EFFECTIVE ELEMENTARY MATHEMATICS INSTRUCTION: A QUALITATIVE STUDY OF FACTORS INFLUENCING TEACHER IMPLEMENTATION

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EFFECTIVE ELEMENTARY MATHEMATICS INSTRUCTION: A QUALITATIVE STUDY OF FACTORS INFLUENCING TEACHER IMPLEMENTATION

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Abstract

A goal of recent educational reform efforts to increase the achievement in mathematics of students in the United States has led to increased attention to the effectiveness of elementary-level teachers. Understanding elementary teachers’ perceptions about teaching mathematics, their beliefs about how mathematics is learned, their preparedness, practices implemented, and external factors can help improve the mathematical success of students. This qualitative research study sought to expand the current research concerning effective mathematical instruction. The purpose of this study was to examine the factors that influence teachers’ mathematical instruction in the elementary classroom.

Twenty-one kindergarten through fifth-grade public school teachers from two suburban school districts in Central and South-Central Pennsylvania participated in this study. The participants completed an online questionnaire and open-ended questions using Google Forms. Two participants volunteered to take part in individual interviews.

An analysis of the data revealed a discrepancy between what instructional practices teachers know to be effective and how they believe the practice should be implemented in an elementary classroom. The results of this study indicated to the researcher that teachers need support to bridge their knowledge of effective mathematics instruction and productive beliefs about mathematics learning to the practices they implement in the classroom. District-provided professional development in mathematics can support teachers’ understanding of productive beliefs about teaching and learning mathematics.
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Chapter One- Introduction

Overview

The educational system in the United States has transformed over the years. From the early days of the one-room schoolhouse, educational innovation has helped the system adapt and respond to the needs of its community. In a discussion of how society influences mathematical instruction, Permuth and Dalzell (2013) noted that the methodology for teaching mathematics is “largely driven within the construct of historical change” (p. 236) instead of the opinions of mathematicians or local school systems. Graumann (2019) examined the historical contexts that drive educational innovations starting in the 1960s and the launch of the Soviet Union satellite Sputnik when schools across the United States implemented the “new math” as an innovative way to help create stronger mathematics and science students. Graumann referred to other historical episodes leading to transformation in educational practices, including the response to the release of the 1997 Trends in International Mathematics and Science Study (TIMMS) and the Programme for International Student Assessment (PISA). This examination presented data that appeared to show the United States student lagging behind global peers in the area of mathematics and science.

Permuth and Dalzell (2013) suggested that federal policy initiatives, such as No Child Left Behind (No Child Left Behind [NCLB], 2002) and Race to the Top (American Recovery and Reinvestment Act, 2009), have put national pressure on schools to improve students’ academic performance. This discussion provided an example of the influence of social drivers by referencing the decentralization of state standards in 2010 with the implementation of the Common Core State Standards for Mathematics (CCSSM); later
standards revisions led to the development of the college and career-ready standards. Instead of experts within the educational system, it was proposed that external influencers continue to drive and impact the progress of mathematical instruction in the United States. A similar conclusion provided by Schmidt and Burroughs (2016) examined how international studies have transformed mathematical instruction through enacted federal policies and mandated practices such as the implementation of large-scale assessments (LSA). Referencing the LSAs used in the United States, the researchers asserted that policymakers focused on test results to measure adequate yearly progress of learning and, as an indicator of teacher quality, overlooked the impact of teachers’ experience, credentials, and perceptions on student learning.

**Need for the Study**

Comparisons of the United States’ educational system to global peers have caused increased attention on raising LSA scores and intensified efforts to implement mathematical teaching practices that support mathematics learning for all students (Valoyes-Chávez, 2019). This study needs to be conducted due to a lack of consensus regarding the most effective practices to use with elementary students in mathematics instruction (Lee and Reeves, 2012).

Accountability-based policies set an increased emphasis on improving both reading and mathematics instruction (Schmidt et al., 2017). Examining the effect of high-stakes testing, Lee and Reeves (2012) discovered that schools have responded to the increased accountability of high-stakes testing by placing more emphasis and greater effort toward improving the instructional conditions for reading than mathematics. These researchers also discovered that despite increased national attention on mathematics
achievement, mathematics instruction is given less priority than reading instruction in the areas of professional development, class time, and resources. Additionally, Clarke et al. (2014) concluded that, based on data from the National Center for Education Statistics (NCES), the amount of research concerning mathematics instruction currently lags reading research.

An investigation is needed to understand teachers’ perceptions of changes in instructional practices. Cochran-Smith et al. (2013) reported that ongoing changes to the practices endorsed for mathematical instruction are responses to external influencers. One of these influencers, federal accountability policy, made improved reading and mathematics achievement a priority for schools. This policy and others developed over the past few decades have been responses to results like those provided by TIMSS and PISA. Data from these studies give the perception of weak mathematics performance for students in the United States, spurring a new age of reform in mathematics instruction (Schmidt & Burroughs, 2016).

Ottmar et al. (2014) used a mathematics teacher questionnaire to identify latent factors influencing mathematics instruction in the lower grades. These researchers stated a need to “understand the nature and content of concepts that are not taught to students, and why teachers make certain choices with respect to individual practices” (p. 137). Examining teachers’ perceptions of the most effective elementary-level mathematical instructional practices contributes to the body of research.

**Statement of the Problem**

Researchers have suggested that data from the National Assessment of Educational Progress (NAEP) show slow improvement for elementary students in the
area of mathematics over the past four decades (Schmidt & Burroughs, 2016). These researchers proposed that policymakers use NAEP data to diagnose problems and institute educational reforms without providing evidence of the best strategies to bring about positive growth.

Following an investigation of why teachers resist adopting reformed practices, Valoyes-Chávez (2019) proposed that teachers receive professional development that does not make assumptions about teachers’ foundational mathematics knowledge of reform-based strategies and tools when implementing instruction. The pre-service requirements for primary level teachers in the area of mathematics, narrow and limited compared to secondary level teachers, raise the question whether the preparation of future teachers of elementary mathematics is adequate (Schmidt et al., 2017). Referring to the Teacher Education and Development Study-Mathematics (TEDS-M), Schmidt et al. (2017) found evidence that primary teachers’ “limited” (p.123) experiences in pre-service mathematics content prevented those teachers’ acquisition of solid foundational knowledge of basic mathematics, a knowledge essential for future student success in mathematics. The foundational mathematics skills and knowledge introduced at the primary school level contribute to and are essential for success in upper-grade mathematics instruction. This research stated that in the United States, at the lower elementary grade levels, more than half of pre-service teachers of mathematics graduate in the bottom fourth of teacher training programs. To improve student learning, these researchers proposed that policymakers need to increase the opportunities for future primary teachers to learn school-level mathematics.
Over the past half-century, there have been ongoing changes in what mathematical practices are endorsed, and with these transitions, teachers are expected to adopt new strategies or transform familiar methods. Many elementary teachers lack pre-service training and ongoing professional development in order to implement reformed instructional practices. Evidence from research suggests that high levels of academic and practical preparation are needed to ensure teacher quality (Tatto, 2015). Discussing teacher accountability policies attempting to determine quality teachers, Tatto et al. (2016) opined that these policies do not help pinpoint the most effective instructional practices for mathematics instruction. These researchers recommended that uncovering data about teachers’ perceptions of navigating and implementing transformational changes in instructional practice would be more helpful than high-stakes accountability measures to determine teacher effectiveness and quality instruction.

**Definition of Terms**

For the study, the following terms are defined:

*Barriers*- Factors that create challenges for teachers to implement instructional practices (Corkin et al., 2019).

*Conceptual factors*- matters that impact a teacher’s ability to understand and apply theories of mathematical learning (Corkin et al., 2019).

*Cultural code*- the ideas and values of a dominant culture that define society's norms and education systems (policies, curriculum, and practices) (Louie, 2017).

*Cultural factors*- matters from outside the classroom setting that impact instruction success (Corkin et al., 2019).
Culture of exclusion- the dominance of a select culture over the system of mathematical instruction (Louie, 2017).

Economically disadvantaged student- Student from a family who qualifies for free or reduced lunches due to low income (Max & Glazerman, 2014).

Effective instruction- Understandings and skills that result in successful student learning (Jackson et al., 2020).

Facilitators- Factors that help teachers implement instructional practices (Corkin et al., 2019).

Growth mindset- the belief that individuals can develop new skills and accomplish challenging tasks through effort and persistence (Bobis et al., 2021).

Large-scale assessment- State, national and international testing that is used to collect data for comparison and accountability (Schmidt & Burroughs, 2016).

Mathematical content knowledge- A teacher’s understanding of facts and procedures of mathematical learning, teaching resources, and practices (Delgado-Rebolledo & Zakadryan, 2020; Jackson et al., 2020).

Mathematical mindset- The development of “different representations in mathematics, with students creating ideas in visual, numerical, verbal, and other forms, encouraging connections between pathways in the brain” (Anderson et al., 2018).

Novice teacher- A teacher with little teaching experience, a limited understanding of the school’s culture, and who has not established common beliefs and rituals for learning with colleagues (Amador & Lamberg, 2013).
Pedagogical content knowledge- A teacher’s combined understanding of students’ mathematical thinking and the knowledge of the most effective practices to teach mathematical concepts (Copur-Gencturk, et al., 2019).

Pedagogical factors- Matters that impact a teacher’s ability to align student-centered instructional practices with curriculum materials and programs (Corkin et al., 2019).

Political factors- Matters produced by community stakeholders, district politics, or government policy that impact the availability of instructional resources to deliver effective instructional practices (Corkin et al., 2019).

Professional development- Programs used to instruct educators on endorsed instructional strategies (Valoyes-Chávez, 2019).

Pre-service teacher- Student in a teacher education program (Savard et al., 2017).

Resistor Teacher- A teacher unwilling to adopt new instructional strategies (Valoyes-Chávez, 2019).

Resistance to change- A term used to explain barriers that obstruct reform; during an implementation change, the clash of different opinions and lack of persuasion (Valoyes-Chávez, 2019).

Science of learning and development- A study of the function of experiences, the brain, and human capacities that interact in physical cognitive, and affective domains along a developmental continuum to support a whole child’s welfare (Darling-Hammond et al., 2020).

Student-centered- Instructional strategies that have a constructivist foundation that utilizes active learning practices, student agency, and collaboration (Corkin et al., 2019).
Teacher-centered- Instructional strategies in which the student experiences learning through lectures and repeated drills and practice (Corkin et al., 2019).

Zone of proximal development- the potential that exists between what a child can do independently and what he or she is capable of doing to grow a skill with assistance from others (Darling-Hammond et al., 2020).

