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TEACHERS' PERCEPTIONS OF MATHEMATICS An Attitudinal Study of 5th-grade Teachers' Perceptions about Mathematics and the Influence on Instruction Submitted by Margaret Knight A Disse...

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1 author:

Margaret Knight
Richland County School District One

An Attitudinal Study of 5th-grade Teachers' Perceptions about Mathematics and the Influence on Instruction

Submitted by

Margaret Knight

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An Attitudinal Study of 5th-grade Teachers' Perceptions about Mathematics and the Influence on Instruction

by

Margaret Knight

has been approved

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Michael Hylen, Ph.D., Dissertation Chair ____

Julie McGaha, Ph.D., Committee Member ____

Candice Moore Ph.D., Committee Member____

Abstract

Research suggests that math anxiety correlates directly with individuals' views of mathematics-related experiences. Research also suggests that math anxiety may begin in early elementary grades and remain into adulthood. This study examined how teachers' experiences, perceptions, and mathematics confidence levels influence mathematics instruction. To understand teachers' perceptions of mathematics, the researcher used a qualitative phenomenological approach to probe into their earliest memories of mathematics before entering school and their experiences during formal education. Seven 5th-grade teachers with two to fourteen years of experience agreed to participate in the study. The participants responded to ten open-ended questions focused on mathematics instruction and seven interview questions examining participants' experiences with mathematics. The researcher also observed mathematics instruction in each teacher's classroom. The results indicated that teachers recalled fond early memories of mathematics and felt reasonably confident about their math instruction. Some teachers struggled with mathematics as elementary students, while others excelled. The majority of participants completed the basic requirements for mathematics in high school. Most teachers did not engage in a mathematics methods course focused on standards-based elementary mathematics. Teachers' weak areas in mathematics corresponded with similar studies regarding complex mathematics topics. Several key components of mathematics instruction were absent during observations. Future research may need to increase the number of observations and the sample size.

Dedication

I dedicate this work to my dear brother, Charles, who is watching us all from Heaven. Not many older teenage brothers read Rudyard Kipling's "Just So" stories and the National Geographic magazine to their three-year-old sisters. Not many explain that Lassie did not die; she will be back for the next episode because they could not keep having a show if she did not, and she is a he, by the way, because female dogs are more temperamental; the wolf man is not real and not under your bed. Bats do not transform into vampires; the sun will not burn out in your lifetime, and no volcanoes exist in Louisiana. For these and many other reasons, I dedicate this work to you, my dearest brother. I wish you were here to read the final copy and provide commentary. You read through my papers, comps, and dissertation proposal before you left to complete the final journey. You will always inspire me, and I will believe in myself because you did.

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Dr. McGaha is very candid with her feedback. She makes me think more deeply about the reader's perspective and the clarity needed to ensure that other researchers can duplicate or build upon the research. She also encouraged me to explore literature about systems outside of the United States and to consider the complexity of test data and the importance of examining all factors involved in the results. The complicacy of international tests is that scores do not reveal the whole picture. These data include socio-cultural, socio-economic, and internal policies within the countries that contribute to their scores.

I appreciate Dr. Moore's willingness to join the committee and the keen insight and thoughtful feedback she provided. Without any background about the study, she swiftly completed a first read of the entire dissertation from top to bottom in a compendious way with very insightful comments, which motivated me to probe deeper into the actual problem and purpose of the study. I also want to acknowledge Dr. Lisa Hall-Hyman for her sincere and heartfelt support before and during the dissertation process.

The ladies of the "Fabulous Five" will always be very near my heart. We have come a long way, and all had challenges, but we stand far stronger together. I am thankful for all the support and love you have given throughout the process. I hope we can all walk down the aisle together in May, and if we cannot, I know we will continue to support each other until we all make it there. Much love to Candice, Tammy, Tiffany, and Krystal.

I want to thank Shannon for his patience and support throughout these three years. You are an exceptional example of what love and devotion truly mean. Thank you to my children, Charles and Carol, for your confidence, guidance, and unconditional love. To my sisters, Elizabeth and Frances, thank you for always listening to my worries and encouraging me along the way. To my beloved best friend, Deborah Q., we have been together since we were six, a beacon of light and inspiration through the darkest and happiest moments of my life. Thank you to my friend and colleague, Dawn Scott. Your advice, proofreads, subtle hints, and encouragement will never be forgotten. My project completion would not have been possible if it had not been for Dr. Sandra Brossard. I am forever thankful for your persuasive ability to make things happen.

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Chapter 1

Introduction

The relationship between mathematics self-perception and performance has traditionally been explored in terms of "math anxiety" and "math self-concept" (Fitzgerald, 2012). Math anxiety is derived from a person's self-perception of math skills. One's self-perception of ability in mathematics may influence math anxiety and performance levels. Mathematics self-perception refers to a person's confidence level in mathematics abilities and efficacy. People who suffer from math anxiety often have a low opinion of their abilities, contributing to poor performance and attitudes about mathematics (2012).

Prior research indicates that math anxiety is a legitimate phobic reaction (Ashcraft, 2002). A more recent study by Schaeffer et al. (2021) suggested that math anxiety in teachers is linked to poorer mathematics performance in both male and female students.

Unfortunately, this phenomenon affects so many people in the United States that it is a fixture of our culture. In Beilock's (2019) article, *Americans Need to Get Over Their Fear of Math*; he states that it is socially acceptable for people to admit that they struggle in math in our nation. By contrast, people in the United States generally do not proclaim that they cannot read (2019).

In 1983, A Nation at Risk supported the belief that teachers played an integral role in improving student mathematics and science learning (NCEE, 1983). When teachers are anxious about understanding and teaching mathematics concepts, students' confidence and success may be impeded (Lewis, 2018). Teachers may unintentionally communicate their attitudes about math to students, positively or negatively influencing students' perceptions of mathematics (Lewis, 2018). The influence of negative mindsets toward mathematics is well-researched as an indicator of low mathematics achievement in students of all ages. However, research needs to recognize teachers' significant role in this issue and how their attitudes may influence instruction (Ramirez et al., 2018).

Problem Statement

Many American students are not performing in mathematics at the same level as their counterparts in other countries (Federico, 2016). It is essential to consider how students perform in mathematics in other areas to compare educational policies and teaching strategies that may be useful in understanding how teachers' attitudes about mathematics in this country affect mathematics instruction and inevitably influence student achievement.

The Programme for International Student Assessment (PISA) is a thorough exam and a reliable indication of students' skills that nations use to assess education policies and practices. The test is administered to fifteen-year-olds triennially throughout the globe. In research from Jerrim (2021), the common impression of PISA as the measurement of science, reading, and mathematics skills of 15-year-olds is somewhat more complex. Some top-performing institutions in China and other countries have been criticized for omitting a substantial section of their 15-year-old population from their sample selection for PISA 2015 and PISA 2018. (Loveless, 2014). It is especially likely to inflate PISA scores in nations where a substantial proportion of 15-year-olds, mainly lower and middle incomes, are not enrolled in school (Jerrim, 2021).

The United States may want to consider the differences between other countries' policies and the differences in the size and make-up of the populations when comparing students' performance on the PISA. Nevertheless, the current state of the United States educational system needs to be revised; the question is whether political and educational leaders are open to learning from the rest of the world (Anderson, 2013).

The OECD publishes the test results and an analysis of the state of education worldwide, providing evidence of the most effective policies and methods for assisting nations in delivering quality education (OECD, 2020). The most recent report published in 2018 from the OECD indicated that students in the United States ranked third from the bottom in mathematics (2020). Also, in the United States, socioeconomically advantaged children outscored disadvantaged students on the most recent 2018 PISA in mathematics (OECD, 2020). Additional assessments, such as the National Assessment of Education Progress (NAEP), also reveal students' low achievement in mathematics. The (NAEP) was given in 2019 to a representative sampling of fourth and eighth graders in participating districts across the states. The assessment measured students' mathematics understanding and problem-solving ability. In South Carolina, all fourth-grade students taking the (NAEP) scored significantly below the national average (2019). International and national assessments provide information about the state of mathematics teaching and learning across the country and the similarities with underperforming school districts in South Carolina.

Evidence of a deficit in content knowledge was revealed in a study that asked preservice teachers to reason about procedural algorithms using whole numbers (Thanheiser et al., 2014). Researchers found that only seven out of seventy-one preservice teachers could explain why the algorithm worked conceptually. There is also evidence that mathematics content knowledge does not improve with teaching years (Browning et al., 2014). Seasoned teachers may not have a stronghold on conceptual understanding. Conceptual learning is very present in the South

Carolina College and Career ready mathematics standards. If teachers lack a conceptual understanding of mathematics standards, an adequate content representation may be lost in instruction.

The teacher's frustration and lack of understanding could be a factor that contributes to instruction which may influence students' low achievement. The stress of re-learning a content area can create a tense classroom environment that is not conducive to learning (Sun, 2017). Beginning in 2021-2022, all elementary schools' grades, k-5, were self-contained in the participating district. Departmentalization no longer exists at the elementary level. Many teachers who have not taught math currently teach all content areas, including mathematics.

The South Carolina College and Career-Ready Assessment (SC READY) is a state assessment with English Language Arts (ELA) and mathematics components. It is administered to students from third to eighth grades during the last weeks of school. Educators established four performance levels for the South Carolina READY assessment (SC READY) to indicate student mastery and command of the skills and understanding defined in the South Carolina College and Career Ready Standards (SCCCRS). Most students have some knowledge of academic standards; nonetheless, performance levels succinctly convey the extent to which students have demonstrated mastery of the knowledge and skills defined in the SCCCRS. By outlining the information and skills students must display to reach each level, performance levels provide meaning and context to scale ratings. The four performance levels include: *Does Not Meet Expectations, Approaches Expectations, Meets Expectations, and Exceeds Expectations* for the SC READY assessment (South Carolina Department of Education, 2021).

A student who fails to satisfy the grade-level content standards for knowledge and abilities required for the grade level will require significant academic support to prepare for the next grade level and be on track for college and career readiness. A student who approaches the grade-level knowledge and skills necessary for this level requires further academic support to prepare for the next grade level and be college and career-ready. A student who meets the expectations for grade-level content standards is prepared for the next grade level and on track for college and career readiness. As described by the grade-level content standards, a student who excels at this level of learning is well-equipped for success in the next grade level and is college and career ready (2021).

With the introduction of South Carolina College and Career Ready Standards in 2015, teachers were confronted with teaching mathematics conceptually to support current mathematical practices and future learning goals. From 2015 to 2019, the participating district's 5th-grade scores ranged from 26% Meets and Exceeds in 2016-2017 to 35 % Meets and Exceeds in 2017-2018. In 2019, approximately thirty-three percent of all fifth-grade students in the participating district scored at Meets or Exceeds on the South Carolina College and Career Ready Exam in the 2018-2019 school year. Out of the Meets and Exceeds categories, about 16% of 5th-grade students scored Exceeds, and around 17% scored Met. Thirty-one percent of fifth-grade students scored Approach's Expectations, and almost 36% of students scored Does Not Meet Expectations.

Although students were administered the exam in the 2020-2021 school year, 678 5th-graders within the participating district did not take it. Therefore, the district 2018-2019 data was compared with the state data from the same school year. It was evident in the SC READY 2018-

2019 mathematics scores that almost sixty-seven percent of 5th-grade students in the participating school district were not fully grasping mathematics' content. Because students' understanding of mathematics needs improvement for scores to increase, a close examination of teachers' understanding of the content and feelings about mathematics is necessary. A thorough investigation of the literature associated with math anxiety and lower math achievement provided fundamental background information about how this phenomenon may influence teachers' and students' confidence and perceptions of mathematics.

Significance of the Study

Teachers, students, and all stakeholders benefit from the qualitative nature of the data gathered from this study. This study differs from Commodari and La Rosa (2021), who examined connections between students' overall academic anxiety, math anxiety, and student achievement. Instead, it investigates past experiences and feelings towards mathematics and the relationship of those experiences to teachers' current attitudes toward mathematics instruction. Teachers' narratives and feelings about mathematics and confidence in understanding mathematics concepts make this study unique. The focus is on the teachers' confidence in teaching math concepts rather than a connection between student achievement and teacher anxiety. The data from this study will be used to support teachers' understanding and comfort level with teaching fifth-grade mathematics concepts. Additionally, the researcher used the data to make recommendations in Chapter 5 that support mathematics instruction in other school districts outside the participating district's demographic area.

Purpose of the Study

This study explored the relationship between teachers' mathematical self-perceptions and their influences on mathematics instruction. The researcher examined contributing factors between teachers' confidence level with mathematics competency and the quality of instruction. Exploration of teachers' past experiences in math clarified how or when teachers' notions of mathematics developed. Examining teachers' self-perceived strengths and weaknesses gave the researcher insight into which mathematics domains impacted the conceptual understanding of mathematics and instruction.

Observations of teacher instruction indicated positive and negative influences and perceptions. Observations also revealed teachers' levels of mathematics competency. The qualitative design sought to uncover the factors contributing to teachers' attitudes and perceptions about mathematics instruction. The methods included interviews, classroom observations of instruction, and an open-ended questionnaire.

Research Questions

Question 1: How do 5th-grade teachers' experiences and self-perceptions of mathematics influence mathematics instruction?

Question 2: How do 5th-grade teachers' understanding of mathematics concepts influence instruction?

Rationale for Methodology

The methodology consisted of a qualitative phenomenological design. The design was chosen to explore teachers' experiences and perceptions of mathematics by collecting data from interviews, observations, and responses to a questionnaire. A descriptive phenomenological investigation was appropriate in illustrating a deeper meaning of how teachers' experiences and attitudes played a significant role in mathematics instruction. Phenomenology allowed for examining teachers' past and current mathematics experiences that influenced instruction. Through this approach, the researcher developed a theory based on teachers' interpretations of their lived mathematics experiences, with phenomenology as the research philosophy.

The qualitative interviews captured in-depth personal information from participants (Creswell, 2014). Personal experiences of teachers' mathematical journey through early childhood, school careers, and experiences with teaching mathematics were vital to this study's foundation, rooted in teachers' confidence and attitudes about mathematics instruction. The questionnaire delved into teachers' comfort level with mathematics content and which areas of mathematics were enjoyable or frustrating to teach.

