several times. The top five themes that emerged in this process were based on importance and frequency among participants' feedback when obtaining the key subthemes. The five themes were: (a) professional development, (b) planning and preparation, (c) student engagement, (d) building foundational skills, and (e) curriculum. Each of the themes is explored to answer the three research questions.

***RQ1*.** How knowledgeable are teachers in inquiry-based instruction in early childhood mathematics?

Theme 1: Professional development. Professional development sessions aid teachers by providing opportunities to build knowledge about inquiry-based instruction and how to

implement inquiry-based instruction within the classroom. Teachers felt they had significant knowledge around inquiry-based instruction. However, teachers felt they could improve inquiry-based practices and make them interdisciplinary. Administrators believed there are effective teaching practices around inquiry-based instruction that should be incorporated at the building level. Both perceptions can be addressed through professional development. Teachers and administration credited professional development opportunities for the success of inquiry-based instruction thus far. Teachers also felt further professional development will help strengthen their current practices in inquiry-based instruction. Several teachers explained that without professional development they would not be successful in knowledge and implementation of inquiry-based instruction. Some teachers pointed out that there was a lack of or no training in inquiry-based instruction in their teacher preparation programs.

Theme 2: Planning and preparation. Planning and preparation play a significant role in the success of inquiry-based instruction, but at first posed a challenge for teachers. Teachers admitted that making connections from their knowledge of inquiry-based learning and the implementation of the approach took planning and preparation. Teachers were able to apply knowledge gained about inquiry-based learning to planning lessons with the essential components of inquiry-based instruction.

Theme 3: Student engagement. Student engagement is crucial to learning and motivating students to stay on task in order to complete assignments. Teachers and administrators believed their knowledge of inquiry-based instruction and the approaches to inquiry-style lessons increased student engagement since inquiry provides students opportunities to interact with the content. Teachers and administrators also disclosed that students were able to take ownership of the learning through inquiry-based learning, which also increased engagement. Administrators

felt that when teachers had a clear understanding of inquiry-based instruction there was greater success of implementation. Several administrators expressed that in classrooms where inquiry-based instruction was implemented there was an increase in student engagement. This was visible through student confidence, student led discussions, student participation, and increase test scores.

Theme 4: Building foundational skills. Building foundational skills was perceived to be the result of inquiry-based instruction and the knowledge base of the teachers as well as the administrators. Teachers discussed that their knowledge of inquiry-based instruction helped them to develop lessons that provided students with supports to build foundational skills and to build on those skills from lesson to lesson. Teachers applied strategies of learning to various tasks. Administrators discussed the impact of knowledge on using inquiry-based instruction to provoke discussions and higher-order thinking to build foundational skills.

Theme 5: Curriculum. Curriculum is the culmination of the professional development and reflection on planning. Teachers and administrators revealed that the curriculum is refined from year to year based on the feedback from teachers and administration. Additionally, reflections on planning and professional development opportunities guide changes to the curriculum as curriculum must incorporate teaching practices that are believed to be effective. Knowledge of inquiry-based instruction is crucial in making decisions for improvements to the curriculum and overall student achievement.

***RQ2*.** What are teachers' perceptions of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

Theme 1: Professional development. Throughout this study, all 12 participants verbalized the importance of professional development around inquiry-based instruction. One major

argument was that teachers found the opportunity to view inquiry-based instruction in action during professional development sessions helpful. The visits allowed the participants to see how inquiry-based instruction differs from traditional teaching methods of instruction. The demonstrations provided a framework for implementation and application of inquiry-based instruction, but also guided future professional development opportunities as well. Participants, 2c and 2d had no professional development in inquiry-based instruction. However, they seemed to have a clear understanding of inquiry-based instruction. Participants, 2c and 2d explained that professional development is vital to the learning process and they would greatly appreciate the opportunity to learn more about inquiry-based instruction in mathematics.

Theme 2: Planning and preparation. The 12 participants admitted that planning and preparation looks significantly different in inquiry-based lessons than traditional style lessons. The biggest difference is that with inquiry-based lessons, the ownership of learning is on the students. Educators act as facilitators and set up prompts or scaffolds to guide the students to the learning without directly front-loading the information. The learning in inquiry-based lessons is acquired through discourse around the content. In traditional lessons, the teacher directly provides information and students jot notes to use for an assigned task. The teachers who participated in this study verbalized the mindset change that must occur in order to gradually release that responsibility to the students. The administrators admitted that evaluations became a significant part of how the teacher used data and supports to ensure all students had access to the learning.

Theme 3: Student engagement. All 12 participants provided an in-depth discussion of their perceptions of inquiry-based learning to increase student engagement considerably over traditional style lessons. The participants attributed increased student engagement to the

collaborative nature of inquiry-based instruction. Students have opportunities to "talk and play" but in a way that promotes learning with planned scaffolds. Inquiry-based instruction provides a structure for students to interact with the content rather than just being passive listeners. Students demonstrated an increase in collaboration and discussion when inquiry-based instruction was successfully implemented. Teachers explained that traditional methods such as teacher directed lessons had a low level of student engagement. Students also struggled to develop a cognitive understanding of early mathematical concepts. However, when teachers used the inquiry-based approach there was an increase in student engagement and understanding of mathematical concepts.

Theme 4: Building foundational skills. Teachers and administrators verbalized how impressed they were with the increase in students' foundational skills through the use of inquiry-based instruction. The overall consensus of the participants was that traditional lessons do not allow for differentiation, but inquiry-based learning does. Inquiry-based instruction uses student data to group students and drive assigned tasks. Inquiry-based instruction also provides opportunities for students to participate in tiered assignments and roles, regardless of performance level.

Theme 5: Curriculum. All 12 participants will be able to use the findings of this study and the reflections gathered after planning to adjust the curriculum. Adjustments may include incorporating more inquiry-based lessons rather than traditional lessons. Participants voiced an increase in retention and achievement when lessons were inquiry-style versus traditional lecture. Additionally, teachers felt more comfortable verbalizing challenges faced during implementation of inquiry-based instruction as well as the support and monitoring systems needed for success. Teachers explained that inquiry-based instruction would support the mathematics, reading, social

studies, and science curriculum. However, teaching writing needs far more teacher modeling and direct instruction. Administrators had an opportunity to consider the teaching and learning implications of inquiry-based instruction on math performance compared to traditional teaching methods.

RQ3. What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

Theme 1: Professional development. The administrators who participated in the study voiced that professional development would provide an appropriate vehicle for addressing the obstacles that teachers disclosed throughout the process of this study. Teachers suggested professional development opportunities on topics related to the support systems they felt they needed or would benefit from to improve inquiry-based learning practices. All participants admitted that professional development is needed to expand inquiry-based instruction school-wide. Administrators discussed the financial constraints in providing professional development. Some administrators pointed out budget cuts and funding impact the number and types of professional development. However, administrators expressed that empowering teachers to share best practices through intra-classroom visitations and lunch and learns would help in deepen the staffs understanding of inquiry-based instruction without formal professional development. All participants pointed out that visiting schools or other sites to see exemplar inquiry-based instruction classrooms would benefit their practice.