Limitations of Study

When studying effective elementary mathematics instruction through an examination of teachers’ beliefs, preparedness, and practices, as well as the factors that influence implementation, there are several limitations. Teachers must understand how to determine what makes an instructional practice effective. A limitation would be that teachers lack an understanding of how to evaluate an instructional practice’s effectiveness (Tatto et al., 2016). Second, teacher interpretation of the terms and vocabulary used in the instruments could result in incorrect responses. Another limitation is the number of elementary teachers participating in the study. There may be difficulty getting a large enough sample of teachers who are willing to openly share the depth of their knowledge of different practices for mathematics instruction. The data collected are based on teacher-reported information about effective mathematics instructional practices and not a direct observation. Other limitations to consider would be external barriers that may contribute to the effectiveness of instructional practice. These factors such as class size, COVID, student absences, teacher years of experience, and teacher professional development in mathematics could influence the ability to judge the effectiveness of instructional practice.
Research Questions

The following research questions guide this study:

1. What are teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom?

2. What are teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom?

3. What are teacher perceptions regarding the factors that influence the practices selected for mathematics instruction in the elementary classroom?

Summary

The purpose of this study was to examine how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematical instruction in the elementary classroom. According to Permuth and Dalzell (2013), from the National Defense in Education Act to the Common Core State Standards, historical contexts drive changes in teaching and influence new episodes of reformed practices in mathematics instruction. Aligned with this conclusion, Myers et al. (2015) noted that during each new decade over the last half-century, guided by external influences, the educational system in the United States has experienced ongoing episodes of reform regarding the best way to instruct mathematics with no significant gains in success for mathematics students. Valoyes-Chávez (2019) found that often overlooked during reform episodes is the subject of mathematics teachers. This researcher stated that a detriment to efforts to transform practices in mathematics instruction has been that these efforts “disregard teachers’ social and cultural experiences” (p.189). Further, this study proposed that change initiatives acknowledge teachers’ “struggle over the articulation of meanings”
(p.189). The literature review used for this study examined the research regarding teacher perceptions of the most effective practices and productive beliefs to teach mathematics, preparedness to teach mathematics, and factors that impact teaching and learning in the elementary mathematics classroom.
Chapter Two- Literature Review

Thompson and Davis (2014) asserted that the most recent tide of reform for mathematics instruction in the elementary classroom is a residual product and influence of TIMSS and PISA data that suggest the poor performance of students in mathematics. Bolden and Tymms (2020), referring to National Assessment of Education Performance (NAEP) data, noted that after four decades of reforms and efforts to increase accountability with policies such as the No Child Left Behind Act of 2001, data trends show "remarkably stable" (p. 721) growth in mathematical performance results for children in the United States. NAEP’s National Center for Education Statistics (NCES) (2019) mathematics assessment report disclosed that 59% of fourth-graders scored below the proficient achievement level. This statistic showed no “significantly different” change from 2017 results (National Center for Education Statistics, 2019, “NAEP achievement levels by student group” section). Nine percent of fourth-graders scored at the NAEP advanced level, and the report described that students performing at this level could solve sophisticated real-world problems in all content areas. These fourth-graders correctly interpreted data and justified their answers, clearly and succinctly communicating how and why they reached solutions. The low number of students achieving this advanced level and the overall lack of achievement growth for fourth-graders reinforce a need for increased opportunities for students to experience instructional practices that promote more complex reasoning and problem-solving (Bolden & Tymms, 2020).

Bolden and Tymms (2020) opined that the lack of achievement in mathematics growth for elementary students in the United States suggests that large-scale change has been ineffective. Further, the researchers proposed that the product of reform is evasive
due to the transitional structure of government leadership driving policy, the rate at which new initiatives occur due to policy changes, and the lack of research regarding a thorough comprehension of educational systems. Additionally, it was proposed that lasting transformation would occur for educational systems with small steps that produce results over time. In a discussion of the slow process of meaningful and lasting transformations in the system of education, Harris and Jones (2017) opined that the global comparisons, such as those of PISA, have created “a cult of finding solutions and borrowing policies from other cultures and contexts” (p. 639) instead of looking within existing structures for ways to move forward with educational change.

Hiebert and Morris (2012) noted that efforts to improve the quality of instruction by focusing on improving the quality of teachers had produced "little effect" (p. 96) on transforming what happens in the classroom. These researchers found that the United States’ attention to accountability stressed teacher effectiveness, focusing on teachers' characteristics rather than quality instruction. Furthermore, this study emphasized teachers' and researchers' collaboration to develop the best methods and resources for mathematical instruction. In comparing several studies that examined the implementation of short-term, phased, classroom-based methods to reform instructional practices, Star et al. (2016) found that meaningful transformation occurs when methods are already familiar to and supported by teachers. This study noted that impactful education reform will be a change that recognizes the factors that impact classroom instruction, is realistic about the time transformations take, and does not underestimate the importance of teachers’ perceptions.
This chapter presents a review of literature that identifies learning theories implemented in elementary mathematics instruction and what research indicates about how children learn mathematics. The research focused on what the current literature suggests are the most effective instructional practices to use in the elementary mathematics classroom. The chapter examined teacher beliefs related to instructional techniques for leveraging effective change in mathematics education. Another focus of the literature highlighted in this chapter was to gain insight into the elementary teachers' preparedness to teach mathematics, their ability to adapt to a cycle of reform initiatives, and their willingness to concur with new techniques that require a change in established systems. The literature examined the factors that influence the mathematical instruction delivered in the elementary mathematics classroom. These topics were relevant to understanding what teachers perceive as the most successful instructional practices in the elementary mathematics classroom.

Theories about Learning

Behaviorism and the constructivist theory of cognitive development are learning theories influencing current mathematical instructional practices. When discussing teacher perceptions of effective practices in the elementary classroom, it is important to examine how these methods stem from theories about how children learn.

Behaviorism

Stoiles (2016) presented an overview of the debates and shift of applications of learning theories during the past few decades in the United States and stated that repetition and reinforcement are the two critical ingredients for learning according to behaviorism. Behaviorists also assert that learning is measurable. Stoiles found that
behaviorists such as Skinner, Bloom, and Gagne theorized that teachers need to employ strategies and rules to teach learners mathematical content; however, this learning theory is often challenged. Further, Stoilescu shared that the research community's criticism of behaviorism is that it does not consider the influences of learner attitudes, metacognition, or independent thinking. This work suggested that another disadvantage of behaviorism is the teacher-centered instructional approach and focus on repetition and reinforcement. Stoilescu (2016) stated that an emphasis on large scale assessments consists of closed questions, the narrowing of teaching objectives with a focus on skills in isolation and an outcomes-based focus for instruction, mastery-orientated learning, along with scripted programs were aspects of behaviorism that opposed teaching for understanding and the application of knowledge. According to the researcher, “despite its shortcomings and critics” (p. 142), the behaviorism theory is a component “heavily influencing” (p. 142) recent educational initiatives such as No Child Left Behind (NCLB) and the Common Core State Standards for Mathematics (CCSSM).

**Constructivism**

Emphasizing the stages of transformation for children in which experiences can influence content mastery, Stoilescu (2016) asserted that Piaget's constructivist theory of cognitive development contrasts with behaviorism. Darling-Hammond et al. (2020) noted that teachers’ knowledge of cognitive development supports student learning. Darling-Hammond et al. examined the science of learning and development (SoLD) and provided supportive constructivist instructional strategies for kindergarten through twelfth grade, emphasizing the importance of teachers implementing Vygotsky’s zone of proximal development (ZPD), embedding students' prior experience, providing collaborative
opportunities, and cognitive supports to create a classroom environment that supports learning. Stoilesescu opined that learning results from a person's life experiences, state of mind, and actions. Constructivists' beliefs about how children learn best are currently widely implemented in elementary mathematics programs, and these ideas include: metacognition, prior knowledge, cooperative learning, interactive problem solving, real-world mathematics situations, feedback, and student-centered learning (Darling-Hammond et al., 2020; Stoilesescu, 2016).

Applying learning theories to mathematics instruction enables understanding how teaching can help facilitate learning. In a comparison of learning theories used in mathematics teaching methods, Lessani et al. (2016) concluded that the constructivist theory, more student-centered and discovery-learning based, encourages students to develop problem-solving skills, ideas, and solutions that could be used in their daily lives; these were more effective than methods that were teacher-centered and lecture focused.

**Social-Emotional Learning.** Darling-Hammond et al. (2020) reported that “as teachers infuse skills such as self-management, empathy, collaboration, and responsible decision making into instruction, and explicitly cultivate executive functions that support SEL through classroom routine and habits, they strengthen students’ abilities to focus and persevere in their learning” (p. 129). Using the emotions and affect work of Vygotsky, Roth and Walshaw (2019) discussed the affective domain of mathematical learning through a case study of one mathematical lesson involving three fourth-grade students. The setting for this case study was an algebra task in a French immersion classroom. Roth and Walshaw proposed that affect and emotion change throughout instructional
activities, sharing that student participation in the mathematical instruction led to a change in affect and to “more positive values when students, despite frustrations, engage in the task” (p. 121). There is an inner relationship between a student’s thinking process, background knowledge, predisposition for mathematical skills, and putting conceptual ideas into concrete practice (Roth & Walshaw, 2019). More research is needed to examine experiences, like the mathematics classroom, where “we are not only the active agents but also are undergoing events over which we never have absolute control” (p.122, Roth & Walshaw, 2019).

To understand how students adapt emotionally during the process of learning, McCaslin et al. (2016) conducted a study of approximately 400 students in fourth through sixth-grade. These students attended one of five schools, ranging from 63% to 97% of students receiving free or reduced lunch support, within a single district in the Southwestern United States. During two data collections, teachers gave a grade-level specific mathematical test. Following the test, students completed a School Situation survey to examine student-reported emotion and coping strategies for mistakes. McCaslin et al.’s (2016) research suggested the importance of cultural context, classroom instruction that incorporates social structures, and an individual student’s readiness for learning mathematics as assets to students’ emotional well-being and ability to respond to mathematical mistakes. The study reported that it “is difficult for students with fewer resources (due to school poverty density or readiness to learn) to cope with negative emotions when making mistakes and to realize pride upon success” (p. 1, McCaslin et al., 2016). McCaslin et al. stated that interventions that address students’ emotions related to achievements, such as self-awareness and reflection, can help develop emotional adaption
and support students, including those who live in poverty-dense conditions. These researchers opined that these interventions provide opportunities for all students to access and benefit from the social structures of school and realize their potential as learners.