The researcher also sought to understand or explain teachers' experiences and perceptions by contextualizing the math anxiety phenomenon. The purpose of the qualitative observations was to determine if teachers found mathematics engaging and exciting content to teach or felt uncomfortable and anxious about their instruction and depth of knowledge. The teacher's confidence level affected how the content was taught. Bandura et al. (1977) stated that evidence of a teacher's belief in their ability to instruct students could explain individual levels of effectiveness.

Examination of teachers' instructional practices was mutually agreed upon and negotiated in which the teacher chose the times and dates of the observations to avoid stress. During the data-gathering process, research subjects felt at ease, which ensured that interactions produced valid results (Aluwihare-Samaranayake, 2012). Some teachers felt self-conscious about inexperience with mathematics or mastery of mathematics concepts. However, they readily admitted to not understanding the mathematics concepts yet felt satisfied with their grasp of procedural knowledge. This study came at a crucial time when policies changed, leaving some teachers vulnerable and unprepared to teach 5th-grade mathematics. The researcher ensured that the stress levels involved in research participation needed to be kept at a minimum during this disquietful time.

The questions used in the interview promoted metacognitive thought without placing more stress on the teachers. The researcher hoped to stimulate teachers' reflective thoughts about their content knowledge and classroom interactions during mathematics instruction. The interview questions also probed teachers' childhood experiences with mathematics to identify particular periods of stress or enjoyment of mathematics. Seven 5th-grade teachers were interviewed to assess their perceptions about teaching mathematics. Additionally, classroom observations of the same teachers and their responses to an open-ended questionnaire provided meaningful qualitative data. A thorough examination of the interviews, observations, and questionnaire data and analysis of developing themes provided a basis for evidence compared with the literature review and the researcher's suppositions.

Theoretical Foundations and Conceptual Framework

The constructivist approach to mathematics demonstrated that it provides a solid basis for learning mathematics conceptually while still adhering to the intent of standards (Van de Walle, 2004). The primary idea underlying this research study was grounded in conceptual mathematics teaching and learning. Piaget claimed that children utilize arrangements like mathematical structures and patterns to reason about mathematical contexts (Wavering, 2011). These structures, characterized by propositional logic, focus on children's reasoning and practical logic (2011). According to Lev Vygotsky, students construct their mathematical understandings as they learn to explain and defend their reasoning to others (Steele, 2001). This constructivist theory suggests that acquiring mathematics language and expanding mathematical understanding occurs through a sequence of connecting concepts to generate additional meaning (2001). Students need opportunities to grapple with conceptual understanding to connect mathematical ideas and structures. A confident mathematics teacher that fosters the development of metacognitive strategies provides students with the means to justify thinking with a command of mathematical language and deep conceptual understanding.

Dr. John A. Van de Walle, a well-known mathematics leader, states that following procedural directions without reflective thought provides little to no construction of mathematics understanding. Student learning becomes limited because of the rules and procedures (Van de Walle, 2004, as cited in Smith, 2010). The rules and steps followed in mathematics sometimes blur proper conceptual understanding. "The ineffective practice of teaching procedures in the absence of conceptual understanding results in a lack of retention and increased errors, rigid approaches, and inefficient strategies" (Van de Walle et al., 2016, p. 25). Teachers who are not comfortable with mathematics concepts may revert to strictly procedural teaching. When students cross-multiply fraction numerators and denominators to determine an equivalency, they follow a procedure that could just as well be performed using whole numbers. As a result, students get bogged down trying to remember steps that can cause distress and lead to negative feelings towards math. The whole concept of equivalence as it relates to fractions is lost.

Therefore, teachers must understand the foundations for effective mathematics instruction to give students a thorough understanding and lessen their anxieties regarding mathematics instruction (Smith, 2010). Teachers must also have a deep understanding of mathematics, how it appears in daily life, and how to effectively move students from concrete to abstract understanding. The Concrete Representational Abstract (CRA)(2012) is an effective instructional sequence that prepares students to understand abstract mathematical concepts. When students begin to think mathematically, they must be supported by concrete material before reaching the more abstract operations phase of learning. This combination of experiences with concrete objects eventually leads to the sense-making of more sophisticated mathematical structures.

Piaget (1964) indicates that conceptual mathematical understanding is an experience of the child's interactions with concrete materials instead of the concrete materials themselves. He emphasized that mathematics content is heavily abstract, and it is vital for students to begin with sufficient concrete experiences necessary for understanding the abstractions like the concepts. (Yıldırım & Yıkmış, 2022, p. 94).

According to research from Concrete Representational Abstract (CRA) (2012), The initial phase of the CRA sequence is known as the concrete stage. It involves physically manipulating items to understand math conceptually. The next step is the representational stage, which bridges the concrete and the abstract. Students can move from hands-on manipulation to drawings as representations of concrete objects at this stage. The final stage of this method is known as the abstract stage and involves solving math problems using only numbers and symbols. CRA is a continuous progression. Each stage is dependent on the previous stage and must be taught sequentially. However, students' rate of successfully moving through the stages is not necessarily a linear progression (*CRA Assessment*, n.d.). Teachers must be confident in their ability to provide appropriate instruction based on this sequence for students to be successful with mathematics beyond elementary.

In this study, the researcher will rely on the collected data and literature from similar studies and professional journals to gain insight from multiple theories and interrelated ideas to support and inform the research. The core of a structure or an experience is the focus of phenomenological research. It is a method of inquiry that explores inner feelings and experiences. Participants' experiences are evaluated and compared to determine the essential qualities of the phenomenon (Merriam & Grenier, 2019). The goal of this study was to explore the phenomenon of math anxiety contextually with 5th-grade mathematics elementary teachers to uncover the implications for teachers' perceptions of mathematics teaching and learning.

Definition of the Terms

Concrete- Representational-Abstract (C-R-A): (*Concrete Representational Abstract (CRA)*, 2012). Concrete Representational Abstract (CRA) is a three-step approach to teaching mathematical concepts that have proven to be highly effective.

Math Anxiety: An unfavorable response to math and mathematical situations (*What Is Mathematics Anxiety? | Centre for Neuroscience in Education*, n.d.).

Organization for Economic Co-operation and Development (OECD): OECD (2020). OECD is the abbreviation for the Organization for Economic Co-operation and Development, consisting of 34 countries that discuss and develop economic and social policy. The OECD allows different countries' governments to solve common problems worldwide.

Programme for International Student Assessment (PISA): PISA - PISA. (2019). OECD. https://www.oecd.org/pisa/. PISA is the abbreviation for the Programme for International Student Assessment, which measures 15-year-old students' scholastic performance in mathematics, science, and reading every three years.

South Carolina College and Career Ready Test (SCCCR or SCReady): *South Carolina Department of Education Test Scores*. (2019). South Carolina Department of Education. SC Ready is the abbreviation for the standardized test administered in late spring to students in South Carolina from third to eighth grades in mathematics and English language arts.

Survey of Adult Skills: Programme for the International Assessment of Adult Competencies (PIAAC): PIAAC (2019). This survey measures adults' proficiency in essential information, processing skills, literacy, numeracy, and problem-solving. It gathers information and data on how adults use their skills at home, at work, and in the broader community.

Summary

In the United States, aversion to mathematics is a phenomenon often discussed in research (Beilock, 2019). However, with unsuccessful attempts at reform, an inadequate understanding of mathematics prevails in our nation. Agasisti and Zoido (2018) referenced a 2012 OECD study comparing the numeracy proficiency of 16- to 65-year-olds in 20 nations; Americans were among the lowest five in terms of numeracy. Mathematics proficiency levels are low across age levels. Teacher candidates and veteran teachers fit into the age span in the OECD study. If elementary teachers are not comfortable with mathematics, will they be comfortable teaching mathematics? Could instructors' experiences, attitudes, and levels of mathematics confidence influence how they teach mathematics?

This study explored teachers' earliest memories of mathematics before entering school and mathematics experiences during formal schooling to learn more about the elements that influence their perceptions of mathematics. The study also considered the elements impacting teachers' current attitudes toward math content and instruction. Additionally, the study explored the possible relationship between the teacher's competency levels in teaching mathematics and the quality of instruction. In the next chapter, the researcher analyzed the literature associated with the topic. In Chapter Two, the researcher chose literature similar to the topic but not necessarily in agreement to provide a wide range of literature that provided insight and challenges to the study.

Chapter 2

Review of Related Literature

Mathematics is taught at all grade levels throughout a student's education. It is one of the primary fields of study needed for success in daily life. However, it is an area that people are afraid of the most and fail the most (Gürbüz & Yıldırım, 2016). This study aimed to examine the relationship between fifth-grade teachers' experiences and perceptions of mathematics and the quality of their instruction.

The decreasing numbers of students meeting and exceeding achievement requirements led to exploring teachers' attitudes towards mathematics and their confidence in mathematics instruction. In 2019, 2021, and 2022 SC READY scores showed a marked decrease in fifth-grade mathematics students who scored met and exemplary in the participating district. Overall, close to 55% of 5th graders in South Carolina landed in the "not met" or "approaches" category on the SC READY for the 2019 school year, which increased to 73 % in 2021 and decreased by 1 % in 2022. (South Carolina Department of Education, 2022). This research aimed to determine how common math anxiety was in 5th-grade teachers in the participating district and how that might have affected fifth-grade math instruction.

In this section, the literature is associated with mathematics anxiety, mathematics content, perceptions, confidence levels, and the relationship to mathematics instruction. The discussion examines society's perceptions of mathematics and how attitudes may impact the enjoyment of teaching mathematics. The literature also includes research focusing on a connection between math anxiety, neurological activity in the brain, and the ability to perform mathematics tasks. In addition, the review includes research concerning the conceptual understanding of mathematics content and its implications on instruction. How math anxiety impacts students' perceptions and understanding of mathematics provides a broad spectrum of information. Lastly, the researcher examined the literature on teachers' math anxiety and confidence in understanding and teaching mathematical concepts.

Mathematics Anxiety and Neurological Factors

Mathematics anxiety is trait anxiety and differs from test anxiety and state anxiety. "State anxiety" is a short-term reaction to a traumatic experience, while "trait anxiety" is a more enduring personality attribute (Saviola et al., 2020). It differs from dyscalculia, a specific learning disability that affects the development of arithmetic skills. A brain imaging study focusing on adults and comparisons of brain response between groups with high and low levels of math anxiety found that high-level math anxiety is linked to more significant activity in brain areas that process danger and pain (Hartwright et al., 2018). Elevated levels of math anxiety were also linked to a depletion of working memory during complex mathematics tasks (2018). Working memory is a brain function that affects how we process, utilize, and remember information (Child Mind Institute, 2021). Working memory is required to remember a phone number, directions, and math facts and procedures. Working memory is like a mental file folder that holds all the information we need to recall quickly (2021). Some anxiety is favorable to performance, but high levels can undermine thought processes (Hebb, 1955).

Working memory, flexibility in thinking, and self-regulating composure are all controlled in the brain. Problems with cognitive processing can impede focus and control over emotions. Emotions can cloud thinking and stop processes necessary for carrying out mathematical procedures. Emotions heighten math anxiety. People with high mathematics anxiety will be less proficient at computation and less likely to utilize effective strategies or make connections between mathematical concepts (Omoniyi-Israel, & Olubunmi, 2014). Ashcraft and Kirk (2001) delved into math anxiety's impact on mathematical thinking and processing. They found that when regrouping was added to a computational task, it temporarily overloaded participants' working memory, and their performance dropped dramatically. Furthermore, lower accessible working memory capacity was linked to higher levels of arithmetic anxiety, but not permanently, but as a transitory functional loss in processing capacity (2001).

Lauer et al. investigated math and spatial anxiety in children during elementary school years (2018). Prior research suggested that general anxiety accounted for the impacts of math anxiety on math performance in school-aged children (Hill et al., 2016). Lauer et al. found gender disparities in math and spatial anxiety across the board and domain-specific anxiety as a distinct predictor of children's performance on arithmetic and spatial tests (2018). Additionally, the findings demonstrated the need for educational interventions to reduce math and spatial anxiety, particularly in females, implying that such treatments may be most advantageous if implemented in the initial years of school (2018). In summary, math anxiety is a phenomenon that temporarily blocks the ability to think through challenging aspects of mathematics.

Mathematics Anxiety and Mathematics Achievement

High math anxiety is frequently associated with low math achievement. Recent research primarily examines the potential factors influencing the association between math anxiety and math achievement. Studies indicate that as America's math phobia increases, achievement and opportunities for success decrease. Ramirez et al. (2013) conducted a study to assess math anxiety in 154 first and second-grade students. They found that math anxiety appears in students as early as first and second grade. More than half reported varying levels of math anxiety during the assessment. The results revealed a strong correlation between high levels of math anxiety and poor performance. The higher the anxiety, the lower the score (2013).

Cargnelutti et al. (2017) conducted a study to advance other recent studies associated with early childhood mathematics anxiety. Cargnelutti et al. examined whether math anxiety impacts early math proficiency and gathered information from children in Grades 2 and 3 to identify existing and developing patterns of anxiety (2017). Overall, the findings suggested that a proactive response to math anxiety in early childhood is crucial to preventing negative experiences in subsequent grades, possibly due to early learning gaps (2017).

A study conducted by Claessens and Engel (2013) investigated whether beginning kindergarteners with low math skills predicted subsequent outcomes for students as they progressed through school. Researchers measured students' kindergarten mathematics proficiency levels and other markers of school performance in eighth grade and at different stages throughout primary school. The study revealed that children with poor math skills are nearly twice as likely to be Black or Hispanic (nearly 40%) compared to only 24% of the overall population (2013). Data collection and analysis revealed that early mathematics knowledge and skills are the strongest determinants of later math achievement and achievement in other content areas. "Interestingly, these results indicate that kindergarten entry math scores on Proficiency Levels 1 and 2 are more predictive of math and reading achievement in eighth grade than is the reading test score at kindergarten entry" (2013, pp. 13-14). The results acknowledge that low-income schools need strong teachers in early childhood years to ensure success in upper elementary and secondary levels.

Several studies in the United States indicate that ill-prepared teachers are more likely to work in low-income schools (Tröbst et al., 2018). Research also indicates that American teacher preparation programs draw from a weaker pool of future mathematics teachers since the population generally performs poorly on international K-12 mathematics examinations (2018). "The fact that early mathematics knowledge and skills are the most important predictors not only for later math achievement but also for achievement in other content areas and grade retention indicates that math should be a primary area of academic focus during the kindergarten year" (Claessens and Engel, 2013, p. 23). School districts often focus the majority of professional learning and support efforts on the "tested" grades rather than concentrating on preemptive measures in the early childhood years. Confident and well-prepared teachers are vital to strengthening the foundation for early childhood mathematics. Children with gaps in learning who are also anxious about mathematics find it exceedingly more difficult each year they spend in school.