Theme 2: Planning and preparation. Planning and preparation are crucial to inquiry-based learning, as the teacher must plan ahead the supports that will be needed for students to be self-regulated in completing tasks. Both teachers and administrators voiced concerns related to the implementation of inquiry-based learning. One concern was the amount of time spent on

planning for independence and self-assessment. Another concern was monitoring student work and accountability for cooperative learning tasks. Through this study however, teachers and administrators understood the importance of realizing the systems that are needed for success.

Theme 3: Student engagement. All participants significantly discussed struggles with student engagement that were improved with inquiry-based learning. All participants verbalized that with inquiry-based instruction students had increased stamina and were able to spend more time on task without distractions. All participants recommended the use of inquiry-based instruction as a tool for increasing student engagement in learning. A challenge to inquiry-based learning included engaging all students in one task; however, the consensus was that providing scaffolds and differentiating for the various needs allowed students to be engaged in the learning as they had entry points for access.

Theme 4: Building foundational skills. Teachers described their struggles to build foundational skills for each student, especially in classrooms with over 30 students with various needs. Teachers described obstacles related to foundational skill building including entry points and prior knowledge about math skills. Participants discussed the need to consider each individual's learning style and individual students' gaps in knowledge when creating lessons. Teachers explained that many students struggle with social skills that greatly impact their learning. Teachers explained that many students struggle to engage in discussion, participate in whole class or small group activities. Another obstacle teachers pointed out is that students struggle with problem-solving. They are not solution oriented. All participants believed inquiry-based instruction can offer opportunities for building foundational skills and challenge students to improve. Teachers claimed that inquiry-based instruction can offer students a greater opportunity to build social skills and become solution oriented.

Theme 5: Curriculum. Teachers described obstacles related to the curriculum. Teachers struggled to make existing curriculum hands-on and interactive for inquiry-based learning. Another struggle outlined by the teachers was time management. Staying on track with the pacing of the curriculum is difficult when using the inquiry-based approach. Teachers found that inquiry-style lessons took a significant amount of class time. The struggle of balancing time and using inquiry-based lessons to deepen mathematical concepts was a concern for many of the participants. All participants verbalized the struggle to design inquiry-style lessons but found that once they tried inquiry-based approaches, students were able to retain the information and apply it in more ways. The participants described increased student involvement and student achievement stemming from the use of the inquiry-style approach in contrast to traditional teaching methods. Realizing these outcomes made teachers feel more comfortable with inquiry-based instruction.

Summary

The teachers in this study felt inquiry-based instruction in early childhood mathematics had a significant impact on student learning and engagement. Teacher T2d summed up inquiry-based instruction in mathematics as both engaging and fun. The findings showed that inquiry-based instruction in mathematics in early childhood provides students with learning opportunities that foster critical thinking skills. The participants explained that the implementation of inquiry-based instruction is not without obstacles. Participants described obstacles related to time management, planning, and curriculum pacing. The findings from this qualitative case study resulted in five key themes: professional development, planning and preparation, student engagement, building foundational skills, and curriculum.

The inquiry-based instruction for early childhood mathematics experiences of prekindergarten and kindergarten teachers and administrators at two elementary schools are summarized in Chapter 5. The overall influence of inquiry-based instruction on student engagement and achievement is presented. Chapter 5 also contains an overview of how prekindergarten and kindergarten teachers and administrators described inquiry-based instruction in mathematics and a discussion of the results as they pertain to the literature review. Chapter 5 includes the limitations and delimitations of the study and several recommendations for practice and research.

Chapter 5: Discussion and Conclusion

Chapter 5 contains a summary of the study, the conclusion, and the teaching and learning implications that will guide future professional development for improvement of teacher pedagogy. The purpose of this qualitative study was to explore teacher perceptions of the benefits of inquiry-based instruction in early childhood mathematics. Inquiry-based instruction provides benefits for building foundational mathematical skills for early childhood students (Bailey, 2018). Chapter 5 includes a discussion of how inquiry-based learning impacts math instruction in early childhood and the obstacles that keep educators from using inquiry-based learning from the perception of teachers and administrators. The findings' relevance to the literature reviewed in Chapter 2 related to constructivism is noted to substantiate the conceptual framework of the study. The chapter includes recommendations for teachers to develop teaching pedagogy, professional development opportunities, and implementation of inquiry-based learning using the research from this study. Chapter 5 concludes with recommendations for further research and a conclusion.

The researcher conducted a qualitative case study to determine the impact of inquiry-based instruction in mathematics in prekindergarten and kindergarten classrooms in two NYC schools. A case study allows for responses to questions about present day issues (Yin, 2014). Case study constitutes an effective research approach that uses questions and analysis to connect data and establishes criteria for interpreting the findings of the study (Yin, 2014). One reason the researcher chose to conduct a qualitative study is that the existing literature on inquiry-based learning is rarely qualitative in nature or based on the perceptions of teachers (Abdi, 2014; Bailey, 2018). This qualitative study was an attempt to engage participants in a discussion of their experiences with inquiry-style lessons. The focus of this case study was to gain an

understanding of teacher perceptions of inquiry-based teaching and learning in mathematics in early childhood. Gaining teacher understanding of inquiry-based instruction is instrumental in identifying the factors in early childhood that may impact the development of mathematical skills, and consequently increase student engagement and improve academic achievement. The selection of a qualitative method allowed more flexibility during data collection compared with quantitative research. A qualitative method was useful for exploring participants' firsthand experiences and perspectives on inquiry-based instruction in educational settings (Maxwell, 2012; Merriam & Tisdell, 2015; Ritchie et al., 2015).

The researcher conducted open-ended interviews with nine teachers and three school administrators in two NYC public schools to explore teachers' perceptions of inquiry-based learning in mathematics in early childhood classrooms. Findings from this study highlight the value of inquiry-based instruction and its effectiveness in early childhood mathematics from the perspectives of educators who utilize inquiry-based approaches in the classroom.

Summary of the Results

The research questions that guided this study were:

RQ1: How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?

RQ2: What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods?

RQ3: What perceptions of obstacles do teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction?

The research questions were directly related to the participants' perceptions of inquiry-based instruction as a vehicle for increasing student achievements in mathematics. The

researcher selected the questions to determine the impact inquiry-based learning has on math instruction in early elementary classrooms. Twelve teachers and administrators in two public elementary schools located in NYC participated in the qualitative case study. The researcher used one-on-one interviews, teacher surveys, review of artifacts, and member checking sessions to collect data for the study. Data collection methods allowed for an in-depth discussion with each participant regarding the educator's perceptions of the use of inquiry-based learning in early elementary mathematics instruction.

The questions developed by the researcher for the one-on-one interviews and survey were intended to support the topic of inquiry-based learning and its impact on mathematics achievement. Additionally, the questions allowed the researcher to gain insight into educators' knowledge about inquiry-based instructions and obstacles to implementation of inquiry-based instruction in the mathematics classroom. The questions used for the interviews afforded various opportunities for a comprehensive dialogue around inquiry-based instructional approaches to teaching and learning from the collection of teachers and administrators who participated in the study.