**Effective Mathematical Instructional Practices**

In a study of the transformation in mathematical education throughout the 20th and 21st centuries, Steffe (2017) discussed the failings of each theory period and proposed that the continued examination of children’s learning and development will lead to the discovery and implementation of instructional practices that benefit children’s achievement in mathematics:

By building an understanding of children’s mathematical concepts and operations and how a teacher/researcher can engage children to bring forth changes in those concepts and operations, a vision of children’s mathematics education can emerge in which children engage in productive mathematical learning and development and teachers/researchers engage in productive mathematical teaching. (p. 39)

**Learning Theory-based Practices**

Steffe (2017) traced the changes in educational learning theory in the United States, marking ongoing episodes of transformations in the methods of the mathematics instruction endorsed as reactions to perceptions of crises. The researcher opined that during the 1960s, during the first transformational period in the modern mathematics movement, teachers continued to teach mathematics using traditional, behaviorism-based practices instead of the “new mathematics” focus on problem-solving and learning by discovery. Steffe presented three reasons why teachers held onto these practices. First, teachers lacked background information regarding why these changes were beneficial.
Next, textbooks of the era, a tool for instructional guidance, did not present material aligned with new theories. Lastly, Steffe (2017) asserted it was easier to teach the way teachers felt most comfortable and concluded that teachers did not change their traditional, behaviorism ways of teaching mathematics. As a result, mathematics instruction during the 1970s became a “conceptual wasteland” (p. 34). New periods of transformation in mathematics instruction followed with the publications of *A Nation at Risk* in 1983, ushering in an emphasis on problem-solving; the *Curriculum and Evaluation Standards for School Mathematics* in 1989 along with NCLB in 2001 prioritized standards-based instruction (Steffe, 2017). Steffe noted that the recent outcome-based education movement aligned with the 2010 release of the CCSSM. This researcher recommended that for lasting transformation to take root, a field devoted to mathematics for children be created “rather than continue with the historical practice of basing mathematics curricula for children on the first-order mathematical knowledge of adults” (p. 37).

**NCTM Mathematical Teaching Practices**

In examining the influence of the methods of professional mathematicians on the teaching of mathematics, Schoenfield (2020) explored effective mathematical classroom practices and the development of students as mathematical thinkers. This researcher suggested that policies and researchers influencing the United States educational system have focused on content over practice. This exploration, advocating for inquiry-based methods, found that effective mathematics instruction “made use of problems as opportunities for developing mathematical practices and habits of mind” (p. 1171). According to the researcher, engaging all students regardless of ability in productive
mathematics learning does not mean thinning the content; instead, it requires teachers to start where a child is in their content understanding and make connections to prior learning as the foundation for moving learning forward.

The National Council of Teachers of Mathematics (NCTM) (2014) attempted to change the direction of recent reform in mathematics education by recommending a research-based framework that includes effective instructional practices and skills. The Eight Mathematical Teaching Practices teachers should implement as prescribed by NCTM are: (a) establish mathematics goals to focus learning, (b) implement tasks that promote reasoning and problem solving, (c) use and connect mathematical representations, (d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking (p. 8). In an overview of these practices, Smith et al. (2018) explained that NCTM promotes essential instructional methods that teachers must implement for productive student learning in the mathematics classroom. Using a case involving a middle school mathematics teacher’s lesson on dividing fractions, the researchers modeled the authentic implementation of these practices. To overcome the challenge of learning to incorporate the eight practices into daily instruction, Smith et al. suggested that teachers co-plan and reflect on lesson outcomes with colleagues.

According to an analysis of a study conducted by the National Center for Education Evaluation (NCEE), Clements et al. (2013) found that mathematical instructional practices can be connected to student achievement. The study used an instructional practices observation protocol to examine first and second-grade
classrooms. Student achievement in mathematics was measured using the Early Childhood Longitudinal Study-Kindergarten. NCEE examined how each instructional practice aligned to student achievement. The study suggested instruction balance student-centered and teacher-centered techniques, an increase in instructional time, meaningful representations of ideas, the interaction of students around mathematical tasks, and differentiation of tasks. According to Schoenfield (2020), mathematical practices should accomplish this balance by establishing a climate of inquiry, focus on big ideas, student discourse about mathematics, and a respectful, collaborative classroom environment. In further support of this recommendation, Ottmar et al.’s (2014) data analysis of a survey of 1,583 fifth-grade mathematics teachers suggested effective instructional techniques encourage students to think critically, communicate thinking through writing, encourage collaborative problem solving, visual representations, and connect to other content or real-world experiences. The data used were collected during the sixth wave (fifth grade) of the United States Department of Education’s and NCES’ Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K). The ECLS-K study started in 1998 and followed a data sample of 22,782 students from kindergarten to eighth grade.

**Teachers' Reported Perceptions About Teaching Mathematics**

NCTM (2014) asserted that “teachers’ beliefs influence the decisions that they make about the manner in which they teach mathematics” (p. 10). According to NCTM, the outcome of these beliefs can be categorized as unproductive or productive. Unproductive does not equate with bad, but as a limitation to both the effectiveness of instruction or student exposure to mathematical content (NCTM).
Given the categorization of individuals as mathematically minded or not, “it appears that a significant challenge in accomplishing ambitious reform at some scale entails the recognition of how teachers view their students' capabilities” (Jackson et al., 2017, p. 38). In a study of 122 middle-grade teachers’ perceptions of their students' abilities to be successful with reformed mathematical practices, Jackson et al. (2017) used a qualitative analysis of teacher interviews. The researchers discovered that the majority of the participants shared that their students were unable to find success with the rigors of reformed mathematical instruction. The participants were from two large urban school districts in the process of implementing reformed mathematical instruction. Although participants assigned some learning challenges to barriers created outside the classroom setting, about 70% perceived that instructional practices contributed to the difficulty. Additionally, it was reported that teachers lowered the “cognitive demand” (p. 32) of a lesson when students struggled with concepts instead of perceiving the struggle as a teachable moment. Jackson et al. recommended that an assessment tool would help construct a clear picture of how teachers view their students' abilities; such a tool would enable the design of training that helps teachers productively target student needs, monitor the implementation of the productive supports, and serve as an ongoing assessment of teachers’ perceptions of student capabilities once practices are established.

Discussing reformed mathematical practices, Collis (2016) noted that changes in teaching mathematics, one of several content areas that elementary teachers instruct, increase the difficulty of an already challenging subject. Emphasizing that the struggle is “particularly prevalent” (p. 4) for elementary-level teachers, Collis stated that the challenge of adopting new practices for teaching mathematics exists because teachers at
this level of the school system lack an understanding of the mathematical content and are often satisfied with the outcomes of current practices. The researcher suggested that the ineffectiveness of traditional methods of mathematics instruction utilized up to the 2000s remained hidden by three factors: students who left the school system before high school graduation, the basic level of understanding for mathematics that was deemed acceptable, and those students, naturally talented in the content area, able to see the bigger picture beyond the limitations of procedural approaches. Collis recommended that revising the mathematics curriculum is not sufficient to create transformational changes in teaching methods; long-lasting reform will be the product of transforming teachers’ beliefs through opportunities that grow their understanding of why change is needed and how to apply the most effective instructional practices.

In an investigation exploring elementary mathematics teachers’ ability to observe student thinking and use that thinking for instructional planning as well as during instruction, Lee and Francis (2017) found evidence to support a connection between teachers’ perceptions of student thinking and observations; however, there was “great misalignment” (p. 125) when comparing perceptions of student thinking to instructional practices. This study used interviews with 33 in-service teachers of kindergarten through fifth grade from three different Midwestern United States school districts. The teachers were part of a two-year professional development program to build their mathematical content knowledge, interpret student thinking, and gain a bank of practices that align with high-quality instruction. Lee and Francis suggested that the study’s results show that although teachers can observe and note students’ thinking, teachers cannot incorporate student thinking into the instructional practices they implemented. For example, the
investigation revealed that teachers who demonstrated high perceptions of understanding students’ thinking did not score equally high on a Mathematical Quality of Instruction (MQI) instrument regarding how they imbedded that thinking as part of the lesson taught. In a comparison of the 33 teachers’ perception rankings using their average scores on the Working with Students and Math (WSM) dimension of the MQI instrument, “only seven of the participants’ average scores on the MQI aligned with their rankings for perceptions of students’ thinking” (Lee and Francis, 2017, p. 125). It also was discovered that teachers valued students’ correct thinking over incorrect thinking, failing to notice the importance of using errors as opportunities for instruction. Lee and Francis asserted that teachers need training on transferring understanding of student thinking into instructional planning and practices for teaching.

**Performance-Oriented vs. Mastery-Oriented Practices**

Park et al. (2016) suggested that teachers’ beliefs are entrenched in their instructional practices and influence the learning and mindset of even the youngest school-age children. The researchers conducted a year-long study across 21 elementary schools of a large urban area involving 424 first and second-grade students to examine teacher-selected instructional practices, performance-oriented versus mastery-oriented, and their impact on student mathematics achievement and motivation. Park et al. reported that teachers who believed a child’s mathematical ability is fixed implemented performance-orientated instructional practices that emphasized high test scores and recognized the best-performing students over one school year. These researchers described mastery-oriented instructional practices that present learning as incremental, highlighting the importance of student persistence, and learning progress.
Park et al.’s (2016) study, including 58 elementary teachers, found that the teachers who emphasized the importance of high assessment scores used performance-oriented practices. Those teachers who stressed growth in learning utilized mastery-oriented practices. [This study showed that when comparing students results on a standardized mathematics test achievement scores in the fall compared to their scores on a spring standardized mathematics test, students with a performance-orientated motivational framework had lower achievement than students with a mastery-orientated framework (Park et al. 2016).] The same study compared data collected from teacher-reported instructional practices and data regarding student beliefs about their ability, task preference, and learning growth from the start of the school year to the end of the school year. The study concluded that performance-oriented instruction “significantly and negatively” (Park et al., 2016, p. 308) impacted student motivation and created a fixed sense of mathematical identity for students. Park et al. noted, “Though small, the relation between teacher-reported instructional practices and students’ motivational frameworks is significant and could likely intensify over the course of several years with repeated teachers who focus on performance-oriented instructional practices” (p. 309). The same data for teachers with a reported mastery-oriented practice did not predict if a student would develop a fixed mindset or not. Park et al. proposed that “although teachers’ own beliefs about the malleability of intelligence were related to their reported instructional practices, their beliefs were not directly related to students’ motivational framework development across the school year” (2016, p. 310).

Collecting data from 494 elementary students and 53 teachers of kindergarten through fifth grade to investigate the relationship between elementary mathematics
teachers' beliefs about instruction, the practices used, and the results in the form of what is learned, Polly et al.'s (2013) mixed methods design examined data regarding the instructional practices teachers use and how those instructional practices influence student learning. The teacher participants were elementary certified and represented two urban school districts from the southeastern United States. The study discovered a “significant” (p. 22) connection between teacher beliefs about mathematics instruction, student learning, and teaching techniques. Polly et al. found that students of teachers who used teacher-centered approaches to instruction had smaller gains on curriculum-based assessments than students in classrooms where teachers used student-centered approaches. Additionally, the data collected indicated that teachers with a teacher-centered inclination were willing to change to a student-centered approach after understanding more about constructivist theories of how children learn.