A recent meta-analysis of the relationship between math anxiety and math achievement was conducted by Barroso et al. (2021) and discovered a strong link between math anxiety and math achievement, implying that high mathematics anxiety results in poorer academic achievement. Math anxiety may also impact particular brain functions such as working memory, flexibility of thought, and self-control (Ashcraft and Kirk, 2001). Issues with neurological and cognitive processing in the brain may decrease focus and control of emotions, influencing student achievement outcomes (Beilock and Willingham, 2014). Math anxiety may affect competence in math-related circumstances. The neurological shutdown may also result in long-term consequences when people are anxious about math (Beilock, 2019). Low math skills, course selection, and even occupational choices are associated with mathematics anxiety (OECD, 2020). Because of its link to math achievement, math anxiety is crucial when improving math experiences. Students' past and recent test scores demonstrated a need to examine mathematics instruction and 5th-grade teachers' attitudes toward mathematics.

Vanbinst et al. (2020) suggest that mathematics anxiety results from a complicated interaction between nature and nurture. In nature, the brain reacts to anxiety by inhibiting the individual from efficiently attending to a task or assessing numerical information (Corbetta and Shulman, 2002). Even the anticipation of participating in mathematics activities activates the same neural centers in the brain that register threats and physical pain (Corbetta and Shulman, 2002). Data from Vanbist et al. pointed to a complicated familial basis for mathematics anxiety.

People with math anxiety take fewer math courses, earn lower grades in the classes they take, and demonstrate lower math achievement (Ramirez et al., 2018). Some teachers' negative perceptions about mathematics may be exacerbated by instruction focusing on rote memorization and procedures over conceptual learning from early childhood experiences in mathematics (Geist, 2010). The realization that children with negative math perceptions could become elementary teachers with negative mindsets toward mathematics needs to be considered to create positive change. In this study, the researcher explored the origins and impacts of math anxiety in teachers and how their current perceptions of mathematics influence instruction.

The literature portrays a convincing argument that more investigation is needed on the origin, progression, and mode of action of mathematics anxiety in children and its impact on achievement. It is also evident that children from lower-income situations may enter kindergarten without a firm grasp of basic mathematics understandings. This demonstrates the need for equal access to knowledgeable and confident teachers to avoid the onset of math anxiety in early childhood.

Self-Perceptions of Mathematics

Poor attitudes toward math have plagued our nation for quite some time (Looney et al., 2017). According to a Stanford study, a positive attitude toward math enhances the brain's memory region and positively impacts math achievement even when anxiety is present (Chen et al., 2018). A negative attitude towards mathematics may cause evasion of classwork, disorderly behavior, and mathematics anxiety (Dossel, 2016). Avoiding classwork and misbehaving will not improve students' foundational mathematics knowledge to compete for higher-paying jobs. The strong connection between mathematics skills and wages is represented in the United States (OECD, 2020). Students who struggle in mathematics have limited career choices as young adults. Even students who perform well in mathematics courses are unlikely to enjoy mathematics into adulthood (Browning et al., 2014). As a result, individuals with math anxiety continue to struggle with mathematics as adults and reinforce their negative beliefs about their abilities in mathematics (Jameson, 2014).

Female students' confidence and achievement levels are more likely to be negatively impacted by teachers with high math anxiety than male students (Beilock et al., 2010). According to a study conducted by Cvencek et al. (2011), math gender biases occur early in life and exhibit a distinct impact on boys' and girls' perceptions of mathematics. Researchers found that elementary school girls demonstrated a weaker association with mathematics through implicit and self-report measures than boys (math self-concept) (2011). This shows that the math–gender stereotype emerges early in life.

Robinson-Cimpian et al. (2014) collaborated to explore how teacher perceptions may influence the relationship between gender and mathematics achievement. The findings suggested that teachers perceive girls' mathematics abilities equally with similarly achieving boys only if they believe the girls exhibit more effort and behave better than the boys (2014). More typically, teachers ranked girls' mathematical prowess lower than boys', which may account for the widening mathematics gender gap favoring males at the elementary level (2014).

Bafflingly, some college students pursue careers in elementary education, knowing that they lack mathematics content knowledge and experience mathematics anxiety (Stoehr, 2017). Stoehr's investigation included three female preservice teachers who expressed worry about teaching elementary mathematics. They experienced mathematics anxiety about teaching mathematics to k-12 students and found difficulty with math methods courses required in their teacher preparatory programs (2017). Unfortunately, gender-specific mathematics anxiety impacts students who pursue teaching careers, where 90% of the workforce is female (United States Department of Education, 2017). Elementary teachers, unlike secondary, are held responsible for acquiring a solid understanding of all content areas they teach. Teachers may gain knowledge through professional learning opportunities, graduate courses, or research.

Mathematical Content Knowledge

If teachers feel that they know the mathematics content well, they are more confident in teaching math and imparting a positive attitude (Geist, 2015). The Survey of Adult Skills (PIAAC) was administered to 5,010 people in 15 countries worldwide (2019). The results indicate that almost one-third of individuals tested in the United States have a numeracy score below level two (2019). Level two includes proficiency with whole numbers, simple decimals, percent, and fraction calculations. It also includes measurements, estimation, simple data analysis, and probability. A solid grasp of elementary mathematics content is crucial for teachers of young children.

In the United States, a third of adults scored below a level of mathematics that contained elementary concepts. This deficit suggests a critical need for knowledgeable mathematics teachers in early grades and upper elementary. Research in mathematics content knowledge is limited (Gresham, 2018). According to research conducted by Thanheiser et al., preservice teachers' knowledge of whole number operations may be inadequate and grounded in knowledge of standard algorithms alone (2014). A study conducted by Chen et al. suggests that teacher confidence varies with specific math content knowledge and teaching and assessing mathematics (2014).

Antonelli (2019) conducted a mixed-methods study including kindergarten through fifth-grade teachers. Her study investigated teachers' perceptions of their technical abilities, mathematics content understanding, pedagogy, and readiness to use technology integration in their classrooms. In the past, expectations for teaching and learning mathematics were substantially different, according to most of the participating teachers in the study. Their educational experiences and academic achievements influenced participants' attitudes toward mathematics. They stated that past experiences impacted their current confidence levels as mathematics teachers. Although similar in some aspects to Antonelli’s, this study delved into teachers’ perceptions about math instruction and confidence with the concepts they teach. It explored the earliest childhood memories of mathematics interactions. It focused on how well-prepared teachers felt to teach mathematics and what mathematics methods courses they took in college. Additionally, teachers recalled what experiences influenced their current feelings about mathematics and how that has impacted their current instruction.

Antonelli's quantitative data analysis revealed that teachers' perceptions of mathematics content knowledge were strong. However, qualitative data suggested they were primarily focused on rote skills and procedural actions rather than deep learning of concepts. Participants believed they had a solid grasp of fundamentals but struggled with problem-solving, conceptual knowledge, and teaching various math strategies. Similarly, some teachers in the current study felt confident about teaching mathematics, but observations revealed that the instruction was primarily procedural in those classrooms.

If teachers have a poor understanding of mathematics, they may teach students discrete procedures that exclude the mathematical thinking required for conceptual understanding (Thomas & Hong, 2012, as cited in Antonelli, 2019). Teachers are expected to apply conceptual and procedural knowledge in various contexts. The new expectations and demands of instructing and mastering mathematics are significantly demanding, and teachers perceive this as a significant paradigm shift and steep learning curve for which they are unprepared (Antonelli, 2019).

Teacher education programs must provide continual professional support to mathematics preservice and in-service teachers and determine specific contexts in which the level of math anxiety can be decreased (Thanheiser et al., 2014). Sun (2017) analyzed teacher interactions with others and learning communities' participation to understand more clearly how mathematics teachers construct their identities. The study aimed to learn more about the relationship between mathematics teacher identities and professional development involvement, specifically how teachers' identities influenced how they participated in learning communities and professional learning opportunities (2017). Sun found that teachers were aware of the need to continuously develop their content knowledge and instructional strategies to stimulate, analyze, and respond to student thinking and reasoning (2017). However, Sun found that it was difficult for teachers to be wholly committed to mathematics professional learning when they disagreed with the school's vision and did not have a clear and consistent understanding of the goals of the professional development sessions (2017). For mathematics professional learning communities to thrive, characteristics must include collaborative participation in professional learning, commitment to the school's goals, and teacher input into the topics for professional learning (2017).

Teachers must model the thinking process necessary for understanding mathematics concepts. Students must be taught how to think and persevere through problem-solving and make logical decisions to solve and represent problems. In a study comparing constructivist and traditional methods of instruction, Alsup (2005) found evidence of a strong interaction between content knowledge and instruction. Preservice teachers with math anxiety took a semester-long course focused on conceptual learning. Teachers that took the course became less anxious about math content and gained self-efficacy (2005). However, the control-group students took a more traditional mathematics course. They experienced the steepest decrease in math anxiety of all participants, indicating that the overall decrease in math anxiety was likely due to the instructor's clarity and teaching style rather than the course itself (2005). Teachers' success with the course was primarily due to the instructor's ability to communicate and clarify mathematical ideas, the emphasis on deep conceptual understanding, and the interconnectedness of mathematical concepts. The instructor's use of various representations and approaches to problems may have had the most pronounced effect on students' mathematics anxiety and teaching efficacy (2005).

The math course was necessary for teachers' success because math anxiety has devastating effects on learning mathematics content. According to research with preservice teachers, negative experiences in the past potentially lead to mathematics anxiety at some point in students' academic journey. The major source of occurrences is linked to the behavior of the teachers from students' past school experiences (Bekdemir, 2010). The consequences of these negative experiences increasingly worsen as students proceed through school (2010). Teacher education programs should include proactive support to decrease or prevent the cyclical perpetuation of anxiety before preservice teachers graduate. Research findings regarding the continuance of math anxiety in our nation raise the question of the role of teacher education programs in mitigating negative perceptions of mathematics among preservice teachers (Looney et al., 2017).

Student Anxiety in Mathematics

Mathematics anxiety is measured through the level of enjoyment associated with items having to do with making good grades or the level of comfort when doing mathematics work (OECD, 2010). Research shows that anxiety toward mathematics differs by grade level, and anxiety toward assessment is higher among middle and secondary levels. Escalera-Chávez et al. (2016) used a unique scale to quantify math anxiety in their research. Test anxiety, anxiety about temporality, anxiety toward understanding mathematical issues, anxiety about numbers and mathematical operations, and anxiety toward real-life mathematics situations were among the 24 items on the scale. Escalera-Chávez et al. discovered that math anxiety among high school students was linked to worry associated with assessment outcomes (2016).

In another study, mathematics anxiety was most common among second graders and found less often in fifth graders (Sorvo et al., 2017). More recent studies confirm that math anxiety is linked to math achievement and math self-esteem in early school-age children (Szczygieł, 2020). Furthermore, findings by Szczygiel also indicate that math anxiety in children is a distinct type of anxiety, separate from general test anxiety. A study conducted by Foley et al. (2017) suggested that the better a student is in math, the more intensely their performance will be diminished by anxiety. Math anxiety and the brain's emotional system interfere with students' ability to retrieve information during a test, so they perform much worse than they would if they were not anxious (2017). Furthermore, the study indicated that the relationship between anxiety and achievement occurs in the United States and worldwide (2017).

According to data from 2018 PISA results, in several countries, including the United States, students scored higher in reading when they perceived their teacher as more enthusiastic, especially when their teachers seemed interested in the subject (OECD, 2020). While Finland excels academically on PISA, it has a low equity ranking (Sahlberg, 2021). In 2015, the country's equality scores for boys and girls and immigrant students were below the OECD average (2021). The United States, on the other hand, fared about average in terms of gender parity among boys and girls and slightly better than average in terms of immigrant students (2021).

In Finland, only nine compulsory school years are required for students (Sahlberg, 2021). According to the National Center for Education Statistics (2017), compulsory age limits in the

United States range between sixteen and eighteen. PISA tests children enrolled in a school at grade 7 or higher between the ages of 15 and 3 months and 16 and 2 months (OECD, 2020). In Finland, Upper Secondary School students prepare for the Matriculation Test, which determines whether they will be admitted to a university after three years. This choice is typically based on their achievements during primary education. The other path for Finnish students is vocational training for various non-university careers with the option of taking the Matriculation exam after three years of training. In new research from Pulkkinen & Rautopuro(2022), most, but not all, of the PISA students in Finland are in the ninth grade, meaning they are at the last grade level of primary education before Upper Secondary School or vocational training. In America's present educational system, students between fifteen and sixteen, regardless of achievement or socioeconomic level, may be eligible for the PISA examination.

Finland's policies work because it is a small country with a relatively homogeneous population; however, comparable changes may be difficult to implement in large countries with vast social differences and immigrants or English language learners (Hendrickson, 2012). Furthermore, Finland's changes go beyond the classroom, with all students receiving free health care, nutrition, counseling, and further education, removing some variables that negatively affect academic performance (2012). The United States may want to consider the differences between the two countries' policies and the differences in the size and make-up of the populations when comparing students' performance on the PISA.

An OECD study in 2010 focused on students' perceptions of math teaching and learning and the connection to performance in mathematics. According to the study, mathematical competencies are highly connected with confidence in one's strengths in mathematics and a strong sense of efficacy in meeting challenges in learning tasks (2010).The disciplinary climate at the student and school levels, as well as total hours per week of homework, stand out as having the most substantial effects across the majority of countries, with student use of strategies and student-teacher relations having positive associations with mathematics performance in some countries but not in others (2010). Research has also shown that students differ tremendously in their teacher's perceptions (Göllner et al., 2018).

Siebers (2015) found that elementary students considered understanding patterns and solving problems fun, but students with math anxiety began to avoid mathematical thinking and problem-solving in upper grades. The same students were frustrated during math discourse and were found to have low self-efficacy about math (Siebers, 2015). Math anxiety results are apparent in students who negatively compared themselves to their classmates because they tended to earn lower test scores. These findings indicated that it is critical to consider students' confidence levels in mathematics when examining factors associated with achievement (House & Telease, 2011). Students' anxiety levels can vary across grade levels, but the relationship between frustration and low levels of confidence is apparent in those students with mathematics anxiety.