The results of this study showed that teachers and administrators believe inquiry-based learning is an effective approach to increasing math instruction in early elementary classrooms. Five themes emerged from the analysis of the data: (a) *professional development,* (b) *planning and preparation,* (c) *student engagement,* (d) *building foundational skills,* and (e) *curriculum*. The 11 classification groups or codes developed by the researcher included (a) inquiry-based instruction, (b) reflection, (c) scaffolding, (d) time on task, (e) student engagement, (f) student-centered, (g) ownership of learning, (h) collaboration, (i) obstacles, (j) support, and (k)

monitoring. The alignment of the research questions and associated themes/codes is presented in Table 2 in Chapter 4.

All 12 participants suggested inquiry-based learning is an effective method of teaching that increases mathematics achievement. Teachers and administrators verbalized they saw increased time on task, which maximized learning time. The results support the themes and codes discovered in the analysis of data.

Participants described their experiences with inquiry-based instruction as impactful in creating a student-centered environment that promotes content-rich discussion in collaborative groups without direct instruction from the teacher. The teacher in a student-centered classroom is a facilitator who provides support as students acquire learning. All 12 participants verbalized a fundamental component to building a student-centered classroom is planning and preparation as well as having supporting resources to supplement the curriculum. Planning and preparation are vital in developing systems for monitoring and collaboration within inquiry-based tasks. The administrative leaders at both study sites fully supported inquiry-based learning as an instructional practice. School leaders and administrators supported teachers by sharing practices and resources and providing professional development around inquiry-based learning. The purpose of professional development is to provide support to teachers who are willing to implement inquiry-based learning, and to make inquiry-based learning a school-wide practice.

Discussion of the Results

Five themes emerged from the findings of this study: (a) professional development, (b) planning and preparation, (c) student engagement, (d) building foundational skills, and (e) curriculum. Each theme will be reviewed below.

Professional development. The theme, *professional development*, directly answered RQ 1: *How knowledgeable are teachers in inquiry-based instruction in mathematics in early childhood classrooms?* Analysis of one-on-one interviews and teacher surveys identified professional development as a theme to describe the use of inquiry-based learning. Teachers and administrators worked together to provide professional development opportunities. Professional development is critical for training teachers on nuances of inquiry-based instruction and expectations for implementation in the classroom. Leaders who plan for professional development opportunities must take into consideration the school's overall vision and goals for improvement. Professional development is essential for creating consistency within a specific practice and around the school vision. Haslip and Gullo (2017) concluded professional development helps teachers develop 21st-century skills and build confidence in their practices.

Through *professional development* teachers receive the support and materials needed to be successful in implementing instruction and meeting school expectations. Teachers explained they have greater success with follow through of inquiry-based learning when administrators are monitoring and examining the practices taught during professional development. Many teachers also verbalized feeling more confident in their inquiry-based instructional practices when they are asked to partake in curriculum revisions and decisions. Haslip and Gullo (2017) supported the confidence building teachers feel through professional development. Teachers expressed appreciation for the opportunity to offer professional development to other teachers based on the successes they are having with inquiry-based learning.

Professional development is necessary to emphasize a common language and unified vision for expectations and practices within a school. Administrators and educational leaders can offer professional development opportunities to address gaps found in teacher pedagogy,

curriculum, and instruction. Professional development in inquiry-based learning provides a framework for teachers to implement a student-centered environment. Erfjord et al. (2012) stated that support for teachers through professional development helps build teacher pedagogy and strengthen instruction. The key to building a school-wide practice in which teachers feel confident in implementing inquiry-based learning is to make professional development a priority (Erfjord et al., 2012). Teachers and administrators agreed professional development helped strengthen the practice of inquiry-based instruction at their schools.

Planning and preparation. The discussion of successful implementation of inquiry-based learning practices revealed the theme of *planning and preparation* in answer to RQ2. True success in inquiry-based instruction requires planning and preparation (Love et al., 2015). Planning and preparation play a significant role as teachers develop a student-centered classroom. Structures should be considered and addressed to support independent learning. Teachers verbalized protocols, procedures, checklists, task cards, and support tools should be prepared prior to the lesson and should be available for students' use during the lesson. Love et al. (2015) explained supportive structures should be in place and consistently used from the beginning of the school year to set expectations for inquiry-based learning. Student-centered environments afford students control over their learning at a pace at which they are able to learn. Teachers and administrators denoted inquiry-based assignments create a student-centered learning environment that promotes increased questioning and discussion techniques, collaboration, and problem-solving. Giving students more control also increases their engagement and retention.

Student engagement. *Student engagement* emerged as the first theme in answer to RQ2: *What is the teacher's perception of the value of inquiry-based instruction and its effectiveness as*

opposed to traditional teaching methods? Student engagement was determined by time on task, student engagement, ownership of learning, and collaboration. Teachers monitored time on task to be longer during inquiry-based learning tasks versus traditional lecture methods of instruction. Teachers noted inquiry-based assignments increased the level of student engagement in assigned tasks. The results of the study suggest that inquiry-based learning classrooms create a collaborative environment where students can take ownership of their learning through hands-on tasks. Based on data gathered about the students, teachers designed learning tasks that allowed all students in the assigned groups to participate and to improve students' understanding of content. Data is an important driving force to instruction, as it allows the teacher to adjust lessons and tasks.

Building foundational skills. The theme of *building foundational skills* emerged as teachers discussed collaboration with curriculum in answer to RQ2. Based on their perceptions, teachers disclosed students were not engaged in independent learning because they lacked the foundational skills to enter conversations around a topic. Building students' foundational skills allows students to take risks and gain control over their learning (Wu, 2014). Without prior knowledge in a topic, discussion cannot take place, nor is there an entry point into a conversation about the topic. Teachers and administrators admitted that building foundational skills is crucial for progress and mastery of standards. Wu (2014) explained students are highly motivated in early childhood and building early numeration skills in young students can have a positive impact on their ability to learn mathematics. Without foundational skills, connections cannot be made to new learning (Wu, 2014). Scaffolding lessons to meet the needs of all students will help students make connections to learning. Scaffolding also allows students to build foundational skills at their own pace. Additionally, the depth of knowledge suffers when foundational skills

are lacking (Hourigan & Leavy, 2017). Teachers in this study explained inquiry-based lessons gave students the opportunity to build foundational skills in mathematics. As Wu (2014) explained, building early foundational skills in mathematics is core to success in mathematics.

Curriculum. RQ3 was supported through the theme of *curriculum*. Teachers explained curriculum should be aligned with support for inquiry-based instruction. Hourigan and Leavy (2017) stated teachers must have a clear understanding of math curriculum so they may apply inquiry-based instructions to assignments. Curriculum poses an obstacle for teacher implementation when it is not aligned with support inquiry-based instruction. Cook and Borkovitz (2017) argued that having an inquiry-based math program and curriculum in early childhood can help students succeed as lifelong mathematicians. Teachers in this study explained some math programs used in the curriculum do not always support inquiry-based instruction. This obstacle of adopting math programs that do not support inquiry-based instruction also impacts teacher implementation of inquiry-based learning. Teachers explained their challenge is to find ways of adapting the curriculum or changing it to utilize a more inquiry-based approach. Teachers stated greater support from administrators is needed to revise and adapt math curriculum. Teachers also shared support through monitoring will aid in understanding and implementing inquiry-based instruction in the classroom. Teachers stated administration can provide monitoring through classroom visits and feedback to help improve practice.