**Teacher Personal Mathematical Experience**

Using a qualitative case study method, Harbin and Newton (2013) examined the relationship between intermediate elementary mathematics teachers' beliefs, their personal mathematical experience, and the instructional techniques used to teach mathematics. Using observations and interviews of six mathematics teachers with at least three years of teaching experience for third, fourth, or fifth grade, the researchers collected data on the perceptions of these teachers and how these beliefs aligned with their classroom instructional practices. This study reported that teachers' previous experience as students strongly influenced the strategies implemented as teachers and discovered that after prior school experiences, in-service professional development influenced the instructional techniques that teachers chose. Harbin and Newton asserted
that this discovery is significant because, through their instructional decision-making, teachers decide on “the most important ideas in the curriculum” (p. 540), how to manage time and resources, and as a result, the development of mathematical thinking for students. This study concluded that teacher training and in-service professional development need to acknowledge the power of teachers’ prior learning experiences and construct new transformative experiences that help teachers implement reformed practices in their classrooms.

Jao (2017) used a mixed-methods approach of surveys, essays, and interviews of Canadian pre-service teachers for grades fourth through tenth to measure how mathematics methods courses influence teacher beliefs about mathematical instruction. Of the 19 teachers who participated in the survey and essay components, 12 also completed an interview. The results indicated that teachers are inclined to teach in ways most familiar to them, but a methods course can help to transform mathematical beliefs. It was reported that before a methods course, participants only experienced traditional practices and found the opportunity to try out reformed practices as a learner helped change their beliefs. The researcher stated that methods courses could not shift beliefs in isolation; there is a need for ongoing support for teachers to transfer principles into practice.

**Teachers’ Ability to Adapt to the Cycle of Reform Initiatives**

In an analysis of a quantitative study surveying 45 elementary mathematics teachers from one suburban school district in the southeastern United States implementing a state curriculum aligned with the Standards for Mathematical Practice in the CCSS-M, Hughes et al. (2019) shared that elementary teachers' beliefs strongly
correlated to the mathematical instructional choices made and techniques selected. The study defined two types of beliefs for participating elementary teachers: problem-solving view and instrumentalist view. Those participants who valued a problem-solving view of mathematics aligned with NCTM's recommended practices were more receptive to the standards-based approach. Hughes et al. found that veteran teachers whose instruction was teacher-centered and delivery-focused were more inclined to hold an instrumentalist view; they resisted implementing updated CCSS-M practices. The researchers suggested the resistor teacher is a product of skepticism generated by a continual change process, sharing that in 10 years, the standards had undergone three revisions.

As part of a longitudinal qualitative analysis from survey data and interviews of teachers and leaders from 14 elementary schools in a medium-sized urban district in the United States, Spillane et al. (2018) followed the district’s adoption of new mathematics standards and the professional development that supported the changes. An investigation of teachers' use of standards for mathematical practices showed that teachers adopted reformed practices to teach mathematics over time and that opportunities to engage with colleagues in one year were “significantly associated” (p. 558) with instructional beliefs for the following year. Spillane et al. reported that over three years, more than 50% of the teachers transformed their beliefs to be more reform-based, about 33% of the participants transformed their beliefs to less reform-based, and about 10% had no change in their beliefs. The researcher found a “significant and positive” (p. 547) connection between what teachers believed about mathematics instruction and the colleagues with whom they interacted. Results showed that teachers expressed reform-based beliefs when they worked with individuals who held reform-based beliefs; of teachers associated with co-
workers who held beliefs that did not support reform, they would express a similar belief. Spillane et al. advocated that professional development and systems within a school help provide opportunities to develop communities of practice that transform teacher beliefs and practices.

Using teacher observation and interview analysis of 11 high school mathematics teachers from Santiago, Chile, Valoyes-Cháves (2019) explored the idea of the resistor teacher. The researcher proposed that a teacher’s resistance to adopting and implementing a reformed instructional practice reflects a contradiction with established classroom culture. This research discovered that when expected to change accepted practices that place the teacher in control of both the lesson and the students’ participation and thinking, the mathematics teachers questioned their effective instruction and identity definition. In addition, Valoyes-Cháves suggested that professional development introducing reform practices and attempts to transform teachers’ resistance to change should not ignore the established structures within the school culture.

**Teacher Preparedness**

In a discussion of the challenges that teachers face when enacting reformed practices for mathematics instruction that are not native to them, Chapman (2012) asserted that "if the teachers' beliefs are not in harmony with those framing the curriculum, this can affect the level of their participation and success in activities to help them to understand and to implement the curriculum as intended" (p. 263). In addition, the researcher suggested that to assist teachers in understanding and implementing change, training must be practice-based, sustainable over time, and not viewed as an isolated event with a beginning and an end.
**Teachers' Pedagogical Content Knowledge and Mathematical Content Knowledge**

There is a distinction between teachers’ pedagogical content knowledge and mathematical content knowledge. In order to meet the challenge of implementing initiatives such as CCSSM and the Standards for Mathematical Practice, Campbell et al. (2014) asserted that “teacher beliefs related to mathematics teaching and learning, such as allowing students to struggle and not limiting instruction to an incremental demonstration of mathematical procedures, will need to be examined and discussed in terms of alignment with expectations for students’ mathematical practices” (p. 455). Campbell et al.’s study involved 266 upper-elementary and 193 middle-grades early-career teachers of mathematics. This study reported that teacher training programs and in-service professional development opportunities grow teachers’ understanding about facts and procedures of mathematical learning, teaching resources, and practices while also increasing their understanding of students’ mathematical thinking and cognitive development.

**Pedagogical Content Knowledge.** After conducting a quantitative analysis of a professional development model, combining online and face to face meetings, Anderson et al. (2018) concluded that despite a plethora of initiatives and the supporting professional development designed to improve mathematics instruction in the elementary classroom, the procedural nature of teaching and passivity of learning have not changed. The year-long study included 40 teachers from 8 school districts in the United States participating in a professional development model that blended online and in-person sessions to learn about a Mathematical Mindset Approach. The researchers reflected that in the past, despite having multiple professional development opportunities concerning
reformed practices in areas such as teaching mathematical problem solving and project-based learning, training did not include opportunities for teachers to change their beliefs about individual mathematics potential by including information related to neuroscience. Positive results from a mixed-methods analysis conducted by Anderson et al. (2018) discovered that when teachers learn about neuroscience, how the brain can develop mathematical pathways through instruction and practice, students' belief in their abilities, the teachers' instructional techniques, and test scores improve.

In a case study of the relationship of South African teachers' discourse about their practices to their understanding of student mathematical cognition, Henning (2013) found that the teachers' training to deliver a standardized mathematics competency test to children ages 4-8 did not incorporate reflections on how children learn as part of the assessment process. The study reported that participating teachers did not view the assessment as an opportunity to apply learning theory to selecting mathematics activities based on the learner's cognitive development, ensuring that objectives are appropriate for learners. This researcher discovered that study participants followed whatever instructional methodology they were prescribed to follow, with little reflection concerning its alignment with the conceptual development of their students. Henning maintained that to improve mathematics instruction, instead of the use of scripted practices found in textbooks and teaching manuals, elementary teachers should receive more training in current neuroscience and psychology research about how learning occurs.

**Mathematical Content Knowledge.** A cross-case analysis conducted by Hill and Charalambous (2012) comparing three teachers that taught the same content discovered
the teachers had varying levels of mathematical knowledge for teaching (MKT) and that the level of MKT contributed to the level of instruction. Their research showed a weakness in the quality of lessons when teachers' MKT was lacking; their evidence concluded that the higher teacher's MKT, the stronger the instructional quality. This study concluded that teachers with stronger MKT are at an advantage when teaching mathematics because these teachers can build upon student understandings to provide a more meaningful explanation or extend the learning to related mathematical concepts. Based on data from this study, the researchers recommended using peer mentors and lesson studies focused on selected topics to create professional learning opportunities for teachers with low MKT.

Copur-Gencturk et al. (2019) found that professional development opportunities for teachers that connected training with state standards, grade-level content map progressions, and daily instruction could transform teachers’ understanding of effective teaching. This quantitative study of 542 teachers participating in 21 programs integrating mathematics and science instruction focused on professional development content and implementation practices. The resulting data suggested that teachers improve their MKT when communities of teachers see the application of professional development to their daily practice using authentic student work to understand mathematical thinking and discuss the most effective way to respond. Similar to this recommendation, in a survey of 490 teachers of kindergarten to high school from California, Riggs et al. (2019) used qualitative and quantitative methods to examine how the value of a method and beliefs transferred to the enacted instructional practices; they found that teachers consistently implemented a practice when it aligned with their values and understanding of the
mathematical content. The study showed that teacher “self-efficacy and outcome expectancy positively correlate with MKT”; Riggs et al. (2019) asserted that teachers with these characteristics establish classroom environments that “expect students are capable of learning, given effective teaching” (p. 392).

Analyzing mathematics diagnostic assessment data collected from pre-service mathematics teachers (PSMT) enrolled at the University of Limerick, Ireland, between 1997 and 2013, Fitzmaurice et al. (2021) proposed that teachers' core mathematical content knowledge "plays a fundamental role" (p. 262) in affecting student learning, influencing the what and how of instruction. These researchers’ quantitative study showed a downward trend in the core mathematical understanding of PSMT in all topic areas, content considered prerequisite knowledge for admission into the University of Limerick’s teacher training program. The study suggested this research supported evidence of a "vicious cycle" (p. 274) where elementary teachers with low content knowledge instruct primary students who, as a consequence, have lower core mathematical understanding. The researchers also proposed that the improvement of the core mathematical knowledge of pre-service teachers’ content knowledge must be addressed as part of teachers’ preparation to instruct mathematics.

Pre-Service Teacher Programs

Comparing the preparation programs for teachers in 16 countries, Schmidt et al. (2017) analyzed the Teacher Education and Development Study- Mathematics (TEDS-M). This quantitative analysis found that mathematical training provided to “many” (p. 127) pre-service teachers in the United States was not internationally competitive. The researcher reported that the mathematical coursework rank for future teachers in the
United States was between 11 and 14 of 16. In addition, about 50% of primary teachers took all of the courses measured by TED-M. Further, it was shared that almost 60% of lower-secondary mathematics teachers graduate in the bottom 25% of their programs. The researcher suggested that this data revealed a cycle of low mathematical content knowledge teachers instructing students who develop low mathematical content knowledge. Supporting this suggestion, Tato and Senk’s (2011) mixed-methods study discussed teachers’ preparedness in the United States to teach reformed mathematical practices and examined how TEDS-M and policies regarding more rigorous curriculum standards impacted pre-service teacher programs. Based on the TEDS-M report, the discussion shared that pre-service primary teachers in top-ranking countries had more opportunities to take grade-level and advanced-level mathematics courses. In order to improve the quality of education in the United States, the researchers recommended that teacher preparation programs require coursework aligned to countries that rank highest.