Teacher Anxiety in Mathematics

According to recent studies, it has been found that mathematics teachers who like their jobs have lower anxiety levels than those who do not like their jobs (Gürbüz & Yıldırım, 2016). Many factors contribute to the development of mathematics anxiety, such as the quality of instruction, motivation, peer influences, the method of teaching, lack of opportunities to relate math to daily life, topics not appropriate for the cognitive level of students, the very nature of mathematics, students' preconceived negative attitudes against mathematics, inadequate level of basic mathematics, and the quality of teacher-student relationships (Gürbüz & Yıldırım, 2016).

Research has also revealed that mathematics anxiety has roots in some preservice teachers' histories, low-performance and weak backgrounds, and a lack of positive experiences in school. Some negative experiences included embarrassment, humiliation, shame, being dumb or stupid in front of peers, and being afraid of speaking up for fear of being the only student that did not understand (Stoehr, 2017). Students may sense teachers' negative attitudes toward the content they are teaching (Dossel, 2016).

In a recent study, Hardacre et al. (2021) examined possible factors related to minority teacher candidates' low test-passing rates on the required standardized exams for teacher certification in California. According to survey findings, students expressed general anxiety about taking teacher exams, particularly math exams. Respondents did not score well on math-related multiple-choice and constructed response questions. Key findings included students' beliefs that math test anxiety was a barrier to passing the examinations and entering the teacher preparatory program and the teaching profession,

In a study comparing constructivist and traditional methods of instruction, Alsup (2005) found evidence of a strong interaction between content knowledge and instruction. Teachers that took the course became less anxious about math content and gained self-efficacy (2005). Math anxiety was studied because it has a devastating effect on learning mathematics. Research has revealed that preservice elementary teachers have the most significant level of math anxiety of any college major (2005). Research findings regarding the continuance of math anxiety in our nation raise the question of the role of teacher education programs in mitigating negative perceptions of mathematics among preservice teachers (Looney et al., 2017).

Additionally, teacher preparatory programs should examine prospective teachers' mathematics skills at the onset of college education to better understand the progression of prospective teachers' competencies (Samuels, 2015). Elementary teachers must be well-prepared as preservice teachers to positively affect the future of quality mathematics instruction.

Summary and Integration

Students and teachers suffer from math anxiety. Research shows that the notion of math anxiety is common and accepted by American society (Ramirez et al., 2018). Many new teachers, as well as veteran teachers, suffer from math anxiety or dislike mathematics. Teachers with negative feelings about their teaching content could pass those attitudes on to students. Students may develop a distaste for mathematics that begins early in their careers and festers as students progress through school. Research indicates that disciplinary issues in mathematics classrooms could also play a part in mathematics anxiety (OECD, 2020). The nature of math and teacher responses to students' needs, teaching methods, and teacher knowledge of content could affect students' mathematics perceptions. In the next chapter, the researcher discusses the methodology and research design in detail.

Chapter 3: Methodology

Introduction

In the previous chapter, the literature connected research that suggests many students and teachers may suffer from math anxiety. Additionally, the research indicates that some elementary teachers may need more confidence in teaching mathematics because mathematics was a historically weak area throughout their school years. The literature also reveals that math anxiety is a common occurrence and is acknowledged by American society. According to Fiss, math anxiety's history in America persists in the manner of math communication. The current written high-stakes assessment is still a source of anxiety akin to the previous feeling of stage fright while writing on the blackboard in front of the class (2020).

In this chapter, the author discussed the purpose of the study, the research questions, the research methodology, and the study's design. Also included in this chapter is information about the sample represented in the study. In addition, the author addressed the limitations and ethical concerns of the research. A brief and concise synopsis was provided to summarize the chapter.

Purpose of the Study

This study aimed to determine how 5th-grade teachers' experiences and perceptions of mathematics influenced mathematics instruction. The researcher examined the literature to determine if there was evidence of teacher anxiety towards mathematics and math instruction and teachers' lack of content knowledge and math achievement. The researcher also considered other factors that might impact teachers' perceptions of mathematics and included literature suggesting that other extraneous variables contribute to anxiety in mathematics learning and instruction. The research questions were crafted to explore the roots of math anxiety and whether this phenomenon guided teachers' perceptions of mathematics. The questions also aimed to investigate whether teachers' understanding of mathematics content influenced math instruction.

Research Questions

Question 1: How do 5th-grade teachers' experiences and self-perceptions of mathematics influence mathematics instruction?

Question 2: How do 5th-grade teachers' understanding of mathematics concepts influence instruction?

Research Design

By its very nature, qualitative research is exploratory and descriptive. Additionally, it is utilized to delve deeper into topics and investigate intricacies tied to the topic under investigation. This type of "research has a long history of living with the criticism that it engages in some revealing theorizing based on evidence that would otherwise not satisfy traditional criteria" (Gioia, 2017, p. 455). The qualitative approach assumes that organizational phenomena were socially built by individuals who understood what they attempted to do and explained their thoughts, intentions, and behaviors (Gioia, 2017). Gioia et al. (2013) state that a qualitative researcher seeks a credible, defendable explanation of the how and why of a phenomenon.

For this study, a qualitative phenomenological design was utilized. This approach used a structured interview protocol, open-ended questionnaire, and observations to answer the research questions. Phenomenological studies help researchers better understand and describe the impact of specific experiences and perceptions of individuals. Phenomenology attempts to explain the meaning of people's experiences. Phenomenological investigations look into what people have experienced and focus on their feelings about the phenomena (Groenewald, 2004). The researcher's goal is to describe the phenomenon as precisely as possible, avoiding any prenotions while remaining factual (Groenewald, 2004).

The researcher focused on a phenomenon in mathematics instruction in which a small group case study included three sources from which data was accessed (Igbol, 2021). The qualitative data collection and analysis process included combining the data and identifying links to the literature review and analysis. The purpose of the design was to collect cogent data from the interviews, the questionnaire, and observations to bolster the validity of the findings. The research questions focused on the experiences and perceptions of teachers and required qualitative data collection to provide a chronicle of authentic embodiments from participants.

The inductive nature of this qualitative approach necessitated vignettes from teachers' experiences, attitudes, and instructional behaviors associated with elementary mathematics. The research utilized qualitative surveys, interviews, and observation data to capture the essence of participants' feelings and actions fully. The qualitative surveys and interviews aligned with the research questions' purpose. The interview questions probed the participants' experiences in mathematics, their current feelings toward mathematics instruction, and information about their previous and teacher preparatory mathematics courses. The survey questions investigated teachers' current math instruction to include enjoyable and frustrating concepts. The observations were scripted with teacher actions and practices during instruction to investigate connections between verbal and written accounts with actions and observable behaviors.

Sources of Data (Qualitative)

The data sources consisted of interview questions written by the researcher, a modified observation protocol that utilized sound instructional practices found in the Massachusetts Curriculum Framework (2012), and open-ended survey questions created by the researcher. The articles, books, and dissertations were obtained by utilizing Southern Wesleyan's library online resources, "ONE search" and "ProQuest Dissertations and Theses." Other articles and books were gleaned from Research Gate, the Association for Supervision and Curriculum Development (ASCD), and Phi Delta Kappan (PDK).

Data Collection

A successful phenomenological study must focus on the various ways information is extracted from respondents. In a qualitative phenomenological research design, the focus is on the research questions. The researcher must develop rapport without influence to understand the participants' experiences thoroughly. (Essential Guide to Coding Qualitative Data, n.d.). In this phenomenological case study, in-depth research supported the understanding of the group in their actual situations. The goal of combining several data sources was to learn more about different elements of the phenomenon (Maxwell, 2013). This broadened the scope of topics covered. Interviews helped to understand instructors' historical experiences and opinions on mathematics, while observational data looked at the behavior of teachers and students in the math classroom setting. The survey included questions about mathematics instruction, which provided valuable information about particular areas of instruction, content teachers felt confident about, and weaknesses that needed growth.

Qualitative data was collected by recording responses from the online open-ended survey, interviews, and observations. Participants received an email containing a detailed explanation of the study and how data would be collected. A link to surveyplanet.com was provided to respondents to complete the survey. The online questionnaire contained ten open-ended questions constructed by the researcher to generate written responses from participants. The purpose of the questions was to elicit perspectives and experiences from respondents about mathematics content and teaching mathematics. The open-ended survey was used as a prelude to the structured interviews. The data gathered from the survey aided in identifying initial themes. The survey took respondents approximately 20-30 minutes to complete.

The interviews were a structured type of questionnaire conducted verbally. Six of seven teachers scheduled time during their planning periods to meet via Microsoft Teams for the interview. Planning times varied from 7:45 a.m. to 1:45 p.m. One teacher completed the interview through Microsoft Teams after work hours at home. In the structured interviews, the responder answered a set of predetermined questions. During the interview, the researcher did not elaborate or ask further questions for clarification from respondents. The constancy of the interview questions also allowed for easy comparison and analysis of the results. The interviews took twenty to thirty minutes to complete. Teachers allowed the researcher to record the interviews using an iPhone but declined the video recording through Microsoft Teams.

The researcher created a protocol for observing mathematics classroom content and practice using a "look fors" document (see Appendix D) from the Massachusetts Curriculum Framework (MCF) for guidance. The information from the MCF document was used to craft the observation protocol that focused on the instruction and assessment domains. The "look fors" included what the teacher and students did during mathematics instruction. Teachers provided schedules to the researcher to avoid testing or other situations compromising instruction. Each teacher was observed once for thirty to sixty minutes during the mathematics block. The researcher observed from the back of the classroom to minimize disruption to instruction. The researcher recorded audio from the observation using an iPhone to ensure transcription accuracy. The observations revealed further information about the teacher's mathematical and conceptual understanding and instructional practices. The observation data "primarily relied on descriptive field notes" (Maxwell, 2013, p. 89) and transcriptions from the audio recordings. The data was gathered and housed within the participating school district on an encrypted external drive.

Data Analysis

The researcher read the collected data from notes and questionnaire responses, then compared them with transcriptions while listening to audio recordings. Every word, pause, and stutter was recorded. All filler words and unintelligible utterances were later omitted to provide more clarity to the reader without losing the integrity of the response passages.

Questionnaires

The analysis process began immediately upon completing the surveys with assistance from two colleagues with research experience. The first step in the qualitative analysis was to read the survey responses. The research team read all of the survey responses and took note of similar responses and outliers. The team chose highlighter colors to develop overarching categories and assign the data to more refined groupings. Next, a diagram was created to visualize the themes in an organized manner. The visual provided the researcher with a simplified and truthful account of the responses. An organizational chart in Table 1 demonstrates categorizing and coding of the survey data.

Table 1

Questionnaire data chart

Organizational Table for Categorizing Survey Results

Experience		Content Knowledge	
Mathematics Preparation	**Years Teaching**	**Enjoyable Concepts**	**Frustrating Concepts**
High School	Under 5	Number sense	Fractions/Decimals
College	Over 5	Specifically the Coordinate Plane	Measurement

Interviews

After each interview, the researcher listened to the responses with the corresponding notes taken to give an accurate and complete description. Next, the qualitative interview data were transcribed and reread. Notes were taken to gather any missed information from the first read. The researcher provided a transcription generated from the Google tool "Voice Typing" to the two supporting colleagues for review and comparison with the audio recordings and notes. As with the surveys, the research team examined the data to categorize and code the significant themes. The data was then sifted to reveal unique nuances between responses.

The researcher and colleagues also listened to recordings of the interviews for comparison with notes to improve the accuracy of transcriptions. The researcher and colleagues looked for patterns, similarities, differences, and connections from the memos and notes to categorize the data into meaningful chunks of information. The information was placed in a graphic organizer to begin the open coding process. Patterns of phrases and words associated with respondents' experiences and perceptions of mathematics and any outlying data contained in the results were sorted during the process. The researcher and colleagues determined which categories fell under areas that provided substantial, theoretical, or organizational evidence (Maxwell, 2013). Organizational categories provided the big picture and helped drill down information into meaningful topics (2013). Substantial categories were more descriptive and aligned closely with respondents' words (2013). Theoretical categories included information representing similar results from prior studies found in the literature review (2013). Table 2 contains the analysis process of the interview data.

Table 2

Interview Response Themes

Results Categories	Similar Responses	Outlier Responses
Mathematics experiences before school	Counting games	Learning to count from 1-10
Mathematics experiences during school	Struggles with number sense, positive experiences with teachers	Montessori experiences, problem-solving
High School Math Courses	Basic Algebra and Geometry courses	Calculus, Probability, Statistics, Trigonometry

Teacher Preparatory Math Courses	College level mathematics involving Algebra and Geometry	Manipulatives training, connecting children's literature with math
Subject Area Strengths	Mathematics, Social Studies, Science	Reading, Phonics
Influences on Mathematics Instruction	District professional development, mentor teachers	Montessori Training, previous mathematics employment experience outside of teaching
Mathematics Weaknesses	Fractions, Decimals, Metric Conversions, deeper understanding of math concepts, using concrete models to demonstrate math concepts	Number Lines
Mathematics Strengths	No similarities	Finding gaps in understanding, pacing, enthusiasm, teaching procedures, teaching the CRA sequence, and scaffolding
Confidence in Mathematics Instruction	Pretty good, willing to learn more	Very Strongly, I like when kids make connections

Observations

The researcher read observational notes and listened to recordings of the observations. Part of the process involved "writing memos on what was seen and heard in the data to develop tentative ideas about categories and relationships" (Maxwell, p. 105, 2013). The observational data provided comparable information relating to the second research question, which focuses on teacher content knowledge and how that might influence instruction. In the organization and analysis of the observation data, the researcher focused on clearly delineated elements from

Massachusetts's Department of Elementary and Secondary Education Observation Protocol (2012) (see appendix D). Since the protocol focused on specific elements, deductive coding was used to analyze the observed data. The codes arose from the observation protocol "look fors." The research team reviewed the data and aligned the observation excerpts with the codes. In Table 3, an (x) represents the "look fors" observed during an instructional period. This chart provides a clear picture of the frequency of observances from each theme.