Administrators commented they struggle to find math programs that support inquiry-based instruction. Administrators stated schools are limited in their choices of math programs based on district-approved curriculum. This obstacle impacts what program is utilized in the school. Administrators agreed there is a greater responsibility on administration, staff, and teachers to revise the program and curriculum to support inquiry-based instruction. Time and

teacher support hinder this process. Administrators pointed out that revising the curriculum takes a great deal of time and organizing teacher schedules to involve them in the process poses a challenge. Administrators also indicated that many teachers do not always want to stay after school or attend Saturday planning sessions. The challenge for administrators is organizing teachers and staff to work together in revising the current curriculum.

Summary of themes. The results of this study confirmed inquiry-based learning has a direct impact on students' ability to master mathematical standards in early childhood. Inquiry-based learning is demonstrated to improve student engagement, student ownership of learning, and promote greater success in building foundational skills in mathematics (Cook & Borkovitz, 2017). However, teachers must ensure they are planning for and providing the necessary supports for every student to have access to that learning.

The results of this study directly answered the research questions with respect to teachers' knowledge base related to inquiry-based instruction in mathematics in early childhood classrooms. Teachers and administrators reflected on their perceptions of the value of inquiry-based instruction and its effectiveness as opposed to traditional teaching methods. Participants also offered reflections on the obstacles teachers, administrators, and school district leaders have regarding the use of inquiry-based instruction.

Discussion of the Results in Relation to the Literature

The conceptual framework for this study was constructivism. Constructivism in education represents a shift in so-called "standard" or "traditional" teaching practices (Serafín et al., 2015). Constructivism is derived from the broader concept of social constructivism, and when applied to pedagogical theory, constructivism shifts the educator's role from lecturer to facilitator (Wu & Lin, 2015). Inquiry-based learning enhances the role of the teacher as a

facilitator, shifting the responsibility for learning to the student. Inquiry-based learning promotes individual meaning-making, supporting constructivism.

Inquiry-based instructional practices provide teachers with a complementary approach to traditional classroom instructional practices (Eckhoff, 2017). Inquiry-based lessons increase student engagement by placing the focus on questioning and discussion techniques that lead students to their own learning (Eckhoff, 2017). The participants in this case study verbalized inquiry-based instructional practices increased student engagement. Participant T2a explained inquiry-based lessons provided students with a greater amount of time for discussion. In inquiry-based style lessons, educators are facilitators who guide students to the learning rather than front-load it (Smith et al., 2005). One goal of inquiry-based learning in mathematics instruction is to increase student achievement in the mastery of math skills and strategies, specifically in grades prekindergarten and kindergarten as well as to increase student engagement and achievement in the lower elementary grades (Eckhoff, 2017). However, for inquiry-based learning to be successful, teachers must have knowledge of teaching math with inquiry techniques (Kubicek, 2005).

Inquiry-style lessons release some of the teacher control to the students in order to foster child-centered classroom environments (Eckhoff, 2017). Participant T1b stated giving students choice through a menu option created excitement. Participant T1a also pointed out handing control of learning over to students made students enthusiastic about the learning. In inquiry-based lessons, students obtain learning themselves through prompting and discussions with peers strategically planned by the teacher (Smith et al., 2005). Inquiry-based instruction can lead to collaboration for better problem-solving strategies. Participant A3b pointed out teachers who utilize inquiry-based approaches experience success in student engagement, especially in

collaboration. Teachers merely lead students to the learning with supportive guidance, but not direct teaching (Smith et al., 2005).

Constructivist theory proposes student engagement and achievement are fostered when educators create a student-centered learning environment. Traditional or lecture style lessons decrease student engagement and increase frustration levels when content is either too easy or difficult for students to comprehend (Skinner et al., 2009). Escalated frustration can lead to unfavorable behaviors, which ultimately affect instructional time (Skinner et al., 2009). Consistent with Haslip and Gullo's (2017) findings on math anxiety, all participants except T1d, T2b, and T2e explained their students showed the greatest frustration and anxiety in mathematics. Participants' statements supported the idea that anxiety in early childhood mathematics is a common phenomenon (Sorvo et al., 2017). Sorvo et al. (2017) found students' early fluency in mathematics was actually the greatest weakness and a significant reason for math anxiety. Math anxiety affects students as young as kindergarten because of rigorous expectations placed on students (Sorvo et al., 2017). High demands cause students to fall behind and create gaps in learning.

Participants A3a, A3b, and A3c stated in some cases educators also have anxiety in teaching mathematics. Haslip and Gullo (2017) found teacher anxiety is portrayed by a teacher's lack of confidence with the content. Evidence exists of an increase in teacher anxiety for teaching mathematics because of teachers' own math frustrations (Haslip & Gullo, 2017).

Inquiry-based learning takes frustration into consideration as inquiry-based learning benefits student engagement (Smith et al., 2005). Participants credited inquiry-based instruction as a method to break the cycle of math anxiety, consistent with Sorvo et al.'s (2017) findings that building foundational problem-solving skills and fluency in early childhood is crucial to break

the cycle of math anxiety. Participant A3b stated through inquiry-based lessons there is in improvement in problem-solving skills and strong reasoning skills. Inquiry-style lessons are more likely to support student learning because students learn through investigation and discussion (Glassman, 2001). According to Kubicek (2005), traditional teaching does not allow students that opportunity; instead, students are expected to apply skills in a repetitive manner for memorization of facts rather than understanding. Kubicek also indicated traditional style lessons do not always motivate students to take an interest in the task at hand in the same way as inquiry-style lessons.

Inquiry-based instruction is geared toward promoting student independence and self-regulation within the classroom (Glassman, 2001). Inquiry-based instruction utilizes exploration and investigation to lead students to take ownership of learning (Kubicek, 2005). Kubicek (2005) described how inquiry-based lessons are designed to ignite inquisition on a topic. The challenge for teachers is ensuring all students have an entry point into the discussion and tools to access learning needed to be successful. Successful implementation involves knowledge of the curriculum, learning standards, and targeted outcomes students are expected to master (Kubicek, 2005). Once teachers have curriculum knowledge, decisions can be made on how to close learning gaps and meet learning standards. The student role in inquiry-based instruction is to collaborate with peers and work together to explore material presented with the support structures provided (Kubicek, 2005). Participants explained planning and preparation is vital to successful inquiry-based lessons. Through planning and preparation, teachers provided tools to help guide students so the teacher would not have to dictate what students should do; rather, students looked at the tools and then decided how to interpret/apply them to solve their problems.

Scaffolding is one way to help all students be successful and have equal opportunities to engage in learning (Glassman, 2001). Scaffolding provides students with the support needed to enter and stay engaged in a learning task (Glassman, 2001). Scaffolding in inquiry-style lessons provides students with a checklist or prompts to ensure students can access learning with direct help from the teacher (Hmelo-Silver et al., 2007). Teachers must also assess what knowledge students already have or the gaps present within a specific topic or content. Scaffolds offer students the ability to use what they know to figure out what they do not know (Hmelo-Silver et al., 2007). Participants T1a, T2b, T2c, and T2d stated scaffolding the learning allows the teacher to differentiate and meet the needs of each child. Participant T2c explained scaffolding promotes greater student engagement.