Jacobson (2013) analyzed survey data provided by the TEDS-M on the preparation of elementary mathematics teachers. The researcher’s sample studied United States’ teachers of kindergarten to sixth grade who participated in mathematics training programs identified by TEDS-M to compare content knowledge and pedagogical content knowledge levels. This quantitative analysis reported that teachers’ learning about children’s cognitive development was “critical” (p. 626) to the success of their instructional practice. In agreement with this finding, Leavy and Hourigan (2018) also found that mathematical education for young children depends on the ability of the classroom teachers to provide meaningful and developmentally appropriate instructional experiences in the classroom. The researchers examined the content knowledge of 25 pre-
service primary level teachers participating in a lesson study project. An outcome of the lesson study suggested that participant understanding of the learning process for young children increased. Leavy and Hourigan’s qualitative study proposed that teacher preparation programs should focus on developing teachers with pedagogical and specialized mathematical content knowledge. A recommendation was participation in lesson studies as a way to supervise and mentor pre-service as well as novice teachers.

An examination of the traditional model used in pre-service teacher preparation discovered that prospective teachers could not apply material learned to the student teaching classroom (Forrest & Hitt, 2012). The pre-service mathematics teacher preparation findings showed the disparity between the practices promoted during coursework and those utilized during the student teaching experience. Forrest and Hitt asserted that this disparity stemmed from the multi-dimensional aspects of teaching in the elementary school setting, including classroom management and planning for other content areas. Pre-service teachers in this study followed the practice of their mentor teacher, even when the practices did not align with those taught in their methods coursework (Forrest & Hitt, 2012).

As part of a larger qualitative case studies project directed by Boston College, Jong (2016) conducted a three-year longitudinal study involving one novice elementary mathematics level teacher and discovered that to support pre-service teachers implementing reformed instructional practices, teachers need exposure to opportunities that transform their identity to “reform-oriented” (p. 308). As products of the study, the researcher identified three themes related to opportunities that influence reform-orientated instructional practices: educational influences, commitment to learning, and
school variables. Educational influences were role models who helped construct the teacher’s identity and knowledge of effective instructional practices. A commitment to learning was reported in both the high expectations for student learning and personal professional growth. School variables such as limited resources and inflexible teaching schedules were described as barriers to implementing effective instructional practices. However, curriculum programs and a supportive teaching network contributed to the successful implementation of reformed instructional practices.

Jansen et al. (2017) asserted that pre-service teachers need professional development to balance learning content knowledge and practice appropriate mathematical instructional techniques to transform their perceptions. This study of six first-year elementary teachers, graduates of the same preparatory program at the University of Delaware, found that when teachers taught select mathematics topics, inadequate content knowledge adversely limited their use of instructional strategies. These strategies were: meaningful mathematical representations, evidence of student thinking, and content-specific vocabulary. According to the researchers, teachers need to develop content knowledge in mathematics to select the correct practice to teach conceptual understanding.

**In-Service Professional Development**

Harbin and Newton (2013) suggested that teachers need opportunities to become aware of their previous experiences' influential power on their instructional decision-making. A teacher’s experience as a student and a school’s culture influence their identity as a mathematics teacher. Using standardized test data, observations, and interviews of six mathematics teachers of third, fourth, and fifth grade, this qualitative case study
discovered that professional development and pre-service teacher programs have “limited influence” (p. 538) on teachers’ implementation of new practices in the mathematics classroom. However, these researchers found that recognizing teachers’ former learning experiences as students is a starting point for in-service training as an effective way to transform instructional practice.

Outcomes of a study conducted by Bobis et al. (2021) of the beliefs and mathematical instructional practices of Australian teachers for students ages 5 to 8 suggested that to differentiate lessons to accommodate learning needs, knowledge of students’ thinking needs to partner with the comprehension of what practices are most appropriate. The 148 pre-intervention and 100 post-intervention group teachers who participated in this study also took part in an initiative to support teaching problem-solving to young children. These participants reported to the researchers the belief that when teaching children with diverse abilities, with one main activity, an understanding of each student’s abilities allowed teachers to diversify instructional practices to meet individual needs without degrading the cognitive demand. Bobis et al. advocated that teachers need opportunities for professional development and resources to help them plan and use equitable instructional practices that include the rigor reformed mathematics requires.

According to a study conducted by Spillanne et al. (2018), to implement reformed practices, district and school leaders should create opportunities for teachers to reflect on their beliefs about how mathematics is learned and the practices used. Spillanne et al. proposed that reflection was a tool to help teachers take on the responsibility of transforming how content is taught. Data from a longitudinal project from 14 elementary
schools in one medium-sized suburban school district in the United States showed that teachers looked to school leadership to implement reformed mathematical practices. Additionally, this research suggested that providing professional development that allows teachers to transform fixed beliefs about mathematics teaching and learning requires a change in the school system's infrastructure. The study recommended that instead of focusing on singular mechanisms for instruction, districts need to develop an overarching vision for mathematical instruction that supports teachers and communicates the interactions of instructional components.

**Factors That Influence Mathematical Instruction**

Many factors influence the outcomes and successes of mathematical instructional practices. In a discussion of the factors that prevent positive change in education, inside and outside of the educational system, Harris and Jones (2017) noted that the impact of culture and setting are not “irrelevant background noise” (p. 636) happening during the process of educational reform. The researchers asserted that disregarding the external factors impacting students' lives, not the merit of the proposed instructional practices or a weak plan for implementation, has prevented meaningful change.

NCTM (2014) proposed that mathematical teaching practices support student learning but that these practices do not happen in isolation. Mathematical practices are one part of a mathematics program. NCTM asserted that a successful school mathematics program addresses five “essential” (p. 59) elements: (a) commitment to access and equity, (b) powerful curriculum, (c) appropriate tools and technology, (d) meaningful and aligned assessment, and (e) a culture of professionalism. There are barriers to overcome for schools to address these five essential elements (NCTM).
Corkin et al. (2019), using a structured interview protocol, investigated factors, both barriers and facilitators, for transferring student-centered practices introduced during professional development to the classroom. The researcher categorized these factors as conceptual, pedagogical, political, and cultural.

**Conceptual Factors**

In a qualitative analysis of teachers’ perceptions when implementing constructivist practices for mathematical instruction, Corkin et al. (2019) stated that teacher knowledge and motivation could serve as barriers to providing reformed instruction. The study’s setting was eight school districts and one private school in urban Texas and included 80 mathematics teachers of kindergarten through twelfth grade. Teachers disclosed that the attitudes of other teachers not interested in making changes to instruction, or few colleagues with whom to share ideas, prevented them from successfully implementing new practices. In this study, some teachers shared that they had difficulty understanding the mathematical content and teaching differently from how they were taught. The data presented conceptual barriers of not understanding what constructivism meant both in terminology and in practice. Teachers experienced a disparity between their held beliefs about mathematics teaching and learning compared to the practices that were aligned with the Mathematical Teaching Practices outlined by NCTM.

According to Charalambous et al. (2020), MKT cannot be extracted from other factors such as curriculum resources, student background, and school climate when evaluating the success of instructional practices. The research completed over two years consisted of teacher surveys, student achievement data from state testing, and a project-
specific test based on higher-level thinking and problem-solving skills. The study analyzed data from 434 fourth and fifth-grade classrooms across four Eastern United States school districts and proposed that MKT is one of many factors that influence student mathematical learning when considering practice effectiveness. Charalambous et al. recommended that teachers receive professional development opportunities to acquire the mathematical knowledge for the content taught and an understanding of pedagogical, political, and cultural factors.

**Pedagogical Factors**

According to Corkin et al. (2019), teachers sometimes encounter barriers when attempting to align curriculum materials and programs with student-centered instructional practices. Heyd-Metzuyanim et al. (2019) shared that time and resources support teacher implementation of instructional practices. In a case study spanning one year involving two teachers who co-taught in a sixth-grade classroom from a large urban school district in the eastern United States, the researchers examined changes in the teachers’ practices related to professional development centered on the practices for productive discussions and accountability. The study proposed that the transition away from traditional instructional to interactive student-centered practices requires more time and resources than schools have previously provided teachers.

**Curriculum Materials.** As part of a two-year investigation of how teacher modifications of the same curriculum materials result in different learning environments, Kim (2019) focused on two teacher participants from an urban school district in northern California. The study examined teachers' changes to innovative lesson materials and structures before, during, and after instruction. These changes were identified as created,
adapted, omitted, and replaced. The study described that, at times, the modifications to the lesson materials, often in the beginning stages of implementation, lacked trust or alignment to a reformed program’s curriculum vision. The researcher implied that well-designed curriculum materials are factors that support teachers’ efforts to respond to student mathematical thinking through all stages of instruction. The study proposed that curriculum materials help teachers assess student learning, develop an understanding of mathematical thinking, and guide the teachers to the most effective instructional practices. Regarding teacher training with new curriculum material, the study suggested that ongoing professional development acknowledging teachers at different stages of implementation would be helpful.

**Curriculum Programs.** In a study reviewing four elementary-level mathematics curriculum programs published in the United States, Remillard et al. (2019) examined the connection between these instructional tools' mathematical intent and how teachers implement them. These researchers proposed that mathematical curriculum materials are “key messengers” (p. 102) to realizing a transformation for instructional practices. The four programs used in this study were: Everyday Mathematics (EM), Investigation in Numbers, Data, and Space (INV), Math in Focus (MiF), and Math Trailblazers (MTB). The researchers stated that each program presented several learning objectives for each lesson and that teachers made choices about what goals to prioritize, teaching 1-2 goals for each lesson, regardless of whether more instructional goals were included in the curriculum plan. Remillard et al. suggested that the uneven attention to learning goals could result from several factors. First, teachers opted to use only a few of the recommended practices, and those not used were aligned to goals that went unaddressed.
Next, teachers used all recommended strategies, but specific goals were not stressed during the activities. Lastly, goals were described without enough explanation, and teachers were not given enough guidance on including them in a lesson. Remillard et al. reported two trends from the learning goal data they collected. If a learning goal was described with general information and little support for instruction was provided, teachers overlooked or deemphasized the goal. If the curriculum guide provided ample support and explanation on the importance of a goal, teachers emphasized this learning goal. Given this evidence on how teachers utilized mathematical guides for instruction delivery, the researchers stressed the importance of curriculum designers' clear articulation of and rationale for learning goals. The researcher emphasized that curriculum materials help steer the transformation of mathematical instruction by helping teachers understand learning goals to achieve them through the practices delivered in the classroom.

**Cultural Factors**

Cultural factors, often beyond a teacher's control, are often created outside the classroom setting but impact the success of instruction. These factors, such as cultural exclusion, poverty, student's mathematical identity, and parent and student perceptions of mathematics instruction, can at times become barriers to learning. In discussing cultural factors and instruction, Corkin et al. (2019) suggested that it is difficult to engage learners in student-centered activities when they feel unsafe or hungry.