Table 3

Observation Themes

Themes from Observations

Teacher demonstrated high-expectations for students' work	Use of precise mathematics vocabulary	Concrete objects, illustrations, or abstract sequence of instruction	Teacher provided actionable and specific feedback	Teacher assessed using quick formative measures	Teacher provided exemplars during instruction	Teacher delivered instruction in a planned and logical sequence	Teacher identified and quickly addressed misconceptions
x	x	x		x		x	x
x	x	x				x	
x	x					x	

Note: (x)= observed during instructional period

Study Population and Sample Selection

The researcher employed purposeful sampling to ensure the representation aligned with the research focus. The participating district approved twenty schools for the research. Three of the schools volunteered to participate in the study. The schools included one school from a rural area, one Montessori school from a suburban area, and one from an urban area. Eighty-seven percent of the students in the rural school are African American, five percent are Hispanic, and two percent are white. One hundred percent of students from that school are from low-income homes. Only fifteen percent of fifth-grade students in the school passed the state mathematics exam in 2021 (GreatSchools, n.d.).

The Montessori school's demographics include seventy-five percent white, five percent Hispanic, and fifteen percent African American students. One hundred percent qualify for free or reduced lunch. Seventy-three percent of students passed the state mathematics exam in 2021. The Montessori school is in a suburban area. Students at this school are making significant academic gains in mathematics and are outperforming peers at other schools across the state (GreatSchools, n.d.).

The urban school's demographics include ninety-four percent African American students, Four percent with more than one race, one percent Hispanic, and less than one percent white. One hundred percent of families qualify for free or reduced lunch. Twenty-four percent of students passed the state mathematics exam in 2021(GreatSchools, n.d.).

The participants in this study included five female and two male certified 5th-grade teachers. Participating teachers were current instructors of 5th-grade math from the 2021-2022 school year. The teachers ranged from almost two years to 14 years of experience. Forty-three percent of the participating teachers were African American, and fifty-seven percent were white. The participating school district population spans all socioeconomic levels. The data was gathered and housed within the participating school district. Table 4 displays the participant's demographic information.

Table 4

Demographics of Participants

Ethnicity	***Sex***	***Highest Educational Degree***	***Years Teaching***	***Years Teaching 5th grade Math***
African American	*F*	*Bachelor's*	*3*	*2*
African American	*M*	*Bachelor's*	*4.5*	*2*
White	*F*	*Bachelor's*	*2*	*1.5*
African American	*M*	*Bachelor's*	*2*	*2*
White	*F*	*Master's*	*5*	*3*
White	*F*	*Master's*	*10*	*2*
White	*F*	*Master's + 30*	*14*	*10*

Ethical Considerations

Ethics in a qualitative study required that participants are informed and give voluntary consent. Teachers' names were not used in the study to protect confidentiality, and no participant was harmed in any way. Before the researcher approached people to participate in the study, they were given detailed information about the study's purpose and possible benefits from the results. The researcher made a list of actions needed to accomplish the research goals. The researcher also carefully examined options to clarify that they were ethically sound. The researcher then identified how participants might be affected by any portion of the study to be confident that no one would be harmed.

For the study to be equitable, the researcher ensured that gender, race, and socioeconomic levels were fairly represented. There are nearly 30 elementary schools in the participating district, ranging from rural to urban, with varying socioeconomic levels in each. Fifty-two percent of teachers are African American, and forty-eight percent are Caucasian. To be equitable, the researcher strived to be strategic about choosing the teachers' population to represent the district accurately. The participating teachers in the study included forty-three percent African American and fifty-seven percent white. There were fewer African American and more white participants in the study, with almost a ten percent difference from the district percentages.

Summary

In this chapter, the research method and design were disclosed and outlined in this chapter. The critical points included explaining the population studied, the research design, and the instrumentation utilized to collect data. The researcher explored characteristics and experiences that might affect teachers' views of mathematics instruction and content. The goal of the research questions was to investigate the mathematical memories of teachers and determine if those recollections had a lasting effect on how teachers currently viewed mathematics instruction and content. The qualitative design of the study supported the rationale to examine the human reaction to positive and adverse revelations about mathematics. This design allowed the researcher to explore different feelings and attitudes about teaching mathematics content.

The population of participants embodied the primary goal of examining different views and experiences. The participating schools varied in demographic data, excluding income levels which were the same in each school. Data collection processes enabled the research to gather comparable details applicable to the research questions. In addition, the research questions were reiterated and included to allow the reader to connect the questions and research design. The data was analyzed in Chapter four, and a detailed summary of the findings was presented.

Chapter 4: Data Analysis and Findings

Introduction

Research reveals that some teachers suffer from mathematics anxiety (Stoehr, 2017). There is limited extensive research on how teachers' math anxiety influences instruction (Ramirez et al., 2018). This study examined how fifth-grade teachers' experiences, perceptions, and confidence in mathematics may influence math instruction. The overarching questions utilized in the study are:

Question 1: How do 5th-grade teachers' experiences and self-perceptions of mathematics influence mathematics instruction?

Question 2: How do 5th-grade teachers' understanding of mathematics concepts influence instruction?

Chapter four contains the results of the case study conducted with fifth-grade mathematics teachers. In this phenomenological approach, the researcher completed the qualitative data collection by conducting virtual interviews first, gathering the questionnaire data next, and ending with a face-to-face observation of math instruction.

The organization of chapter four begins with a description of the qualitative data collection process in the study. The next section of the chapter is devoted to qualitative analysis, which includes the transcription of interviews, organization, and coding of the data. Also discussed in the chapter is the process used to analyze transcripts from the interviews to uncover codes and themes. The researcher and colleagues teamed up to evaluate the teacher questionnaire and compared results with themes emerging from the interviews to organize the information into a display. The research team analyzed the observation data and organized it into a table that displayed the elements of the observation protocol. The findings accompany a summary of the data and how the results align with the research questions. The chapter also includes samples from the individual interviews, the questionnaire, and observations that highlight critical areas and substantiate the analyses' organizational flow.

Sample

As stated previously, seven teachers participated in this study. All seven participants completed the questionnaire and the subsequent interviews. Participants' names were not used in the study. Instead, they were represented using the letters A to G. Five teachers in the study were female, and two were male. The male teachers taught math for less than five years. Two female teachers were upper-level Montessori teachers, and most of their students were at a fifth-grade level. The other three female and two male teachers were in a general education setting. The female teachers ranged in teaching experience from two to fourteen years. Three teachers were African American, and four were White and non-Hispanic. Four teachers have a bachelor's degree, and three teachers have a master's degree.

Data Collection

Interviews

The teacher interviews served as the primary source of research data. All interviews were conducted virtually through Microsoft Teams and scheduled over a two-to-three-week period. Six teachers completed the interviews within two weeks, and one teacher during the third week. The teachers opted out of having a video recording through Microsoft Teams. The researcher used an iPhone to make an audio recording of the interview and took hand-written notes. The researcher transcribed the audio recording using Google "voice typing." The researcher destroyed recordings and transcriptions after the analysis and usage of passages in the paper.

Questionnaire

The teacher survey was distributed to participants via email with a link to the open-ended questionnaire. The teachers were given three weeks to complete the questionnaire. All teachers completed the questionnaire within three weeks. The results were listed by the date of submission. The researcher and colleagues downloaded the results and read through each document several times, noting similarities and differences between each participant. The researcher and colleagues used highlighters in the coding process of labeling and organizing to categorize results to identify themes.

Observations

The observations provided information about the second research question focusing on mathematics content understanding and instruction. The observations were each scheduled at the end of the interviews. The observations were completed two to three weeks after the interviews. The naturalistic observations took place in the teachers' classroom setting. The researcher sat in the back of the classroom and did not engage with the students or teachers during the observations to prevent obtrusive interaction. The researcher recorded the sixty-minute observations with an iPhone and hand-scripted all actions and comments from the teacher and students. The Google voice typing tool was used to transcribe the observation data. The researcher repeated the same procedures with the interview data, listening to the audio recording while the transcribing tool typed the recordings. The researcher and colleagues stopped several times to ensure the accuracy of the transcription.

Data Analysis

Interviews

To initiate the analysis process, the researcher asked one colleague with qualitative research experience and one doctoral candidate studying coding and wanted to experience the process. Both colleagues agreed to assist the researcher with the interviews, survey, and observation data. The two colleagues are women. One received her Doctor of Philosophy in educational leadership, and the other pursued her Educational Doctorate in Leadership. The researcher provided the colleagues with copies of the transcribed data from the Microsoft Teams interviews. The researcher recorded the interviews with a cell phone rather than utilizing the recording feature on Microsoft Teams. To preserve confidentiality, the researcher transcribed the interviews using a Google tool called "voice typing." The recorded interview played while the application typed and transcribed the interviews. Although Microsoft Teams was used to complete the interviews, the district policy requires that Microsoft Teams recordings are available to staff. They upload automatically to a shared district folder. By using Google transcription, the researcher protected anonymity.

The colleagues and researcher listened separately to the recordings and verified the transcriptions for accuracy. The three team members compared notes, separated, and looked for themes in the transcriptions. The researcher and two colleagues read each transcription several times while listening to the audio recording to ensure the accuracy of the translation application. The data included positive and negative experiences. The group reconvened to compare notes and created the categories and subcategories noted in the data.

The group agreed that "Mathematics Experiences" encompassed the intent of the questions and the resulting responses. A hierarchical organizational chart displayed the section headings, subheadings, and responses (see Figure 1). Section headings include; education, content, and mathematics instruction. Under the section headings, the subheadings broke the content into smaller, more specific sections, giving readers clarity and making it easier to understand and compare with other chart sections. There were positive and negative experiences associated with various mathematics concepts throughout the interviews and survey. The interview questions and responses related directly to the research questions.

The first two interview questions asked about teachers' experiences in mathematics that related precisely to the first research question, which asked how 5th-grade teachers' experiences and perceptions of mathematics influence their mathematics instruction. To understand how experiences influence instruction, data needed to be collected describing the experiences that influenced teachers' perceptions about mathematics. The first interview question asked participants to recall their first informal memories of mathematics before entering formal schooling. This question also provided comparable data with the second interview question that asked participants to describe mathematics experiences from their school years. Six of the seven teachers reported fond memories from childhood. The memories included counting money, playing card games with siblings, counting real-life objects, and learning to count from 1 to 10. Samples from the six teachers with positive responses are below:

Teacher A: *I remember counting how many plates, forks, and knives we needed to set the table.*

Teacher B: *I guess I remember being little and my neighbor had a garden and we used to go over there and count strawberries. We counted just little things around the house too.*

Teacher C: *I mean I think coins and time. I just always like to play with coins and Daddy let me. Daddy was an engineer, so he always encouraged you to know that kind of stuff like asking me what time it was and playing with coins. Daddy had a collection of other kinds of coins.*

Teacher D: *Before school I learned my numbers 1-10.*

Teacher E: *Before school, hmm, I never thought about that. I guess playing card games with my sisters. Yeah, playing cards and other games.*

Teacher F: *My mom taught me colors and had me sort toys by color. She also had Montessori type toys that we used to count and sort.*

Teacher G: *My mom is also a Montessori educator so growing up even before I went into school, she told me stories of things that she would do with us at home that were very Montessori Centered, and I remember being at the grocery store with my I parents counting the number of items that we had in our cart and a lot of different practical real-life things with counting*

The second interview question asked participants to recall mathematics experiences as students. Out of the seven teachers, three had negative experiences in school. A sample is provided from each negative experience to highlight the patterns in responses. The responses included having difficulty memorizing facts, a hate for math, and a fear of math. Transcriptions provided the passages from teachers' interviews.

Teacher A: *I loved math until 4th grade. The teacher didn't explain why or how the math worked. I was confused from elementary to the present because I am afraid of math. I pray that I never have to take another math class.*

Teacher B: *I didn't like math or have strong fact fluency. I didn't know my math facts and I believe that's why I'm so hard on my kids about it now because after I've gotten in the teaching, I learned the skills. I just didn't ever really know my facts, so I didn't like math because I didn't really have a solid understanding of my number sense at the time.*

Teacher D: *I hated math in school until college where I had good teachers*

In the next section, excerpts from the responses described teachers' positive experiences. One participant enjoyed problem-solving in mathematics and the other attended Montessori school. The responses included strong teachers, self-motivation, and the curriculum. The responses highlight positive and negative experiences related to the first research question that asks how experiences and perceptions may impact mathematics instruction. The interview questions gathered data that excludes other reasons that may influence teachers' perceptions and strengthened the validity of the findings. Below are the positive experience responses from the second interview question:

Teacher C: *In 6th grade and I had a teacher, and she had a big old southern accent and she said she said, "How do you not know your Lawus?" and she kept saying that, so she ended up keeping me after school. My mother was just like "What!? You know she got A's at her old school" She was like "Well she needs to stay after school." Then it turned out she was talking about properties! - you know -the law-us was the properties. She spent time with me. I remember her talking about you know 5 + 4 is 4 + 5 and things like* *that. I knew that but I didn't know the terms. I had questions about math, and she didn't shut me down.*

Teacher E: *I think using manipulatives got my interest and then also trying to figure out the unknown. I like a lot of problem solving. It was really what interested me because I like the challenge. I like trying to figure out things.*

Teacher F: *I really started enjoying learning about math in third grade. My third-grade teacher was very hard, but she made math fun. Third grade is when I realized math doesn't have to be hard or boring all the time.*

Teacher G: I *was a Montessori student which for me I think gave me a real concrete understanding of math which I don't think you get if you are in a traditional school all the time. For me because I was able to really see how the different concepts were connected at an early age. I've always loved math and I really truly think it has a lot to do with Montessori because no concept was taught in isolation. It wasn't just a theory or an abstract concept. Being taught from an early age from elementary on I just really had a concrete understanding of math which allowed me to work towards abstract.*

The third interview question asked teachers what mathematics courses they took in high school and their teacher preparatory program. The third question aligned with the second research question, which asked how teachers' understanding of mathematics concepts influenced their instruction. The interview question revealed the level of mathematics teachers were exposed to in high school. It also provided information about mathematics training received during teacher preparatory training. Two teachers took higher-level mathematics courses, and five took the basic mathematics requirements. All seven teachers had at least one mathematics methods course during teacher preparation. However, only three teachers indicated that the course was at the elementary level. Six out of seven teachers had negative comments about the elementary mathematics course in the teacher preparation program. A sample from the positive response is below, followed by the negative responses:

> Teacher D: *I took Algebra 1 & 2. In college we took a math methods course where we used the lattice method to multiply. It was fun and I used it with my students.*
>
> Teacher A: *I took general math, business math, and algebra in high school. I didn't take geometry until college. I failed miserably at all but the general math. I had a tutor in high school and in college, I guess I was just lucky. My teacher prep only included one elementary math course, yet many reading courses. The math course was all about how to use children's literature to teach math. It didn't help at all. It was mostly about connecting a few stories to math.*
>
> *Teacher B: I took algebra and geometry. In college all I can remember as far as math goes is something entitled elementary math, but now it wasn't any elementary math in it. It was like algebra two or three.*
>
> Teacher C: *I didn't take calculus in high school, but I took the next highest algebra. In college I took calculus and math 101. In my teacher preparatory math course, the first day I walked in there the teacher said, "Don't worry people I hate math too."*
>
> Teacher E: *Calculus is all I can kind of remember from high school. In the teacher preparatory program, we had a methods course, but it was not in depth and not on an elementary level.*

Teacher F: *Algebra 1 and 2 and then throughout college we had the basic prerequisites, but we had to take the class after that which covered how to use manipulatives and I can't remember what we learned.*

Teacher G: *In high school I took a lot of math like probability and statistics. I took AP Calculus. I also took general courses like pre-algebra, algebra stuff like that. In my college coursework I did some more probability and statistics. I did take an education Math course, but it is way too hard to explain. We worked with different number systems, so we weren't working with a number system based on ten.*

The fourth interview question asked participants to share experiences that influenced their perceptions of math instruction. The question aligned with the first research question, which asked how teachers' experiences and perceptions of mathematics influence instruction because it divulges information about how past experiences shape teachers' current perceptions of mathematics. The question also relates to teachers' understanding of mathematics content and whether the experiences involved professional training. Six teachers related their perceptions of math instruction to the district or external professional learning sessions, student teaching experiences, and individual teachers that impacted them. One teacher felt that circumstances outside of education influenced her math instruction.