Hitt and Smith (2017) conducted a study comparing scaffolding techniques within an inquiry-based model. Hitt and Smith found providing scaffolds through inquiry-based lessons increased student engagement significantly. Participant T2c stated scaffolding activities give equal opportunity for students to be part of learning. Scaffolding helps ease their frustration because they have a system of support. Hitt and Smith indicated scaffolding permits students to work at their own pace to take ownership of learning. Teacher roles are simplified in inquiry-based lessons (Kirschner et al., 2006), making planning and preparation vital to the success of inquiry-based instruction. Scaffolding provides tools and support for all learners in the classroom (Hitt & Smith, 2017). Some scaffolding tools are graphic organizers, math manipulatives, and leveled questions. When teachers scaffold the lesson using leveled questions, they are able to meet the various needs of the different learners. Hitt and Smith (2017) explain that scaffolding includes providing support for struggling learners and building from their various entry points.

Teachers in this study also highlighted challenges and considerations such as release of control, planning and preparation, and time management. One consideration for inquiry-based learning is to develop systems for gradual release of responsibility to students (Kirschner et al., 2006). The main concern is to develop systems and routines such as having group leaders, materials organized and labeled, using a timer for time management, having time at the end of the lesson for students to share, and having task cards with clear instructions. Barron and Darling-Hammond (2008) explained teachers must be consistent with the routines they set in place and keep expectations clear for students. Participants in this study stated that time for planning and preparation was a challenge. Participant T2a pointed out inquiry-based lessons take much planning and time management is a concern. Participant A3a explained supporting teachers in the planning and preparation process is essential and collaboration is vital for success. Participant T2c shared lesson plans must specifically demonstrate how all students will be supported to participate and accomplish desired outcomes for the lesson. When students feel supported, they feel safe to explore and problem solve (Lott et al., 2013).

Inquiry-based learning lends itself to early childhood since young children are already inquisitive by nature (Lott et al., 2013). Hourigan and Leavy (2017) confirmed students learn best through interactions with the content. Inquiry-based learning provides a structure for that interaction, where students are held accountable to the task and teachers can monitor and assess learning.

Inquiry-based lessons not only engage students by affording them time to interact with the content, but also foster foundational skills that may be lacking through discourse with peers about the content. Student engagement is crucial for early childhood, especially prekindergarten and kindergarten aged children. Kroll and Meier (2017) confirmed students in early childhood

require learning that is hands-on and engaging. Kroll and Meier recommended using play within inquiry-based learning to afford students chances to cultivate critical thinking skills. Kemple et al. (2015) explained how using play with prekindergarten and kindergarten students can increase student engagement. Play allows students to use problem-solving skills, creativity, and collaboration, which directly impact the growth of social skills (Kemple et al., 2015).

Inquiry-based learning increases engagement with the use of technology. Levin and Tsybulsky (2017) investigated the effect technology and STEM learning had on increasing engagement with inquiry-based instruction. Levin and Tsybulsky concluded there was a direct correlation between technology use and focus on task. All participants in this study agreed inquiry and play are vital to the learning process of early childhood students. Participants A3a, A3b, and A3c stated emphasizing play in early childhood is at the core of their early childhood curriculums. Technology such as games, songs, and interactive activities foster play in the classroom (Kemple et al., 2015). Interactive activities include but are not limited to solving math problems directly on tablets, using various math tools on-line to solve word problems, creating graphs and charts on tablets or laptops. Levin and Tsybulsky (2017) shared the positive impact of using technology to enhance learning in mathematics and how interactive math games build a love of mathematics.

The findings of this study revealed inquiry-based instruction gives students ownership of learning. Participants T2b and T1a stated a child-centered learning environment provides students with an opportunity to be independent learners. When students are in the driver's seat there is greater enthusiasm and increased achievement (Glassman, 2001). Through essential planning teachers can set up parameters to support the inquiry process. Resources, materials, and tools are critical to support students in acquiring intended learning in a way that lets all students

participate and meet learning outcomes. Materials and resources should be leveled and geared to students' readiness levels, but teachers should also provide opportunities to challenge students without causing frustration (Skinner et al., 2009). Kemple et al. (2015) explained students will thrive when they feel safe and happy and when they enjoy learning. Participants all agreed inquiry-based learning creates a child-centered learning environment in which all students take ownership of their learning.

Limitations and Delimitations

Limitations existed in this study. Limitations are factors outside of the researcher's control that can influence the generalizability of the study. In this study, limitations existed in several areas. The study was limited to the teachers and administrators who worked at the schools. Another limitation involved the knowledge an individual teacher and or administrator had related to inquiry-based instruction. Patton (2014) pointed out that environment limitations play a key role in research studies. Teachers may not be comfortable with the questions or may not be honest. Fear of possible retribution for speaking negatively may yield some of the data not as credible. Limitations to this study also include lack of generalizability, as the study is only nine teachers and three school administrators at two particular sites in NYC. An additional limitation was the time frame for approval from the school district's IRB. The school district approval process took several months and therefore the data collection time frame was limited to the last four months of the 2018–2019 school year. Another limitation is working under the Charlotte Danielson's Framework. The framework is utilized to rate NYC public school teachers. The framework includes four domains (planning and preparation, classroom environment, instruction, and professional responsibility) that set the foundation for teaching in NYC's public schools.

Simon and Goes (2011) stated delimitations are the traits of a study that control and outline the study's parameters. One of the delimitations identified in this study is the fact it was conducted within NYC; therefore, it is not generalizable to other large cities in the US. Another delimitation is that participants interviewed were NYC public school administrators and NYC public school teachers in prekindergarten and kindergarten; all participants had at least three years of teaching experience. The sample population is delimited to nine teachers and three school administrators at two sites. This was done in order to keep the total data corpus at a manageable level. Another delimitation was the research methodology of using a case study. A case study was utilized to understand teacher perception of inquiry-based instruction. A case study was suitable for this study because the focus was on the participants' practices within a topic (Creswell, 2013). Another delimitation was the study focused on inquiry-based learning within mathematics instruction rather than other content areas. The researcher investigated perceptions of early childhood teachers on using inquiry-based learning to teach mathematics.

Implications of the Results for Practice, Policy, and Theory

This section examines the implications of the conclusions from the case study for practice, policy, and theory. This section correlates with the conceptual framework, constructivism, to explain implications of the study in relation to the literature. Inquiry-based instruction in early childhood mathematics provides students with greater opportunities for building foundational mathematical skills and reasoning.

Practice. This study is important to the field of education because it provides teachers with an instructional approach that supports students' individual growth and critical thinking skills. The researcher investigated the impact inquiry-based instruction has on teaching mathematics in early childhood from the perception of 12 teachers and administrators in two

elementary schools in NYC. Inquiry-based instruction is an alternative for teachers to build self-ownership of learning in students through multi-sensory lessons. The researcher also examined participants' knowledge base regarding inquiry-based instruction. Participants discussed the obstacles they face in implementing inquiry-based instruction based on professional development and support from educational leaders.

Inquiry-based instruction differs from classroom to classroom and is based on school expectations. For instance, teachers may utilize a flipped classroom approach. In a flipped classroom model one group of students use technology as a tool to solve real world problems while another group works with the teacher (Graca, 2012). Station rotation also supports inquiry-based lessons. In this model students are in heterogeneous groups and move through various stations. Stations vary depending on classroom, student need, and lesson. Stations may include math talk, problem-solving, technology station, fluency building, teacher station, or a combination of any of those elements (Graca, 2012).