**Cultural Exclusion.** Louie (2017) proposed that a “culture of exclusion” (p. 489) constructed by the dominant culture in the United States defines the boundaries of mathematical learning opportunities and prevents meaningful instruction for students
whose cultural background is outside those boundaries. Exclusion is “central” (p. 490) to the cultural code that dictates mathematical instruction. In a study of a large urban racially diverse high school in the western United States, with fewer than 20% of students reaching proficient status on state mathematics tests, Louie examined four mathematics teachers' approach to a mathematical activity and their perceived mathematical activity ability of students. The four mathematics teachers chosen claimed a desire to advance equity in the areas of mathematics instruction. Investigating the culture of mathematics, Louie examined the instructional procedure of presenting rules, providing examples, and student practice modeled after the example mathematical problems. Two exclusionary aspects of this procedure, leading to an imbalance of equitable mathematics learning for students, were discovered: a lack of meaningful instruction due to “narrow” (p. 490) mathematical experiences and “narrow” (p.490) definitions of mathematical aptitude.

Louie (2017) defined the nature of the mathematical activity as exclusionary or inclusive. Exclusionary activity was characterized by the rote practice of a “fixed body of knowledge to be absorbed and practiced” (p. 496). Inclusive practices sought to bring meaning through making connections and incorporating multi-disciplinary skills such as “collaboration, experimentation, and argumentation, not just rote practice” (p. 496). The nature of mathematical ability was also defined by Louie as exclusionary or inclusive. Louie opined that exclusionary mathematics saw mathematical ability as a set range, and either a student has the ability or they do not. Inclusive mathematics viewed ability as multi-dimensional, with each student having mathematical areas of strength and weakness. Louie’s research concluded that enacting equitable mathematical instruction should not be centered on transforming individual teachers; cultural exclusion is not a
teacher-by-teacher occurrence. Louie proposed that mathematical instruction reflects a “macroculture” (p. 515) of the systemic issues of curriculum, teaching strategies, and manner of identifying student ability which must be redefined through an inclusive lens.

In a discussion of NCTM’s Catalyzing Change series (2018), Huinker et al. (2020) suggested ways to address the lack of equity in mathematical instruction. This discussion aligned of the pursuit of equitable instruction and NCTM’s eight- research-based Mathematics Teaching Practices. Huinker et al. asserted that a student’s mathematical identity develops from the learning experiences. For these experiences to be equitable, students must be “doers, knowers, and sense-makers” (p. 787) in the classroom. Huinker et al. noted that “Equitable mathematics instruction not only supports deep mathematics learning but also fosters the development within each student, of a positive mathematical identity that allows students to see themselves with the agency to be successful in mathematics” (p. 787).

**Poverty.** Examining student access to effective teaching, Isenberg et al. (2013) looked at student test score data of third to eighth grades over four years from 29 school districts in 16 states. These districts were different based on locations and student population. To calculate effective teaching, the researchers used a measure called the Effective Teaching Gap (ETG) to compare the average teacher effectiveness students experienced. ETG was determined by a value-added analysis, student and teacher assignments, and students' free and reduced lunch status. This study presented evidence that economically disadvantaged students receive about two weeks fewer than mathematics instruction than other students.
Additionally, these researchers found that schools with higher numbers of economically disadvantaged students experience less effective teaching than schools with lower numbers. Pearman (2019) supported these findings with data indicating “strong evidence” (p. 301) that children exposed to high-poverty neighborhoods are about 45 days behind in mathematics instruction than students from other neighborhoods. This researcher used data collected from the Panel Study of Income Dynamics (PSID) and a value-added design that analyzed the distribution of test scores from the 2002 Child Development Supplement Longitudinal Sampling Weights and Attrition Weights.

Davenport and Slate (2019) used a causal-comparative research design of the Texas mathematics assessment to investigate how poverty affected the performance of Texas third graders. The researchers stressed the importance of the study because approximately 50% of third-graders in Texas fell into the economically disadvantaged category. Students in this study were categorized as “Not Poor“ to “Moderately Poor” to “Very Poor”. The researchers stated that previous studies show a link between poverty and reading achievement but that “limited” (p. 170) research exists concerning mathematics achievement and poverty. This study looked at three levels of performance standards in mathematics for third-graders: Approaches, Meets, and Masters. The results indicated that mathematics performance decreased as the poverty level increased for all standards showing “statistically significant differences” (p.171-172). Davenport and Slate reported that the number of students for the “Very Poor” group who did not reach the Approaches standard was about four times higher than the group who were “Not Poor”. The number of students in the “Moderately Poor” group of students who did not reach the Approaches standard was double the “Not Poor” group. Data concerning the
Meets standard showed the “Very Poor” group of students were twice as likely not to achieve the standard as the students in the “Not Poor” category. The “Very Poor” group of students were less than one-fourth likely to reach the Meets standard than students in the “Moderately Poor” group. Compared to the “Not Poor” group, three-fourths of “Moderately Poor” students did not meet the Approaches standard. The study showed a decrease in the percentage of students reaching the Masters standard progressively from “Not Poor” to “Very Poor”. A recommendation the researchers proposed was that money be provided to schools with large numbers of economically disadvantaged students to provide early interventions in mathematics, support structures such as placing teachers with higher qualifications and experience teaching mathematics in these settings, as well as the reduction of neighborhoods with high poverty (Davenport & Slate, 2019; Pearman, 2019).

**Student Perceptions of Mathematics Instruction.** Student perception of mathematics is a factor that influences the success of instruction in the classroom. A learner’s previous experience and success with mathematical instructional practices, disposition, and special education status are factors that contribute to the success of an instructional practice. In a 6-month longitudinal study of 634 first and second graders in 23 urban elementary schools, Gunderson et al. (2018) examined the dynamic relationship between students’ motivation, anxiety, and achievement in mathematics; the authors determined that children who began their formal education with a fixed mindset displayed more mathematics anxiety and minor achievement in the subject throughout their schooling than peers who had a growth mindset. The data collected implied that children begin to construct a mathematical identity for themselves upon entry into the
educational system instead of the concept that the youngest learners do not comprehend their mathematics abilities until they reach the upper elementary grades. These researchers stated that the primary grades are “crucial for establishing” (p. 35) whether a child will experience an academic future of achievement in mathematics, motivation, and belief in their abilities. It is essential to acknowledge that students’ perceptions of mathematics instruction are a product of mathematical instructional practices (Gunderson et al.)

Researchers found a connection between teachers’ awareness of students’ mathematical mindset and student achievement (Blazar & Kraft, 2017; Campbell et al., 2014). Campbell et al. (2014) conducted a quantitative study to determine the relationship between student mathematics achievement and teacher mathematical content and pedagogical knowledge. Using student achievement and demographic data linked to 459 mathematics teachers of fourth to eighth grade in Delaware, Maryland, and Pennsylvania, the study found a “statistically significant interaction effect” (p. 454) when examining teacher’s MKT and teacher’s score on perceptions of student mathematical ability. This study considered the possibility that a combination of high MKT and understanding students’ mathematical perceptions results in the most effective instructional practices being implemented in the classroom.

Blazar and Kraft (2017) asserted that “…particularly at the elementary level, teachers’ math training is often overlooked” (p. 163). These researchers investigated upper-elementary teachers and their teaching effects on student outcomes and discovered that content MKT and instructional practices predicted students’ achievement, attitude about mathematics, and behavior in the classroom. In this examination of the teacher
effect on student perceptions of mathematics, the study reported that instructional practices predicted the mathematical mindset of students. This conclusion was supported by findings showing a relationship between a teacher presenting material clearly and concisely, without errors, to students’ happiness in the classroom and confidence in their success.

**Parent Perceptions of Mathematics Instruction.** Jay et al. (2018) investigated parent involvement with mathematics learning by conducting interviews of parents representing 16 urban primary schools in southwestern England. This study revealed two obstacles for parent support of student learning: unfamiliar instructional techniques and low levels of communication between home and school. The researchers shared that parents expressed that they were not successful at mathematics while in school or had forgotten the mathematical content. Jay et al. noted that a common parent response, regardless of educational background, was that parents found the methods for solving homework problems unlike processes used when parents were school-aged. Additionally, parents described tense interactions with their children using the parents’ familiar methods instead of those modeled by the teacher. The researchers discovered that some parents struggling to support their child’s learning felt “disempowered” or “embarrassed” (p. 7); these emotions often led to task avoidance. Jay et al. claimed that parents' frustration attempting to use unfamiliar instructional practices led to a need for more school-to-home communications and an increased reliance on the school and the teacher for information and resources. The researchers suggested that providing family training and support is a solution to overcome the obstacles to parents supporting the mathematics instruction techniques schools are using.
COVID-19 Pandemic. A factor Harper et al. (2021) researched was parental experiences regarding engagement in mathematics for their children during and after the COVID-19 pandemic, when approximately 1.5 billion students worldwide transitioned from in-school learning to remote learning at home. These researchers used data collected from social media posts from 228 participants during the pandemic that promoted mathematical learning at home and data collected from 101 parent surveys. These represented 81 parents from North America, 17 from Australia/New Zealand, one from Europe, one from Asia, and one location not specified). These data are related to the remote instructional experiences of parents. Harper et al. suggested that communities already “marginalized” (p. 21) or culturally excluded in the area of mathematical instruction “felt the weight of the disruptions caused by COVID-19 disproportionately” (p. 21). The research encouraged more attention on increasing the role of parents in mathematical education through the use of both human and social capital. Schools should spearhead meaningful conversations with parents about transforming mathematical practices, promoting of online educational resources, and increasing sharing of physical resources. Harper et al. also reported that 75% of participants during the COVID pandemic, regardless of economic status, looked to their child’s teacher for support and guidance.

Political Factors

According to Corkin et al. (2019), district politics and government policy may “negatively impact” (p. 390) the availability of instructional resources to deliver student-centered practices. These researchers referred to budget cuts that prevented or delayed
teachers' access to the materials and, consequently, changed their plan for instruction. Large-scale testing is another political factor.

**Large-scale Testing.** Amador and Lamberg (2013) studied how the preparation for annual state testing influenced teachers' instructional delivery. The researchers found that a shared understanding in the school community of how to support students to perform well on tests encouraged a perception that mathematical instructional planning and practices were effective. Amador and Lamberg concluded that the variable of test preparation could determine how and what gets taught in a classroom. This study also asserted that this type of planning violated NCTM’s first mathematical teaching practice of establishing mathematics goals that focus on learning, not test content. In a review of the influence large scale assessments (LSA) have on educational policy and research in the United States, Schmidt and Burroughs (2016) suggested the purpose of LSA should be to use as an instrument to gather data for research that improves instruction instead of its current use as a “policy instrument” (p. 568). These researchers maintained that using LSA to create a policy that evaluates teacher effectiveness based on generalized outcomes misses an opportunity to understand how the culture and climate of a school and a classroom contribute to instructional success.