Samples from the responses are below:

Teacher A: *The most influential experiences that helped me develop understanding of elementary math instruction came from the state department and district professional training sessions.*

Teacher B: *Not knowing the math actually motivated me to do the work. I had a good relationship with my teacher in student teaching and that experience helped me with math instruction. I may not be the best at math and I might not be doing it right, but I am learning and that's the best part about it.*

Teacher C: *I think a lot of my experience is that I was good at math, and I was in banking before I was a teacher.*

Teacher D: *The most impact has been professional development sessions the district provided.*

Teacher E: *My Montessori training involved a lot of hands-on experience. A lot of concrete materials.*

Teacher F*: I really loved what we had yesterday, so it's on my mind. The external consultant came yesterday, and I think she's helped me with the way I teach math. She helps us with multiplying and dividing decimals. I also like talking to the other teachers on my team and learning about what they do and how I can try to make it my own by combining the different ways.*

Teacher G: *I feel like Montessori definitely has shaped a lot of my view on education as a whole, specifically mathematics. It's even more ingrained and I'm passionate about math. The Montessori curriculum influenced the way that I teach today because I think that's where my passion for education is.*

The fifth interview question asked what content areas the teachers' strengths were. The question aligned with the second research question, which asked how teachers' understanding of mathematics content influences their instruction. Teachers revealed which content areas were their strongest. Six teachers included mathematics, and three teachers included social studies. Only one teacher indicated a specific concept in mathematics. One teacher did not include mathematics and stated that math and science were not favorites.

Teacher A: *Social Studies and Reading. I don't care much for math and science.*

Teacher B: *Math and Reading*

Teacher C: *Math and Phonics are my two strongest areas.*

Teacher D: *Math and Science*

Teacher E: *Social Studies and Math*

Teacher F: *Math and Social Studies.*

Teacher G: *Fractions are my strong suit.*

The sixth interview question asked participants to describe their strengths and weaknesses in mathematics. The interview question aligned with the second research question that asked how teachers' understanding of mathematics concepts influenced instruction. All teachers indicated a strength that did not include a specific mathematical domain; however, specific domains were given as weak areas. Excerpts are shown from the responses to validate the connection between teachers' perceptions of math content and math instruction.

Teacher A: *My strength is that I use a lot of higher order questioning and real-life examples because I didn't have that at all when I was in elementary. My weakness is that I still don't feel totally comfortable with 5th grade math standards. Geometry and Algebra standards are difficult for me. Geometry should be easy because it's everywhere in nature, but to me it's very abstract.*

Teacher B: I *think I'm good at breaking down the steps. I think I can get them pretty good. Conversions in measurement are hard for me because I don't know them as well as I should probably be able to. Then I also struggle with fractions. I know the procedures, but I have trouble teaching the concept.*

Teacher C: *I have enthusiasm and I think outside the box. I think measurement is my weakness. I just don't like it.*

Teacher D: *My strength is being able to scaffold instruction, being able to understand students' struggles having struggled myself. Number lines are my weakness. Especially fractions and decimals. I struggle with teaching a number line. I do not like them.*

Teacher E: *I am able to translate the relationship between concrete and abstract. I make it realistic and applicable to their lives. I think maybe explaining abstract algebraic concepts is a weakness.*

Teacher F: *I think I am good at pacing. I think that one of my strong suits and I try to relate it somehow to their lives. I think knowing when to use certain manipulatives and which ones to use is my weak area.*

Teacher G: *I would say that I am really strong when it comes to math and being able to find gaps in understanding and since I am certified first through sixth grade, I'm able to revert back to lower grades and be able to help fill those holes for these children. I would say an area of weakness when it comes to math and teaching math would be geometry. That's just an area for me where I don't feel as strongly in so I guess it would just be a weak point.*

The final interview questions asked teachers how they felt about their mathematics instruction. The question also aligned with the second research question, which asked how teachers' understanding of mathematics concepts influenced instruction. It could also relate to the first research question, which focuses on perceptions and experiences. Four teachers related their current confidence in teaching math to the lack of understanding at varying levels in their educational careers. Three teachers felt optimistic about their instruction.

Teacher A: *I feel like I have a lot to learn about mathematics to teach it well. I do not have confidence and I am afraid to take a college course because I have failed so often, I just can't see myself being successful. I need to gain confidence so I can be a better teacher to my students.*

Teacher B: *I am a work in progress*.

Teacher C: *I feel that I am a work in progress. There is always more to learn about math.*

Teacher D: *I feel strongly about my mathematics instruction.*

Teacher E: *I feel confident about it and we follow the child so if there's ever a child that needs to go farther than another, then I know what steps to take, and it is something I feel pretty good about.*

Teacher F: I *feel pretty good about it but always open to learn more.*

Teacher G: *I do a pretty good job. There is always room for improvement.*

The interview questions delved into the participants' feelings about mathematics and their experiences with informal and formal mathematics. The intent was to reveal the teachers' perceived strengths and weaknesses in mathematics. The questions also examined the level of mathematics courses taken in high school and during college-level teacher preparatory programs.

The high school courses taken demonstrate the level of mathematics achievement before entering college. The teachers' preparatory information provided a glimpse into the elementary-level math courses provided at the college level.

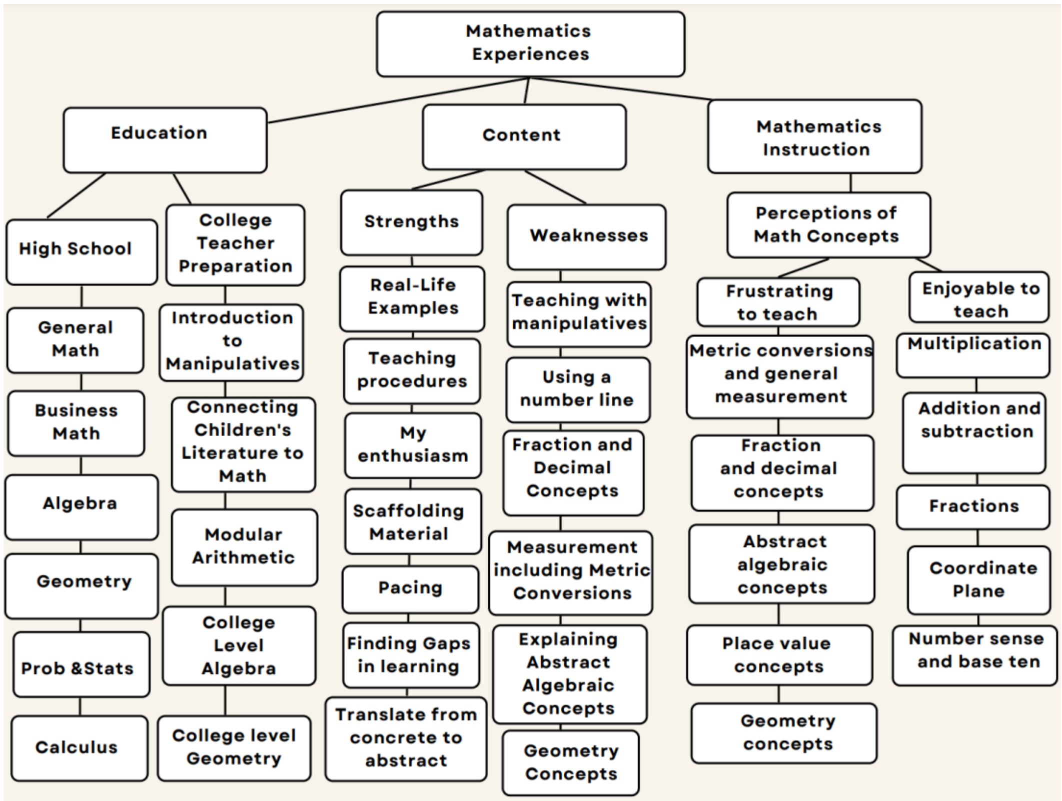
Most teachers related their weaknesses in mathematics to particular mathematics domains and their strengths to instructional practices or broader areas of mathematics. The interview questions provided data to determine if there was a connection between math experiences, perception, content knowledge, and instruction. In the next section, a discussion of survey data supplies the reader with a clearer perspective of the qualitative data and a source of comparison.

Questionnaire

The research team utilized inductive coding in the open-ended responses from the survey to discover repetitive patterns and themes (see Figure 1). Each team member read the open-ended responses several times. The team took notes and created memos. They developed codes from the themes, placed them into categories, and reached a consensus about unique patterns in the data. The open-ended questions provided information regarding mathematics instruction (See Figure 1). Figure 1 represents the data in a hierarchical chart that combines similar themes from the interview data and the questionnaire.

Figure 1

Mathematics Experiences



The first question asked for teachers' highest academic qualifications. Four teachers had bachelor's degrees, and three had master's degrees. The question related to the first and second research questions regarding content understanding and the variety of mathematics experiences. The second question asked teachers to provide the number of years each would attain by the end of the school year. Five teachers have between two and five years of experience. Two teachers will have ten and fourteen years of teaching experience by the end of the year. The question related to the first research question about mathematics experiences.

The third question asked teachers how prepared they felt to teach elementary mathematics during student teaching. This question aligned with the first and second research questions. The question could relate to experiences and confidence in content knowledge. Teachers used terms such as fairly, mostly, somewhat, very, or unprepared. Two teachers felt very prepared or mostly prepared. Four teachers felt somewhat or reasonably prepared, and one did not feel prepared. Excerpts, as seen below, show elaborative individual comments that bring deeper meaning to vague terms.

Teacher A: *During student teaching, I felt fairly prepared to teach elementary mathematics. I knew the content of what I was teaching, but there were some occasions that I was unsure of how to explain concepts.*

Teacher B: *I felt mostly prepared to teach mathematics during student teaching. I learned a lot about teaching math during my time as a student teacher*.

Teacher C: *Not very prepared by the program. I loved math already but most of the other interns did not and the Math Methods teacher started by saying "I hated math when I became a teacher."*

Teacher D: *Fairly confident. I have always been strong in Mathematics, so it is the subject I am naturally drawn to.*

Teacher E: *I felt somewhat prepared. I did well in math class growing up, so it came more naturally to me but my college class about teaching math was unhelpful because it focused on 6th grade.*

Teacher F: *During student teaching, I felt prepared to teach math. However, that was mainly because the students I was teaching were prepared to learn the content.*

Teacher G: *I felt very prepared. I took an extensive elementary math methods course in undergrad and I student taught with a teacher who only taught math.*

Question four asked teachers how long they had taught 5th-grade mathematics. Six teachers have been teaching 5th-grade math for less than three years. One teacher is in her eleventh year of teaching 5th-grade math. Question five asked teachers to list the math concepts they enjoy teaching. Two said they enjoyed teaching the coordinate plane, and three included teaching fractions, multiplication, addition, subtraction, number sense, and place value. Two teachers included geometry as enjoyable. Questions four and five are related to research question one about experiences. Question five could also relate to research question two about participants' confidence in teaching concepts.

Question six asked teachers to list the math concepts they found the most frustrating to teach. Two teachers found fractions frustrating, and one listed decimals and place value. Four teachers included measurement; one mentioned conversion as the most challenging measurement concept. One teacher expressed that geometry was the most difficult to teach. Passages from the questionnaire are below to add clarity to the responses. Question six aligns with both research questions in that participants' confidence in teaching math content and their experiences with teaching mathematics.

Teacher A: *I find teaching fractions most frustrating because it's a difficult concept for me and the students to grasp.*

Teacher B: *Fractions and conversions are two things that can be frustrating to teach.*

Teacher C: *Measurement*

Teacher D: *Decimals and place value*

Teacher E: *Measurement is frustrating because there isn't enough time to teach students and ensure they have mastery of the standards.*

Teacher F: *Measurement*

Teacher G: *At times, Geometry seems the most difficult to teach. It often feels as though I let it slip to the backburner.*

Question seven asked teachers what is needed to be successful in mathematics. Four teachers suggested that number sense builds a strong foundation. Three teachers included basic facts, and two included place value. One teacher indicated that finding patterns in mathematics was integral to success. Excerpts from responses show more detailed responses to illuminate meaning.

Teacher A: *That mathematics is made of patterns connecting all things in our world together.*

Teacher B: *They need knowledge of place value and number sense. They also need to be fluent in basic number operations.*

Teacher C: *They need to know that everything surrounds 10. You need 10 ones to make a ten, ten tens to make one hundred. Students need to know the addition and subtraction and multiplication.*

Teacher D: *Students need a strong, or at least f; oneal, number sense in order to be able to learn any math concepts.*

Teacher E: *Students need to know their basic math facts (adding, subtracting, multiplying, and dividing), as well as math terms. They should also know basic strategies that they can use to solve math problems.*

Teacher F: *Strong foundation of number sense*

Teacher G: *In Montessori, students must have a strong foundational understanding of number sense and place value. All Montessori mathematics builds on these foundational understandings.*

Question eight asked participants to describe their most recent memory of teaching mathematics. Each teacher described a different topic. The broad topics included place value, numbers and operations, fraction concepts, multiplication, and geometry. Four related the memory to the topics they taught, and three included students' reactions to the instruction. Examples of responses show more detail for clarity.