No program or practice can be successfully implemented without proper support from school administrators and colleagues (Olver, 2013). Implementation has greater success when all members of the school community support and are vested in the practice (Olver, 2013). Olver (2013) stated when teachers are supported in the use of inquiry-based instruction they feel more confident in their practices, leading to greater student engagement and achievement. Eckhoff (2017) discussed how administrative support leads to a paradigm shift to encourage the practice to become school-wide. When administrators believe in the practice, they are more likely to get their staff vested (Eckhoff, 2017). In order to build a school-wide practice, administrators should provide professional development, support, feedback, and encouragement (Eckhoff, 2017). This will ensure the practice becomes part of the school culture.

One notable distinction between traditional teaching and inquiry-based instruction is the focus on student ownership of learning (Graca, 2012). in inquiry-based learning, the teacher is a facilitator instead of a lecturer and students change from passive note takers to active interactors with the content. The process leads to creative thinking and deeper understanding (Minner et al., 2010) and promotes independence (Sorvo et al., 2017). Inquiry-based instruction allows teachers to design a classroom geared toward collaboration, exploration, and student ownership of learning.

Teacher knowledge and mindset are crucial to the success of inquiry-based instruction (Capitelli et al., 2016; Sorvo et al., 2017). Although there is no single way to implement inquiry-based learning, there are certain measures of inquiry-based learning teachers must be aware of and consider when implementing inquiry-based instruction (Abdi, 2014; Correia et al., 2016). Teachers should consider setting clear expectations, having established routines in place for materials, having a protocol for classroom and/or group discussion, knowing students' strengths and weaknesses, understanding the curriculum and standards, and being prepared (Abdi, 2014). Expectation setting is also important when introducing inquiry-based instruction into the classroom (Abdi, 2014). Having clear expectations allows students to understand their role and the goals for the lesson. Clear expectations include the teacher role and student role in the lesson. Students know what they must accomplish and what is in place to support their learning. Teachers know what their role is in the lesson and how they can support students in reaching their goals. Clear expectations will bring a smooth transition into the inquiry-based classroom (Abdi, 2014).

Policy. This case study reports the outcomes that directly answered the research questions from the perspective of 12 participants in two NYC elementary schools. The outcomes

of this study may benefit and drive professional development opportunities within the study sites. As more teachers become familiar with and are professionally developed in inquiry-based instruction, the practice can then be expanded school-wide (Ku et al., 2014).Educators at all levels can work toward forming guidelines for creating a “risk free” environment to promote student participation by allowing students to take ownership of learning (Eckhoff, 2017). Professional development supports teachers’ growth and improvement around concepts such as inquiry-based instruction. Professional development is important to improve pedagogy and grow successful teaching practices. Some potential policy changes at both sites include determining professional development opportunities to build compliance with school, district expectations regarding inquiry-based learning and giving teachers a greater voice in selecting what professional development will best support their pedagogical needs.

School stakeholders can experience greater success when they work together to create a mutual vision for inquiry-based learning using common language that labels implementation expectations. Clearly stated expectations can be used to guide teaching practices for successful application of inquiry-based learning. Policies and protocols can be created to connect vision, expectations, and teaching practices to provide a collaborative approach to system-wide change.

Theory. Constructivism in education is a shift in mindset that changes teaching practices (Serafín et al., 2015). Wu and Lin (2015) described the change in teacher role from lecturer to facilitator. The student role changes from answering questions to verbalizing the strategy used and how it was used (Serafín et al., 2015). Common Core standards place emphasis for learning on the application of problem-solving skills and on the reasons to solve problems (Serafín et al., 2015; Wu & Lin, 2015). For skill application to happen and for teachers to have success in

inquiry-based instruction, planning and preparation is vital (Wu & Lin, 2015). Collaboration with peers increases successful planning (Wu & Lin, 2015).

Reflection on pedagogical practices is imperative for growth related to any concept within social constructivism; inquiry-based instruction is no different (Ku et al., 2014; Serafín et al., 2015). Educators must stress the importance of reflection by providing students opportunities to reflect on intended learning. It is important for teachers to clarify and model the types of reflection that are beneficial to learning (Costa & Kallick, 2008). For example, there is a difference between students who write "I liked math today because I got to play" versus "Today I learned to draw a picture to solve math problems." Modeling, checklists, and rubrics are tools to make expectations clear and uniform for better understanding (Costa & Kallick, 2008). Such procedures should be developed to define the task, enhance collaborative work, and aid the presentation of learning. Reflection comes from feedback and conversations with students about strengths and next steps (Bailey, 2018; Dole et al., 2016).

There are various approaches to inquiry-based instruction such as the blended learning model, jigsaw model, and project-based learning. However, one commonality is the use of questioning and feedback (Costa & Kallick, 2008). It is important for both the teacher and students to monitor and document the progress students are making (Abdi, 2014; Costa & Kallick, 2008). Using "think about thinking" is an effective strategy for modeling the process of asking questions and reflecting on the process used (Costa & Kallick, 2008, p24). "Think about thinking" is when students talk through the problem and their thinking. Once reflection and self-assessment become a regular routine, the tasks will become a part of the learning process (Bailey, 2018; Costa & Kallick, 2008).

Modeling, where the teacher demonstrates a skill and/or strategy for the student, is essential for early childhood students as they do not have the skills needed to reflect or self-monitor; those skills must be taught (Bailey, 2018). At the ages of three and four, students tend to copy what they see. Modeling provides students the visual they need to be able to copy behavior. Through planning and preparation, the teacher can make decisions about when, where, and how to model the learning process for the students. Modeling gives teachers an alternative to direct instruction (Wu & Lin, 2015). Teachers can model for students how to join a conversation by adding to or even providing alternative responses to peers' comments around an assigned task.

Wu and Lin (2015) argued another consideration of inquiry-based learning is planning for full participation of all members within a group. It can be challenging to find ways to engage students who are struggling in content they have not yet mastered. Planning and preparation are crucial to ensure success for all students. Teachers must think of what tools or scaffolds are needed for students to navigate unfamiliar content. Without prior knowledge entering a conversation is difficult, especially for prekindergarten and kindergarten aged students. Leveling questions and advanced planning how students will begin the conversation will ensure all students have access to the learning and the discussion (Smith et al., 2013; Wu & Lin, 2015). Beginning with questions that are low-level and then gradually increasing the rigor to higher-order thinking questions ensures not only that all students have an entry point, but also that the discussion will lead to deeper understanding for all members of the group (Wu & Lin, 2015). Tasks can then increase in rigor and complexity once students have established the protocol for inquiry-based instruction and their part in taking ownership of the learning (Graca, 2012).