**Summary**

In an effort to improve student achievement in the area of mathematics the United States has focused on teacher effectiveness, valuing the characteristics of teachers over an examination of the mathematical practices that teachers implement; this has not led to anticipated results (Hiebert and Morris 2012). This chapter reviewed the path of
educational reform in the United States related to elementary-level mathematics instruction and the goal to increase student achievement in mathematics.

Research regarding how children learn mathematics helps improve the quality of instruction (Lessani et al., 2016). An examination of recent episodes of change in theory-based learning practices in mathematics and research regarding the application of behaviorism and constructivist learning theories supports efforts to identify the most effective instructional practices to use in the elementary mathematics classroom (Stoilescu, 2016).

Elementary teachers’ perceptions about teaching mathematics and beliefs about how mathematics is learned influence their selection of mathematical practices used for instruction (Park et al., 2016). External factors (conceptual, pedagogical, political, and cultural) impact instructional practices (Corkin et al., 2019). This review of the literature considered the influence of these factors. Structures such as elementary teachers’ preparedness to teach mathematics, mathematical knowledge, culture, and setting affect the practices implemented by teachers (Harris and Jones, 2017). The research in this chapter examined existing structures to understand teacher selection of mathematical instructional practices.

Chapter Three will describe the methods and procedures used in this qualitative study. The methodology examines elementary teachers’ perceptions of the most effective instructional practices to teach mathematics in the elementary classroom, teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom, and teacher perceptions regarding the factors that influence the practices selected for mathematics instruction in the elementary classroom.
Chapter Three - Methods and Procedures

In a study of elementary mathematics taught in urban high-poverty elementary schools, McKinney et al. (2013) opined that researching the instructional practices of elementary mathematics teachers provides authentic data. According to these researchers, data collected from teachers can help school districts and teacher preparation programs improve educational environments and lead to success in learning mathematics for all students. Ottmar et al. (2014), in a study involving 2,838 teachers of kindergarten through fifth grade, evaluated instruments measuring the instructional practices teachers used to teach mathematics in the elementary classroom. These researchers concluded that teacher questionnaires regarding the instructional practices they employed are valuable sources of information; these questionnaires provide a measure of “the areas of mathematics where teachers nationally underemphasize content, or to determine how differentially emphasizing specific strands of mathematics can improve or hinder children’s achievement” (p. 136).

This study examined teachers’ perceptions of the most effective instructional practices used in the elementary mathematics classroom, their preparedness to instruct mathematics, and the factors that influence instructional effectiveness in the elementary mathematics classroom. Additionally, this study aimed to contribute to the current body of research on the topic of the teachers’ perceptions of the most effective practices for mathematics instruction in the elementary classroom. It may provide information to aid school districts in establishing authentic and beneficial teacher professional development plans to improve students’ success in mathematics learning.
Subjects

The subjects in this qualitative study were 21 regular education elementary mathematics teachers in two suburban public school districts in Central and South-Central Pennsylvania. At the time of the study, the subjects held classroom teaching positions representing kindergarten through fifth grade at primary or intermediate level elementary school buildings. Requests for permission to conduct the study were sent to the superintendents of the two school districts used in the study; both superintendents agreed to allow the researcher to invite the participation of their school district’s elementary mathematics teachers of kindergarten through fifth grade (Appendix A). A proposal to conduct the research was approved by the Research Ethics Review Board (RERB) of Immaculata University (Appendix B).

Approximately 210 elementary teachers were employed by the two school districts in the geographic area of the study. Questionnaires were sent to 11 elementary building principals in elementary schools across the two school districts, with the permission of their school district superintendents. These building principals emailed the Invitation for Study Participation (Appendix C) to regular education elementary mathematics teachers of kindergarten through the fifth grade with valid Pennsylvania teaching certificates employed by their district.

Setting

The setting of this study included 11 public elementary-level primary and intermediate schools that served students, regular education, and inclusive learning support in grades from kindergarten through fifth grade. The schools that participated are located in two different county areas of Central and South-Central Pennsylvania regions.
These school districts include rural, urban, and suburban schools in communities with varying socio-economic statuses. Elementary mathematics teachers of all schools in which the superintendent permitted an invitation for their participation and submitted the Teacher Informed Consent Form (Appendix D) were included in the study results. A questionnaire to collect data was distributed electronically; the researcher conducted voluntary one-on-one interviews in person or through Zoom. The methods and procedures for the instruments used in this study are detailed in this chapter.

**Instruments**

The researcher utilized three methods to collect data to gain the information for this study. The alignment of these instruments to the questions that guided this study and the research of the study can be found in Appendix E. The instruments included a questionnaire composed of Likert scale statement response questions, open-ended questions, and volunteer participant interview questions. Google Forms, an internet-based questionnaire tool, collected the data for the Likert scale statements and open-ended response questions (Appendix F). An interview was presented as an additional option for participants during the completion of the questionnaire tool (Appendix G). A one-page summary of the results was sent to all superintendents of participating school districts at the conclusion of the study.

Referring to the selection of an instrument, Knekta et al. (2018) stated that both the amount of evidence and existing theory for interpreting the data it will collect must be taken into consideration. The questionnaire used in this study collected responses from participants to obtain their perceptions of the most effective instructional practices to teach mathematics in the elementary classroom, their preparedness to instruct
mathematics in an elementary classroom, and perceptions regarding the factors that influence the practices selected for mathematics instruction. An online questionnaire was distributed via email with a link to a Google form directly from the researcher. The email invitation was sent to current elementary school building administrators at approved sites to distribute to all kindergarten through fifth-grade mathematics teachers. Participants were asked to submit an informed consent form prior to completing the questionnaire. An initial component of the first instrument, based on the questionnaire work of Schoen and LaVenia (2019), included questions related to teachers’ demographic details and preparedness for mathematics instruction.

Following a collection of demographic data, the second part of the questionnaire consisted of Likert scale statement responses related to teacher perceptions of mathematics teaching practices and beliefs about teaching and learning mathematics. Carney et al. (2015) proposed that to determine the effectiveness of mathematical practices, an instrument should be used that allows for the “clear conceptualization of practice” (p. 93) and that the evaluation produced by the instrument should accurately match this conceptualization of the instructional practice. To support a clear conceptualization of practice, the Likert scale statement responses used in this study were developed from the eight mathematics teaching practices and the productive and unproductive beliefs about teaching and learning mathematics described in NCTM’s Principles to Action: Ensuring Mathematical Success for All (2014). The final part of the questionnaire instrument included open-ended response questions designed by the researcher relating to questions guiding this study.
Another instrument used in the study was a one-to-one, zoom interview in which two questionnaire participants chose to participate. Interview questions were based on NCTM’s five essential elements of effective mathematics programs (2014). After consenting to the interview in the final item of the online questionnaire (Appendix G), volunteer participants were asked their perception of the factors influencing the effectiveness of mathematics instruction in the elementary classroom.

The online questionnaire, both its structured and unstructured responses, and interview questions were piloted using an expert group of two experienced administrators, who possess doctoral degrees in Educational Leadership; they also have knowledge of effective elementary-level mathematics practices. The administrators provided feedback to the researcher regarding the clarity of questions asked as part of data collected from the demographic and questionnaire items, open-ended responses, and interview questions. The time to participate in the questionnaire and the interview was also estimated by this expert group.

**Questionnaire**

The questionnaire was administered via Google Forms to elementary mathematics teachers from kindergarten to fifth grade. Data collected by Google Forms, a secure online questionnaire tool, were encrypted in transit and used built-in security to detect and prevent threats (Google Cloud, 2020). This instrument began by asking questions that related to participants’ demographics and preparedness to teach mathematics. These questions included years of experience teaching mathematics, the current grade assigned to teach, current certification, whether they hold a mathematics degree (major or minor), and the number of undergraduate mathematics courses taken. Additionally, the
questionnaire asked about the number of graduate-level teaching courses taken in the teaching of mathematics, the number of mathematics professional development opportunities participants completed in the last five years within the school setting and the professional development context of those opportunities.

Following the preliminary questions, the questionnaire continued with a questionnaire composed of 17 Likert scale statements related to the eight mathematics teaching practices and six Likert scale statements related to beliefs about teaching and learning mathematics. Both practices and beliefs are defined by NCTM (2014). NCTM’s eight mathematical practices are: (a) establish mathematics goals to focus learning, (b) implement tasks that promote reasoning and problem solving, (c) use and connect mathematical representations, (d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking (p. 10). NCTM categorizes the beliefs about teaching and learning mathematics as unproductive or productive. The online questionnaire concluded with the three researcher-designed open-ended responses investigated in this study.

The questionnaire’s Likert scale asked teachers to evaluate their perception of their practices and beliefs using a scale ranging from strongly disagree to strongly agree. According to Boudah (2020), a linear numeric scale, or Likert scale, is utilized to “convert the data to numbers easily and use statistics to describe and make statements about the included sample” (p.144). The three open-ended response questions, related to the research questions driving this study, asked teachers about their perception of the most effective mathematical instructional practices, what factors contributed to their
preparedness to teach mathematics, and what factors influenced the practices selected for mathematics instruction. Responding to the demographic questions, 23 Likert scale statements and three open-ended response questions were expected to take 20-30 minutes. The responses were collected using Google Forms. The demographics data, Likert scale statement responses, and open-ended response answers were electronically imported by the researcher from the Google Form to a Google Sheet. The Google Sheet data were downloaded to an Excel spreadsheet. Questionnaire participants were anonymous to the researcher, and responses were transferred by the questionnaire tool onto the spreadsheet in the order in which they were submitted.

**Interview**

The researcher conducted two participant interviews with individual questionnaire respondents who, when answering the questionnaire, consented to participate in an interview. If the participants were willing to consent to an interview, they reviewed the Teacher Informed Consent Form for Interview page. By checking “Yes,” participants agreed to the terms in the consent form, which allowed the researcher to schedule an interview. These respondents indicated their interest in participating in an interview by providing their name and email address. Both participants chose the option to participate through Zoom, a web-based video conferencing format, instead of choosing a one-to-one, in-person interview. The location and time of mutual convenience for an interview were agreed upon. It was estimated that the interview would take approximately 20-30 minutes. Confidentiality for these interview participants was maintained, though identity and associated questionnaire responses were known to the researcher when the participant submitted contact information on the initial questionnaire. With participant
consent, the interview (Appendix H) was recorded, transcribed, and coded numerically to allow for analysis. Participants could withdraw consent at any time without penalty, at which point, the recording was erased. If the consent to be recorded was not given or withdrawn, data were collected from notes the researcher took as part of the participant’s interview. All of the data were summarized, and no individual can be identified from these aggregated results. The data collected from this study were accessible only to the researcher and maintained on a password-protected computer database. Analysis was a triangulation component consisting of data from the questionnaire responses, open-ended response answers, and interview responses (Boudah, 2020). A check for the accuracy of the transcriptions was provided by the researcher. Transcriptions were coded for patterns and themes. After transcription, interview recordings were erased. To protect anonymity, the names of interviewees were not be attributed to the audio recording or identified in transcripts. All interview responses were kept confidential. Any additional information that could identify an interview participant, including the school district, was not reported in the results or data presented in the study. A summary report of the general, aggregated results was shared with the superintendents of the two participating school districts. To protect the confidentiality of the participants, the transcriptions, questionnaire, and interview responses was stored in a locked cabinet in the researcher’s home office to be destroyed five years following the study’s conclusion. Electronic-copy data were deleted from the researcher’s computer, followed by permanently emptying the computer’s trash can.