Teacher A: *A recent memory is teaching regrouping and borrowing using base 10 blocks. A student said, "this is finally making sense to me".*

Teacher B: *My most recent memory of math is the order of operations lesson I just completed.*

Teacher C: *The "aha" moment when a student learns that multiplication is groups of. Pure Joy.*

Teacher D: *Today, I taught students the skills needed to round numbers to the nearest tenth, hundredth, and thousandths.*

Teacher E: *One of my students that has been working with finding common denominators with fractional materials came to the realization that she was finding multiples.*

Teacher F: *My most recent memory about teaching mathematics was in my classroom yesterday. We are focusing on place value and powers of 10, so we are looking for decimals and the pattern that happens when we multiply.*

Teacher G: *My most recent memory is the geometry lesson I gave this afternoon introducing degrees, the Montessori protractor and how to use a protractor.*

Question nine asked teachers to name the instructional strategies they found most effective in teaching mathematics. Several different responses included games, real-world examples, problem-solving, fluency practice, and using manipulatives. Excerpts from responses are included below:

Teacher A: *I find using manipulatives and showing photo/real-world examples to be effective in my classroom. I also think using strategic questioning is effective. For example, asking "how did you solve that?"*

Teacher B: *Using manipulative and creating/ playing maybe games that get kids competitive and eager to win. It helps them stay engaged and want to actually learn the concepts.*

Teacher C: *Using manipulatives in my classroom. This is the best way for students to learn the conceptual understanding of mathematics.*

Teacher D: *The most effective strategy I have found is consistent number sense/fluency practice.*

Teacher E: *Presenting content at the child's level and allowing them to problem-solve on their own. Knowing when to interject and stand back is vital in a child's learning development.*

Teacher F: *No certain one. The cool thing about math is that there are many ways to answer and different strategies work more efficiently for different students.*

Teacher G: *The most effective strategy is to use the Montessori materials with fidelity and truly assess where a child is and what misconceptions he/she has.*

The final question asked teachers how they knew when a student had mastered a concept. Three teachers indicated that having a student teach the concept to them or another student demonstrated mastery. Two teachers related mastery to consistently completing work without assistance. One suggested that student discussion about the topic demonstrated mastery, and one defined mastery as students being able to transfer the knowledge to other mathematical concepts.

The open-ended questions in the survey complemented the interview feedback. The survey items involved experiences and perceptions of mathematics related to the first research question. The responses provided information regarding teachers' preferences and frustrations about mathematics and instruction. Also, teachers' self-efficacy about math content related to the second research question focusing on content and its influence on instruction.

Observations

Each participant was observed for one sixty-minute mathematics period of instruction. During the focused observations, the researcher ignored entities considered to be insignificant such as classroom cleanliness, temperature, and student behavior. The researcher used an iPhone to preserve an audio record of the observation for accurate transcription. Although the observation protocol (see Appendix D) contains specific "look fors," the researcher grasped all teachers' actions, commentary, and nuances. The researcher checked the notes and transcription for accuracy when the notes were compared with the audio recording.

The use of an online application was the only observable form of instruction in two classrooms and limited the gathering of information related to the protocol. No classrooms used mathematics exemplars during instruction, and one out of seven administered an assessment during the observation. All teachers provided feedback related to behavior or performance. One teacher addressed misconceptions. Three teachers completed a sequence of instruction. Two teachers used concrete objects or illustrations in the sequence of instruction. Two teachers were observed using precise mathematics vocabulary during instruction, and expectations were verbalized in six of the classrooms. Table 5 includes teachers' commentary and the researcher's observations as they aligned with the observation protocol.

Table 5

Observation Results

Observation Protocol

Evidence of Instructional Practices in a 5th grade Mathematics Classroom

Teacher demonstrated high-expectations for students' work	Use of precise mathematics vocabulary	Concrete objects, illustrations, or abstract sequence of instruction	Teacher provided actionable and specific feedback	Teacher assessed students' a variety of quick formative measures	Teacher provided exemplars during instruction	Teacher delivered mathematics instruction in a planned and logical sequence	Teacher identified and quickly addressed misconceptions
Not observed. Not observed. "If you get a 70 on the quiz that is acceptable for me." Let's count by 5's" Teacher counted for student. "My tens doesn't have to have ten in there it just has to look like it does." "Justify your solutions in your work folder." "Show (student) how to find equivalent fractions." "I expect you to use estimation to check your products."	Not observed. "9 x 6 is 54, drop a 4 and carry my 5." Hundredths (little cubes) Tenths (long skinny rods) Whole (waffle) "When we find least common denominators, we must first consider equivalent fractions." Not observed. "When we find the products of multi-digit factors, we can use our understanding of place value and the distributive property to solve them."	An online adaptive learning application was used. Online games were utilized for instruction. Concrete objects were used in the sequence of instruction. Drawings of base ten blocks on the board. Beads, fraction pieces, and other concrete objects to represent various concepts. An online adaptive learning application was used.	"Good job." "Great." "Stop talking". "Sit down." "Wake up." "You are so smart." "Good, keep it up." "Be quiet please."	Not observed. Online quiz game Not observed Not observed Not observed Not observed Not observed	Not observed Not observed Not observed Not observed Not observed Not observed Not observed	Not observed. Step-by-step procedures for multiplying a multi-digit factor times a single digit factor. Building a number three different ways using currency. Procedures to round decimals. Demonstrating the use of concrete materials used to multiply multi-digit factors.	Not observed. Student counted nickels as if they were pennies. Teacher explained the difference between coins. Not observed Not observed Not observed Not observed Not observed

Summary

The qualitative data provided connections and relevance to the research questions. The purposeful interview questions aligned with the study's intent and the research questions. The interview responses presented information about teachers' feelings toward mathematics and the experiences that accompanied their perceptions. The survey data provided comparable responses from the interviews and questionnaire that will be discussed further in Chapter five. The observation data enhanced and illuminated the information gathered from the interviews and questionnaire responses. The observation data also accommodated the second research question by adding coherence and more detail.

In Chapter Five, the researcher will expound upon the results and make inferences based on the findings. Additionally, in the next chapter, the researcher acknowledges the study's limitations in data collection, analysis, and sample size of participants. Further research is suggested, and what impact it may have on future studies. Finally, the researcher will address how the findings may benefit the participating school district and serve as a foundation for a deeper investigation of teachers' mathematical strengths and weaknesses.

Chapter 5: Discussion and Conclusions

Introduction

According to research, mathematics anxiety poses difficulty for many educators, particularly primary school teachers, who often have difficulty with mathematics content knowledge. Depending on their educational paths, elementary teachers may choose or shy away from higher-level mathematics courses before teaching math in the classroom. Since fearfulness of mathematics is associated with math eschewal (Jaggernauth & Jameson-Charles, 2015), educators not confident about math may avoid math specialization throughout their education (Porsch, 2017). Those who want to become elementary school teachers rarely do so because they want to teach mathematics (Porsch, 2017). Elementary school significantly influences a student's math skills and attitudes. Elementary school teachers are role models for their students during the learning process. Therefore, students may encounter primary school teachers with a negative attitude toward mathematics or suffer increased arithmetic anxiety. It is particularly challenging for teachers in elementary school systems where the expectation and certification include all content areas.

Through exploration, the author collected and examined the attitudes and experiences of mathematics teachers and how these intellections presented themselves in their mathematics instruction. Each participant was responsible for teaching the 5th-grade mathematics academic content in the participating school system. Collected data revealed teachers' self-perceptions about mathematics instruction and their understanding of content. The ultimate goals of this study were to explore teachers' self-perceptions and understanding of mathematics and mathematics instruction through the following research questions:

Question 1: How do 5th-grade teachers' experiences and self-perceptions of mathematics influence mathematics instruction?

Question 2: How do 5th-grade teachers' understanding of mathematics concepts influence instruction?

The first research question delved into teachers' lived mathematics memories from early childhood into their professional lives as mathematics teachers. The second research question considered how teachers' understanding of mathematics content influenced their mathematics instruction. The findings depict a montage of attitudes and personal accounts in connection with mathematics content and pedagogy.

Discussion and Interpretation

The participating fifth-grade teachers' diverse backgrounds shaped their experiences and other characteristics, such as professional training and years of experience. Gender, training, and experience allowed for various responses regarding content knowledge and attitudes about mathematics. The qualitative phenomenological research design included three types of data to be gathered. Interviews, questionnaires, and observations supported the research questions with expressive authenticity.

The results from the interviews showed that before attending school, participants were involved in counting activities initiated by family members or friends. Counting activities included currency, household objects, and food. Other math-like activities included learning colors, sorting objects by color, and playing card games. Participants' experiences after entering school included positive and negative accounts. Five participants recalled fond memories of mathematics in elementary school, while only two reported negative memories from their elementary years. The negative memories stemmed from a lack of automaticity with numeracy or a lack of clarity from teachers.

The survey revealed some parallel responses with the interviews. In the interviews, six of the seven participants said that math was their strongest subject. Three of the six also chose social studies as a strength. One teacher included science and math, and another indicated that phonics and math were strengths. One teacher chose social studies and reading. Their weak areas were geometry, abstract concepts in algebra, measurement, how to choose specific manipulatives for concepts with fractions,

algebra, and decimals, and teaching number lines with fractions and decimals. When the researcher asked teachers about their strengths as mathematics teachers, no one mentioned a particular "math topic."
All teachers spoke of instructional strategies such as moving students from the concrete to the abstract, finding the gaps in learning and addressing them, pacing of instruction, enthusiasm for the content, teaching procedures, and using higher-level questioning. However, during the survey, teachers were more specific about particular mathematics content when asked which concepts they enjoyed teaching. The content they enjoyed teaching included multiplication, addition, subtraction, fractions, and the coordinate plane. The math content they did not enjoy teaching paralleled most of the weak areas mentioned in the interview. Teachers found fractions, decimals, place value, general measurement, and specifically metric conversions frustrating to teach. These same areas were also identified as weak by the participants.

Other similarities between the interview responses and the questionnaire included the math courses completed before teaching and how prepared teachers felt when entering the field. Fifty-seven percent of the participants graduated with a bachelor's degree in elementary education. Two had master's degrees, and one participant completed thirty hours above a master's degree. Two participants took calculus in high school and college and felt prepared to teach when they entered the classroom. Both teachers received additional Montessori training and have master's degrees in education. However, they did not engage in an elementary standards-based math methods course during teacher preparation.

The other five participants took general math courses in high school, such as algebra and geometry. Teacher preparatory math courses were unique to each person. All participants reported taking one elementary math methods course during the teacher preparatory program. On the first day of class, one participant's teacher told the students not to worry and that she hated math too. The course focused on higher math, not elementary math. Another said that the only activity remembered from the course was lattice multiplication. Lattice multiplication is not part of a standard or mentioned in the South Carolina supporting documents as a viable strategy. An introduction to manipulatives was the focus of one course;

however, the participant could not recall details from the course. One participant commented that there was no elementary math involved in the methods course, only college algebra. According to one participant, the math methods instructor's new book contained literature used to teach mathematics and involved no elementary mathematics pedagogy of mathematics content instruction.

The findings demonstrate the range of mathematics requirements and expectations in the participants' teacher preparatory programs. A study by Scheiner et al. (2017) focused on determining recommendations for courses preparing elementary (K-8) teachers. It sought to clarify and explore what makes mathematics knowledge specialized compared to other content areas and what mathematics knowledge signifies in the context of teaching. Mathematics teachers need to understand content differently than mathematicians.

Within the mathematical knowledge domain, common content knowledge refers to the mathematical knowledge and skill possessed by any well-educated adult and by all mathematicians used in contexts other than instruction. *Specialized content knowledge* is mathematical knowledge adapted to the specialized applications unique to the teaching profession. It is described as used by teachers in their work but not held by well-educated adults and not typically utilized for other purposes (2017). Mathematics expertise is not an intuitive advantage to teaching mathematics. It requires a different type of knowledge than teachers of other content areas, such as English language arts or social studies. Mathematics teachers must also show proficiency in mathematics pedagogy and deftly organize and understand the progression of learning to sequence concepts and instruction logically. Content knowledge and attitudes towards mathematics noted during instruction attested to individual self-portrayals of pedagogy and command of the subject.

The observations indicated that approximately 30% of the participants used precise mathematics vocabulary, assessed students, or addressed misconceptions during the observation. Approximately 43% of the participants showed high expectations, were involved in direct instruction and completed a logical instructional sequence. In four out of seven observations, students used an online application to complete mathematics tasks, and one class used an online formative assessment. In two classes, precise mathematics vocabulary was used to describe the content during instruction. In two classes, the teachers explicitly conveyed high expectations regarding the criteria for success. The use of a Concrete-Representational-Abstract (C-R-A) teaching sequence, which included students manipulating objects to solve problems with fractions and multiplication, was observed in the two Montessori classes.

Additionally, findings from interviews revealed that most participants' math strengths were not specifically mathematics. One Montessori teacher felt confident about moving students from a concrete understanding to a more symbolic understanding of abstract concepts, uniquely mathematics instruction. However, the other six responses exhibited characteristics of practical teaching in any content area.

"I can see holes in understanding, scaffolding instruction, breaking down steps, my enthusiasm, pacing of instruction, and questioning."

Antonelli (2019) conducted a mixed-methods study involving kindergarten through fifth-grade teachers in an urban setting. She aimed to examine and explore primary school teachers' perceptions of their technical knowledge, content understanding, pedagogy, and readiness to adopt technology integration in mathematics education. The findings below reveal a similar disposition about content knowledge related to the current study.

> "Although quantitative data analysis revealed that participants rated Mathematics Content Knowledge as the second highest mean, the qualitative portion of the study revealed that participants were only referring to the basic skills of mathematics at the grade level they instructed The survey data from the quantitative phase showed that

teachers felt strongly about their mathematics content knowledge. However, this data was divergent from the qualitative findings where teachers expressed that they were only comfortable with basic rote mathematics skills with a single path of inquiry" (pp. 135, 138).