Inquiry-based instruction guides planning with the intent of releasing responsibility and ownership of learning to students through prompting and supports (Smith et al., 2013). The goal of inquiry-based learning is for students to explore and investigate the materials given to problem-solve without direct instruction (Anderson & Cohen, 2015; Minner et al., 2010). Rather, students have questions to guide their thinking and exploration to obtain learning for themselves rather than just being told what to think by the teacher. Graca (2012) pointed out that students retain information longer when they must work at obtaining it. Inquiry-based instruction meets students at their entry points, but gradually moves them to mastery of standards with the help of peers. Additionally, inquiry-style lessons build foundational skills and promote independence in early childhood students (Graca, 2012). During the exploration and discourse among peers in the group, teachers have the role of actively monitoring and assessing student understanding (Anderson & Cohen, 2015; Minner et al., 2010). Graca (2012) showed how data collected from monitoring and informal assessments drive instruction and allow the teacher to create an action plan, constituting the significant role of data in closing learning gaps (Graca, 2012; Minner et al., 2010).

Recommendations for Further Research

Areas for future research. Possible future research based on this study include an investigation of inquiry-based instruction in other subject areas beyond math. Researchers could observe and document the impact inquiry-based instruction has in different subject areas. Researchers have investigated the use of inquiry-based instruction in science. Master et al. (2017) found using inquiry-based instruction in science can help students develop a love for the subject and thus increase the numbers of students who science-related fields. However, there is little research about the use of inquiry-based instruction in teaching social studies. Therefore, it is

recommended to investigate the use of inquiry-based methods to teach social studies. Researchers could examine how an inquiry-based approach in social studies may foster an opportunity to communicate ideas, develop critical thinking skills, and work together. Current research supports the use of inquiry-based instruction in science.

Currently, inquiry-based instruction in early childhood mathematics is utilized as a teaching method but math curriculum does not include inquiry-based instruction. Additional research is recommended to build inquiry-based instruction into math curricula. Publishers of educational resources and other math curriculum developers can begin to examine how inquiry-based instruction can be built into curricula. There are many possibilities for further research. This study focused on prekindergarten and kindergarten classes. It would be beneficial to conduct further research in other grade levels.

This study may benefit both study sites as it can be a tool for designing professional development opportunities. It may also allow the schools to evaluate what practices are being used school-wide and by grade band. Additionally, the school district can use these findings to expand successful practices around inquiry-based instruction to other schools within the district. This study adds to the existing literature on inquiry-based instruction as well as the discourse in teacher perception in inquiry-based learning.

Participants. Creswell (2013) noted the optimal sample size in a qualitative study can include up to 25 participants. Adding participants to the study might affect the results, themes, and codes discovered. Inviting more participants might lead to the addition of staff members and others to gain various perceptions and viewpoints. Participants could include principals, district leaders, parents, and paraprofessionals. School leaders and administrators might contribute their viewpoint on the impact inquiry-based instruction has on student achievement. School leaders

can use study findings to inform their professional development opportunities and create protocols for successful implementation of inquiry-based instruction. It is recommended a larger sample size be implemented. It is also recommended that further research with other staff members including principals, district leaders, parents, and paraprofessionals be included in studies of inquiry-based learning.

Sites. Further research on this topic may benefit from studying a wider variety of school districts to provide a different lens for data analysis. One benefit would be to offer researchers opportunities to compare the results of inquiry-based instruction from various locations such as urban, suburban, and rural settings. For instance, a comparison can be made between public and charter schools. Researchers might also consider widening the pool to include private schools or faith-based institutions. Researchers might collect data using the same methods but from different sites and then compare the results. A site comparison would be useful in determining if teaching practices are more effective in one site versus another to identify what teaching practices are best for inquiry-based learning.

Demographics such as gender, age, ethnicity, English language learners, and special education students can also be considered when using various sites. Researchers might compare the demographics from different sites and then determine whether particular demographics play a role in the success of inquiry-based learning. Researchers could further investigate which demographics affect the success of inquiry-based learning and even how demographics can be addressed to increase student success.

Researchers might compare the number of years teachers have in the classroom to the achievement levels of classrooms using inquiry-based learning. School districts can have a list of practices for future professional development opportunities and for highlighting and expanding

the practices in other settings. Findings from such research might give district leaders a better idea of which practices are successful, which areas need work, and how district leaders may guide the development of opportunities to increase success. Researchers might also consider conducting a longitudinal study. This study would be useful in providing data on the implementation of inquiry-based instruction. The researcher can examine data from pre implementation and post implementation. These findings can provide evidence of the success or lack thereof in a given school or schools.

Additional recommendations. Additional recommendations include expanding the inquiry-based instructional approach to determine the impact it has on student retention and self-regulation. A qualitative case study could be designed to evaluate the impact inquiry-based instruction has on retaining information versus traditional methods of instruction. A qualitative case study on the effect of inquiry-based instruction on student retention would add to the current research but focus on student retention versus student achievement. Findings from the study might provide teachers with additional opportunities for professional development. Additionally, findings might benefit teachers by providing insights into student achievement to build self-awareness and independence in learning.

Another recommendation for future study involves a qualitative case study on inquiry-based instruction from the perception of the students instead of the teachers. Comparing students' perceptions to teachers' perceptions of the benefits of inquiry-based learning may provide additional insight into the impact of inquiry-based learning practices. Student feedback may also help teachers understand what is successful with inquiry-based learning and what needs to be changed or adjusted. Giving students a voice motivates and empowers them to be more productive participants. Students can give insights that teachers may not gain on their own.

Teachers can make inferences and draw conclusions, but students can confirm or reject those views.

Yet another recommendation for future study would be to conduct quantitative research with control groups to pilot different approaches to inquiry-based instruction. Studies can examine specific groups such as ESL students, students in special education, specific ethnicities, and genders. A comparison of different inquiry-based learning approaches would yield data about which approaches are more effective or if all approaches basically yield the same results. Determining what part of inquiry-based instruction is the most effective can further understanding of inquiry-based learning practices. Researchers also might compare the components of exploration, discussion, and questioning for effectiveness. Such a comparison would allow researchers to specifically pinpoint what makes inquiry-based instruction successful. Teachers could then modify practices to include longer periods of time on the components that yield the best results.

Conclusion

In this chapter, the researcher summarized the results of the qualitative case study in relation to the research questions. Participants discussed their understandings and practices with inquiry-based instruction through surveys, one-on-one interviews, curriculum-based artifacts, and member-checking sessions. The findings showed there is a relationship between inquiry-based instruction and improved student achievement in mathematics. Teachers shared their perceptions on the obstacles keeping them from utilizing inquiry-based instruction. The findings are important for creating professional development opportunities to encourage and foster growth within inquiry-based instruction. Participants noted inquiry-based instruction, student engagement, and student achievement in acquiring mathematics skills in inquiry-based learning

increases student participation as compared to traditional teaching methods of instruction. Participants also disclosed students were able to ask and answer questions with peers, a task they would not otherwise be able to do on their own. Participants noticed even though students were in prekindergarten and kindergarten they were able to take ownership of their learning by using the materials provided. Students articulated the learning through reflections and sharing their learning with peers. Students engaged in deeper conversations about the content in inquiry-style lessons as compared to traditional direct teaching lessons.

Participants in this study experienced more collaboration with colleagues regarding implementation and troubleshooting as issues arose in inquiry-based instruction. Communication and collaboration provided participants the opportunity to specify professional development needs and support necessary improvements to expand and duplicate best practices for successful implementation of inquiry-based instruction. Furthermore, teachers and administrators were able to give their personal viewpoints and gain a better understanding of their colleagues' perspectives on inquiry-based instruction.

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Appendix A: PreInterview Survey

Please answer yes or no:

1. Do you utilize inquiry-based teaching in your classroom? _____
2. Are you familiar with inquiry-based teaching? _____
3. Do you also use traditional methods of teaching? _____
4. Have you had professional development in using inquiry in classroom instruction? _____
5. Did you have any preservice training in inquiry-based teaching? _____

Appendix B: One-on-One Teacher Interview

Teacher Code:_____

Date:_____

Length of Interview:_____

1. Share what you know about inquiry-based teaching
2. Does the current math curriculum allow for inquiry-based teaching?
3. Do you currently use inquiry-based teaching in your classroom?
4. Do you use inquiry-based lessons for mathematics? If no, why not? If yes, how often?
5. What are the challenges with utilizing inquiry-based lessons in math?
6. Do you feel supported from leadership, instructional coaches, and others in the use of inquiry to teach math? Why or why not? (For example, do they make themselves accessible to you for assistance? Is getting in contact with them during business hours a difficult process?)
7. Did you learn how to use the inquiry method in any preservice program? If not, where did you learn to use the inquiry method? How about in your undergraduate education courses?
8. What systems or considerations need to be addressed when implementing inquiry-based lessons?
9. Talk about the impact in your classroom. What is the impact on student engagement and achievement?
10. Discuss the difference in student engagement when using inquiry-based lessons versus traditional teaching methods

Appendix C: Email Invitation to Teachers

Dear Teachers,

You are invited to participate in a research study that will focus on the utilization of inquiry-based teaching in the early childhood classroom specifically in mathematics. This study will focus on grades prekindergarten and kindergarten. Eight teachers will be selected for this study that are currently teaching and plan to be in the same grade for the 2018–2019 school year. The expectations for this study are as follows:

- All participants will partake in a presurvey questionnaire that will provide the researcher brief background knowledge on the use of inquiry-based teaching.
- Participants will also partake in one-on-one interviews with questions that address the use of inquiry-based lessons, inquiry in mathematics, teacher understanding of inquiry-based teaching, and the impact it has on student engagement. The interviews will last between 60 and 90 minutes. These interviews will take place in my private location in the school building and will be kept confidential.
    - Researcher will share one-on-one notes with individual participants before publication for further feedback if the participant feels inclined to expand on anything. For confidentiality, only individual participants will be privy to their own notes.

A schedule will be made available with the time and date for the one-on-one interviews. In addition, the interviews will be saved on one password-protected USB device to which only the researcher has access. After the study is complete all data will be shredded and deleted.

Please respond to this email if you are interested in participating in the study or if you have any questions.

Thank You,

Nadim Farooqi
(Instructional Coach)

Appendix D: Permission Letter

Dear Principal,

Attached you will find the research proposal for the research requested to be conducted at your school.

Research Proposal Narrative

Purpose

The use of inquiry-based instruction in early childhood mathematics provides a platform for students to develop foundational skills crucial for success in mathematics. Mastery of skills and reinforcement through repetition has been the trend in teaching mathematics in the early childhood classroom. Students are taught to memorize numbers, shapes, and early computations through repetition. Math anxiety in both early childhood and childhood education is rooted in how students learn math in their early years. This study will examine how inquiry-based lessons foster deep critical thinking and understanding of mathematical concepts in prekindergarten and kindergarten. Inquiry based teaching brings new light to traditional classroom settings. Inquiry based lessons involve student engagement throughout the lesson and greater emphasis on critical thinking and discussion. Through the inquiry process educators facilitate students to become the drivers of their knowledge acquisition. Inquiry lessons grow collaboration, critical thinking, discussion, problem-solving, and independence. The researcher will examine teacher perceptions of using inquiry-based teaching in mathematics in the early childhood classroom. The study will explore what is creating or affecting teacher perceptions of inquiry-based instruction in math in early childhood.

This study will be conducted through qualitative measures. The research method includes a preinterview questionnaire and teacher interviews. Through teacher interviews the researcher will be able to understand the impact of inquiry-based teaching in early childhood mathematics. Teacher interviews will be conducted with prekindergarten and kindergarten teachers. A preinterview questionnaire will be emailed to all participating teachers. The preinterview questionnaire will be utilized to gauge which teacher utilizes the teaching method under investigation and how often inquiry-based instruction is used in the classroom. All questions utilized during the interviews will be field tested with a group of four teachers prior to the study.

Methods

Potential participant population: The population that is being studied is early childhood teachers, specifically, prekindergarten and kindergarten teachers. The teachers that will be invited to participate are from the [Site region redacted]. One school is a Pre-K only school. The second school is a kindergarten through eighth grade elementary and middle school. There are five kindergarten classrooms and six kindergarten teachers. The teachers that will be invited will have at least a minimum of three-year teaching experience and various levels of educational degrees. Each participant's response will be audio-recorded for clarification and triangulation.

Relationship/role with the participants: The researcher is does not have role or relationship with the participants.

Recruited population included/excluded: The total population of prekindergarten teachers at Rose Hill will be invited to participate. All participants will be invited via email. The participants at Am Park will also be contacted via email. The researcher's phone number will be provided in the email. The researcher has spoken to the principal, assistant principal, and grade level instructional coach.

Data Analysis Procedures

The data collected from the presurvey questionnaire will provide a background for understanding what the participants already know about inquiry-based instruction in mathematics. This case study will allow teachers to reflect on their practices, professional development, preservice training, and pedagogy. During the interview teachers will be reflecting on inquiry-based instruction in mathematics in early childhood. The data collected from the interviews will provide insight into teachers' knowledge of, and practice regarding inquiry-based learning in mathematics in early childhood.

This study examines teachers' perceptions on inquiry-based teaching as opposed to traditional methods. It also looks to uncover the obstacles affecting the use of inquiry-based teaching in mathematics in early childhood. Teacher interviews will allow the interviewer to gauge a deeper personal understanding of teacher perceptions. This case study will also seek to uncover the factors that affect teacher perceptions of inquiry-based instruction in mathematics, especially related to early childhood/early elementary students.

Data Protection and Security Plan

Privacy and security is vital to this research. The researcher will store all notes and files with a numeric system. Each participant will be given a participant number that will be utilized in the process of storing information. The researcher will be the only one who will have access to the data. The data will be stored on the researcher's computer. Once the thesis is published the data will be destroyed.

The subjects will not be anonymous to the researcher. However, in the presentation of findings the data will be protected using codes. Each participant's numerical assignment will be their code for the purpose of the study. The data will be stored and presented under the numerical code.

Sincerely,

Nadim Farooqi (Researcher) _____

Principal Name _____

Principal Signature _____

Date _____

Appendix E: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

> As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

> **What does "fraudulent" mean?**
>
> "Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate's final work without full and complete documentation.
>
> **What is "unauthorized" assistance?**
>
> "Unauthorized assistance" refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:
>
> - Use of unauthorized notes or another's work during an online test
> - Use of unauthorized notes or personal assistance in an online exam setting
> - Inappropriate collaboration in preparation and/or completion of a project
> - Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (Continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University–Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication manual of The American Psychological Association*.

Nadim Farooqi

Digital Signature

Nadim Farooqi

Name (Typed)

3/23/2020

Date