In the current study, interview responses suggested that teachers' dispositions about their instruction were primarily positive, with responses ranging from "pretty good" to "very strongly." However, when asked about strengths in mathematics, teachers responded with general pedagogical structures in any content area. The questionnaire asked teachers which math concepts they enjoyed teaching. The majority of responses included teaching coordinate planes and reviewing basic math facts. Two teachers included fractions. Except for fractions and the coordinate plane, the concepts teachers enjoyed teaching involved rote procedural skills. South Carolina 5th grade standards (2020) for whole number operations are procedural, and the coordinate plane involves only the first quadrant. The geometry standards covering the coordinate plane are listed below.

- **5.G.1** Define a coordinate system.

a. The x- and y- axes are perpendicular number lines that intersect at 0 (the origin);

b. Any point on the coordinate plane can be represented by its coordinates;

c. The first number in an ordered pair is the x-coordinate and represents the horizontal distance from the origin;

d. The second number in an ordered pair is the y-coordinate and represents the vertical distance from the origin.

- **5.G.2** Plot and interpret points in the first quadrant of the coordinate plane to represent real-world and mathematical situations.

Although the notion of a plane in geometry is quite abstract, the standards only ask students to follow steps to define, plot, and interpret points in the first quadrant. Similarly, the whole number multiplication and division standards are primarily procedural in 5th grade.

- **5. NSBT.5** Fluently multiply multi-digit whole numbers using strategies to include a standard algorithm.
- **5. NSBT.6** Divide up to a four-digit dividend by a two-digit divisor, using strategies based on place value, the properties of operations, and the relationship between multiplication and division.

Teaching these standards does not involve the level of conceptual knowledge needed to teach to the intent of the fraction or decimal standards. Donovan and Bransford (2004) indicated that frequent student misunderstandings with fractions illustrate the rational number challenges students face. The perpetrator appears to be the persistent taught application of whole-number thinking in contexts where it is inappropriate (2004). Although the research was conducted eighteen years ago, teachers still use whole numbers procedures to teach fraction computation. The weaknesses and frustrations teachers specifically named were mathematical topics such as fractions, decimals, teaching with number lines, metric conversions, general measurement, geometry, and using concrete models to demonstrate math concepts.

Research suggests similar findings in mathematics weaknesses. As stated in the literature review, the Survey of Adult Skills (PIAAC) was administered to 5,010 individuals in 15 countries worldwide (2019). Results suggest that over one-third of those tested in the United

States scored below level two in numeracy (2019). Calculations, including whole numbers, simple decimals, percentages, and fractions, are mastered at level two. Measurements, estimation, elementary data analysis, and probability are all included.

According to Copur-Gencturk (2021), many of the studies on teachers demonstrate that they need help comprehending fraction ideas, mainly conceptual understanding of fraction computation. The research aligns with the responses from the interviews and questionnaire questions asking teachers which math content they felt was a weakness and which math concepts they found frustrating to teach. An example of the fraction and decimal standards expectation necessitates a deep understanding of the concepts beyond procedures. The support document also includes a note in the fraction standard to emphasize that the focus is on using various models.

- **5. NSBT.7** Add, subtract, multiply, and divide decimal numbers to hundredths using concrete area models and drawings.
- **5. NSF.1** Add and subtract fractions with unlike denominators (including mixed numbers) using a variety of models, including an area model and a number line.
    - This standard should focus on using various models instead of "tricks," such as the "butterfly method," which does not contribute to students' fraction understanding.

These examples are directly related to the constructivist theories of Jean Piaget, Lev Vygotsky, and John Van de Walle. Constructivist mathematics teaching provides a solid foundation for conceptual learning while meeting standards-based criteria (Van de Walle, 2004). Piaget believed children use mathematical structures and patterns to reason mathematically (Wavering, 2011). Lev Vygotsky believed that students learn math by explaining and defending their thinking (Steele, 2001). This constructivist idea claims that connecting concepts to create new meaning helps students learn arithmetic language and understanding (2001). A confident math instructor who can organize the progression of learning to develop students' conceptual understanding must be able to explain how mathematical procedures work. Knowing the sequence of steps in calculations does not clarify mathematics for children.

Van de Walle (2004) indicated that following procedural directions without critical thought does not build arithmetic understanding. Thus, teachers must grasp the fundamentals of good mathematics instruction to help students become flexible with strategies and make connections between concepts. Teachers must also grasp mathematics, its use in daily life, and how to help students move from concrete to abstract comprehension.

Before studying abstract operations, students need experience with concrete materials to reason mathematically. Piaget (1964) suggested that conceptual mathematics comprehension comes from the child's encounters with tangible materials rather than the materials themselves. He stressed that mathematics is abstract; thus, students need tangible experiences to understand concepts. (Yıldırım & Yıkmış, 2022). Teachers must also know how to determine which manipulative objects are appropriate for each concept and how to use them. For children to succeed in mathematics beyond elementary school, teachers must be confident in teaching this instructional sequence.

The examples also demonstrate the need for teaching with the CRA sequence to allow children the opportunity to experience mathematics fully. The teacher's primary responsibility in a constructivist classroom is facilitating learning by providing various authentic experiences. Teachers encourage students to explore and experiment while providing opportunities for collaboration. Social interaction and language skills enable children to build on understanding as they develop and acquire knowledge.

The data suggested that most teachers recalled positive experiences and felt confident about math instruction. The weak areas of mathematics were similar to findings from research. Most teachers did not reveal anxious perceptions of mathematics through the interviews and questionnaires. The observation data left some areas open for further investigation. The small sample size and limited data collection time made it difficult to relate the influence of perceptions of mathematics to teachers' instruction.

Limitations and Assumptions

The limitations of this study involved the small sample size of participants and the large size of the participating district. This research design collected data from interviews, a questionnaire, and observations to gather evidence accurately answering the research questions. Further research was needed to fortify the validity and reliability of the findings. These limitations would have been avoidable if the author had researched school district policies and procedures for research earlier in the process. In future studies, the researcher will seek districts with fewer access restrictions and approval time limits.

Through the research approval process, limitations appeared and continued to create extraneous variables and other issues associated with policies and procedures that limited time and access to a more diverse grouping of schools and individual participants. The researcher considered the impact on the sample representation of the participating district's diverse population.The researcher supposed that permission to access school administrators and teachers would be granted soon after the research was approved. However, there was a six-month waiting period between submitting the research proposal and contacting schools. Approximately one-tenth of the total number of principals voluntarily agreed for teachers to participate in the study, which affected the sample's diversity and size. The researcher purported that participants would be candid with interview and questionnaire responses. The researcher acknowledged that bias may occur and collaborated with colleagues during the analysis and interpretation process to ensure the data's integrity.

Implications for Theory

The findings in this study have contributed a sampling of information to the phenomenon linked to math instruction, math content understanding, and how past experiences and current perceptions influence teachers' mathematics instruction. This study yielded findings that indicate teachers feel confident about general instructional strategies and mathematical procedures. The findings concur with constructivist exploration theories with concrete manipulation and inquiry. The weak areas revealed by participants demonstrate the need for teacher exploration with concrete materials, representation, and understanding of how it all relates to abstract notions and symbolic representation. Although interpretations of data collected from a small sample show that teachers were pretty confident and did not show signs of anxiety during instruction, refinements to the prevalence of procedural instruction could enhance and expedite student learning according to the theoretical framework followed in this study.

Implications for Practice and Implications for Future Research

The participating district could benefit from a future study that allows a larger pool of teachers to participate in a follow-up study to determine the course of action regarding professional learning opportunities in mathematics. Moreover, the research suggests immediate actions to ensure that teachers have opportunities to participate in standards-based courses and workshops focused on the primary topic areas of weakness in this study and similar research studies found in the literature review. The researcher should make revisions and additions to the interview and survey questions for future studies to gain more specific information in participant responses.

Future research recommendations include a deeper examination of teacher preparatory program requirements for elementary math pedagogical courses. Also, a larger sample size, more explicit questioning about instructional practices, and at least two observations per teacher may provide more compelling data. One observation did not demonstrate the totality of a teacher's command of content or pedagogy. Having Montessori teachers in the sample was not anticipated at the beginning of this study. However, the interviews, surveys, and observation responses provided insight into differences between the general education teachers' attitudes about mathematics and the Montessori philosophy of mathematics learning.

Recommendations for the field of elementary education include reflective conversations about the current teacher preparatory elementary mathematics curriculum and methods courses—considering teachers' lack of conceptual understanding of elementary curriculum design. The researcher also recommends forming a knowledgeable and committed group of stakeholders to create a plan for designing, implementing, and maintaining high-quality math curricula and instruction in school districts. The Montessori methods of CRA observed were unique, with special concrete materials. The interview and survey responses showed that the teaching philosophy is more closely related to the constructivist view of learning. The researcher suggests that representatives from the Montessori schools would bring expertise and ideas for training general education teachers to use the CRA approach to mathematics learning. The overarching focus for future research should address the question: What do elementary teachers need to know about mathematics to be exceptional teachers?

Summary

This research aimed to examine and analyze the relationships among 5th-grade teachers' attitudes about mathematics and their understanding of 5th-grade mathematics content to investigate the influence on instructional practices in mathematics. Overall, the data collected in this study indicate that teachers felt confident about teaching mathematics, and most teachers' past experiences were positive. The data revealed that the teachers' strengths generally were more related to strategies inclusive of all content areas, not exclusively mathematical.

Conflicting results were found when analyzing and comparing the observational data with the interviews and survey results. Most teachers reported enjoyment in teaching more procedural concepts than those requiring conceptual understanding and concrete application. This was also supported by some of the responses about strengths, i.e., teaching steps and procedures, multiplication, addition, and subtraction of whole numbers.

Teachers did not provide exemplars during instruction, and most did not utilize quick formative assessments of students' learning during the observation. Online activities also prevented the observer from seeing enough direct instruction in some cases. The direct instruction observed was short and primarily procedural. However, when Montessori teachers reported their mathematical experiences, training, and teaching strengths, they included mathematics instruction moving from concrete to abstract sequence. The observation of the CRA sequence of instruction was prevalent in the Montessori classes. More classroom observational visits would give the researcher a more in-depth view of teachers' understanding of content and instruction. A larger sample size of participants from various school districts may provide more compelling results for future studies. Deeper observations of teachers involved in direct instruction and some adjustments to interview and questionnaire items could further explain findings regarding the relationship between mathematics perceptions, content understanding, and mathematics instruction.

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Appendix A

Open-Ended Survey Questionnaire

Question 1: What is your highest academic qualification?

Question 2: By the end of this school year, how many years will you have been teaching altogether?

Question 3: How well prepared did you feel to teach elementary mathematics during student teaching?

Question 4: How long have you been teaching 5th-grade mathematics?

Question 5: What math concepts do you enjoy teaching?

Question 6: What math concepts do you find the most frustrating to teach?

Question 7: To succeed in mathematics, what do students need to know?

Question 8: What is your most recent memory about teaching mathematics?

Question 9: What instructional strategies do you find the most effective in teaching mathematics?

Question 10: How will you know when students have mastered a concept?

Appendix B

Interview Questions

Question 1: What were your first informal memories of mathematics before you entered school?

Question 2: What experiences from school (elementary, middle, high) most impacted your perceptions or attitudes about mathematics?

Question 3: What mathematics courses did you take in high school and your teacher preparatory program?

Question 4: What mathematics experiences have influenced how you currently teach mathematics?

Question 5: What content areas are your strengths as an elementary teacher?

Question 6: What are your strengths as a math teacher? Weaknesses?

Question 7: How do you feel about your mathematics instruction?

Appendix C

Initial Email to Prospective Participants

Date:

Dear ____________,

My name is Margaret Knight, and I am a candidate in the doctoral program at Southern Wesleyan University. Thank you for your interest in participating in a research study exploring the influence of 5th-grade teachers' perceptions of mathematics on instruction. The purpose of this study is to examine how 5th-grade teachers' experiences, perceptions, and mathematics confidence levels influence mathematics instruction. The study utilizes a qualitative approach to probe into the earliest memories of mathematics before entering school and mathematics experiences during formal education. The study also considers factors directly related to teachers' current perceptions of math content and instruction. Exploration of teachers' past and present perceptions of mathematics will elucidate the influences of math perception on instruction. If you agree to participate in this study, please respond to this email by simply stating "yes." I will contact you to schedule an interview face-to-face or through Microsoft Teams. Thank you for taking the time to consider participating in this study.

Sincerely,

Margaret W. Knight

Appendix D

Observation Protocol

"Look fors" of Instructional Practices in a 5th-grade mathematics classroom

The Massachusetts Department of Elementary and Secondary Education (2012) suggests that effective mathematics teachers:

- use instructional practices that convey **high expectations** for content, effort, and work quality.
- use precise mathematics vocabulary during instruction.
- use concrete objects, illustrations, and abstract expressions to teach mathematical concepts and relationships.
- provide pupils with actionable and specific feedback on their mathematics work.
- assess students' mathematical understanding using a variety of formative measures during the observation.
- provide accurate examples during instruction that demonstrate mathematical reasoning and understanding.
- plan and deliver mathematics instruction in a logical sequence.
- Identify and quickly address students' mathematics misunderstandings.

Appendix E

Consent Form

An Attitudinal Study of 5th-grade Teachers' Perceptions about Mathematics and the Influence on Instruction

Consent to take part in research

I ______________________________voluntarily agree to participate in this research study. I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind. I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted. I have had the purpose and nature of the study explained to me in writing, and I have had the opportunity to ask questions about the study. I understand that participation involves participation in an interview, completion of a survey, and one observation of instruction. I understand that I will not benefit directly from participating in this research.

☐ I agree to my interview being audio-recorded.

☐ I disagree with my interview being audio-recorded.

I understand that all information I provide for this study will be treated confidentially. I understand that in any report on the results of this research, my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about. I understand that disguised extracts from my interview may be quoted in the dissertation, final defense presentation, and published papers. I understand that if I inform the researcher that I or someone else is at risk of harm, they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission. I understand that signed consent forms and original audio recordings will be retained in an encrypted external hard drive that only the researcher has access to data until the final dissertation defense committee confirms the results of their dissertation. I understand that a transcript of my interview in which all identifying information has been removed will be retained two years from the date of the final defense. I understand that under freedom of information legalization, I am entitled to access the information I have provided at any time while it is in storage as specified above. I understand that I am free to contact any of the people involved in the research to seek further clarification and information, including names, degrees, affiliations, and contact details of researchers (and academic supervisors when relevant).

Signature of research participant Date________

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Signature of researcher Date _________

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