In a discussion of research interviews, McGrath et al. (2019) stated that “qualitative interviews afford researchers opportunities to explore, in an in-depth manner,
matters that are unique to the experiences of the interviewees” (Introduction section, para. 1). Boudah (2020) stated that an interview is one way to gather data regarding the perspectives and beliefs of participants. Questions were determined before the interviews but allowed participants to respond based on their interpretation and frame of reference. The interview used in this study attempted to learn elementary mathematics teachers’ perceptions of the factors that influence mathematical practices. Interviewees were asked about their perception of the facilitators and obstacles for effective mathematical instruction in the elementary classroom. The 12 interview questions all related to NCTM’s (2014) essential elements of an effective school mathematics program. These elements are (a) access and equity, (b) curriculum, (c) tools and technology, (d) assessment, and (e) professionalism.

Validity

According to Hayashi et al. (2019), validity in qualitative research can be secured with techniques employed during all stages of research. Hayashi et al. opined, “Each step of the study is not isolated but supports the previous one and reverts to action in the next phase” (p. 103). The process of ensuring validity is made up of five elements: (1) alignment of subject, research design, and method of the investigation, (2) organization of the data, (3) coding of the data collected to represent patterns and themes, (4) data analysis, and (5) discussion of study results (Hayashi et al.). This study followed this procedure.

Knetka et al. (2018) asserted that the ability of an instrument to measure what the researcher states it will measure is its validity; these authors concluded that validity refers to the use of an instrument as it relates to a set context. Additionally, these researchers
suggested that validity comes from the interpretation of what the instrument measures. Boudah (2020) stated that four conditions would negatively affect the validity of the questions used in a questionnaire. Questions lose validity when participants do not understand the question asked, do not know the answer, do not remember the answer, or do not want to answer the question. This study used an expert group to review and make recommendations regarding all instruments before data collection to strengthen the study’s validity.

Triangulation in this study resulted from the interrelationship between the information gathered from questionnaire data, open-ended response items, and interviews. The multiple methods used to collect data increased the validity of the research and aided the researcher in understanding of teachers’ perceptions of the most effective mathematical practices used in the elementary classroom (Hayashi et al., 2019).

**Reliability**

Knetka et al. (2018) stated that an instrument’s reliability is the consistency of measurements. Boudah (2020) asserted, “Reliability is the degree to which a study can be repeated with the same results” (p. 63). For the design of all instruments used in this study, three areas recommended by Boudah to address reliability were used: the researcher’s process when interacting with participants was scripted, respondents shared a common interpretation of the questions, and questions were appropriate to the context of the questionnaire. For this study, answer reliability was addressed using an expert group who have knowledge of effective mathematics practices. Included in this group included two experienced administrators, with doctoral degrees in Educational Leadership. The group’s critical review of the instruments provided feedback to improve
the clarity of the directions, questions asked, the vocabulary used, and determine
completion time. Feedback from the expert group allowed the researcher to improve the
format of the questionnaire tool.

Increasing reliability, multiple methods including a questionnaire using 23 Likert
scale statements, three open-ended response questions, and 12 interview questions, were
used to collect data. The open-ended responses allowed participants to expand upon their
Likert scale statement selections. These open-ended responses were compared to the
questionnaire answers to verify participants’ response intent. Boudah (2020) cautioned
that information provided as part of an interview could sometimes be a product of what
the person being interviewed believes is the correct response rather than an authentic
answer. To overcome this, the interview in this study used standardized questions and
open-ended responses. Boudah recommended this type of interview as an approach that
“reduces some potential issues related to trustworthiness” (p. 120).

The researcher coded the Likert scale response statements, open responses, and
interview responses following an analysis to identify themes. To triangulate the
responses collected from the participants, data from these three methods were compared
to the effective mathematical instructional practices, productive teacher practices, beliefs
about productive mathematics, and the essential elements of an effective mathematics
program identified by NCTM (2014)

**Design of the Study**

This qualitative study examined the elementary teachers’ perceptions of the most
effective mathematical instructional practices to teach mathematics in the elementary
classroom, teacher perceptions regarding their preparedness to instruct, and teacher
perceptions regarding the factors that influence the practices selected for mathematics instruction. Analyzing the Likert scale response statements, three open-ended responses, and interview data identified themes; this helped the researcher understand teacher perceptions. The questionnaire’s structured responses and three unstructured, open-ended response questions were administered through the online questionnaire tool, Google Forms. The researcher asked the 12 interview questions to each volunteer participant.

McDermott et al. (2020) stated that whereas quantitative methods are a way to measure an experience, qualitative methods help one to understand the experience. The use of a qualitative design allowed for the collection of elementary mathematics teachers’ perceptions of the most effective mathematical practices. The design of this study helped determine trends regarding teachers’ preparedness to instruct mathematics and beliefs regarding the factors that influence the practices selected for mathematics instruction. Teacher perceptions collected in this study were compared to the existing body of research. As part of the study’s design, coding protected the anonymity and confidentiality of the participants and associated school districts.

**Procedure**

The Superintendents of the two school districts of prospective participants were contacted initially by a phone call, followed by an email and request for approval to solicit their school district’s elementary school mathematics teachers for participation. The researcher received written permission from the superintendents to conduct a qualitative design research study related to effective elementary mathematics instruction: teachers’ beliefs, preparedness, practices, and factors that influence implementation. Before the research was conducted, a proposal to conduct the research was submitted to
the Research Ethics Review Board (RERB) of Immaculata University for approval. Following RERB approval, the researcher emailed the superintendents of the participating school districts, informing them that a questionnaire would be forthcoming. This communication to the superintendents included RERB confirmation and restated the purpose of the study.

Once all permissions, consents, and approvals were secured, the Teacher Email Invitation for Study Participation, the link to the online questionnaire which included the Teacher Informed Consent Form, and the Teacher Informed Consent Form for Interview were sent to the participating superintendents or designee to share with district elementary mathematics teachers via district email; this included instructions for its completion. The researcher sent follow-up emails two and three weeks to the superintendents of the participating school districts after the initial questionnaire email to encourage participation.

Upon opening the questionnaire, participants were presented with the Teacher Informed Consent Form for the online questionnaire, and asked to indicate “Yes,” to allow them to access the teacher questions. The questions were developed to collect both demographic data and data relevant to the study. The questionnaire consisted of nine demographic questions and twenty-three Likert response statements related to teachers’ mathematics teaching practices and beliefs about teaching and learning mathematics. The online questionnaire concluded with three researcher-designed open-ended responses based on the questions investigated in this study. It was estimated that the questionnaire would take approximately 20 minutes. Questionnaire data were collected and analyzed
for themes concerning elementary mathematics teachers’ perceptions of the most
effective mathematical practices.

As part of the questionnaire, teachers were invited to participate in the interview
portion of the study; the researcher contacted these volunteers to schedule a mutually
convenient time and interview using Zoom. Confidentiality for these interview
participants was maintained. Following participants’ consent, interviews were scheduled,
recorded, and transcribed by the researcher. The transcriptions, electronic data,
questionnaire, and interview responses were stored in a locked cabinet in the researcher’s
home office; the researcher will destroy the data five years following the study’s
conclusion. Questionnaires and interview information were analyzed for trends and
discrepancies before the data analysis. At the conclusion of the study, a summary report
of the general aggregated results was shared with the superintendents of participating
school districts.

Data Analysis

Once the data from the participants were collected, the Google Sheet
questionnaire data were transferred from Google Forms and downloaded to an Excel
spreadsheet on the researcher’s computer. Questionnaire participants were anonymous to
the researcher, and responses were transferred from the questionnaire tool onto the
spreadsheet in the order in which they were submitted. Neither the Google Form,
demographics data, nor the questions in the questionnaire gathered information that
would allow the researcher to identify the subject. The name of the participating school
district, superintendent, schools, and teachers were not published. Individual
questionnaire responses were numerically coded to ensure anonymity and confidentiality. The data were organized and analyzed.

The demographic information collected provided the researcher data related to a teacher’s preparedness to teach mathematics. The 17 Likert response statements related to mathematics instructional practices as described by NCTM (2014), provided data about teachers’ perceptions of effective instruction. The eight practices are: (a) establish mathematics goals to focus learning, (b) implement tasks that promote reasoning and problem solving, (c) use and connect mathematical representations, (d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking. Participant agreement with the 17 Likert scale response statements aligned to beliefs about mathematical instruction and determined if teacher perceptions of effective mathematical instruction aligned with those identified by NCTM (2014). An additional six Likert scale response statements aligned with unproductive instructional practices identified by NCTM (2014) and participants’ responses determined if beliefs about teaching and learning mathematics were productive or unproductive.

Data were also collected from three-researcher-designed open-ended response questions, and 12 interview questions. The three-researcher-designed open-ended response questions were the questions that guided this study. Each of the 12 interview questions was based on NCTM (2014) essential elements of a mathematics program. These elements are: (a) access and equity, (b) curriculum (c) tools, and technology, (d) assessment, and (e) professionalism. The essential elements of a mathematics program
align with the factors described in Chapter Two of this study concerning the influencers of outcomes and the success of mathematical instructional practices. Corkin et al. (2019) classified these factors as: conceptual, pedagogical, political, and cultural. After this alignment was completed, the factors participants identified were categorized as facilitators or obstacles to effective mathematics instruction. Data collected from the questionnaire and open-ended response questions were compared by the researcher to identify themes using trends. Inconsistencies and outliers were also identified.

The researcher recorded the interviews, transcribed them, and coded them numerically to remove identifiers. Following transcription, the interviews were analyzed for trends that connected to the themes in the questionnaires and open-ended response data. The interviewees were known only to the researcher. Once the analysis was completed, the results were compared to the research presented in the literature review. A comparison identified common themes, inconsistencies, and anomalies. Electronic-copy data were deleted from the researcher’s computer, followed by permanently emptying the computer’s trash can.

Summary

The purpose of this study was to examine how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematical instruction in the elementary classroom. This study attempted to determine teachers’ (a) beliefs and preparedness to teach mathematics, (b) ability to adapt to a cycle of reform initiatives, (c) willingness to go along with new practices that require a change in established systems, and (d) perceptions of the factors that influence the outcomes and successes of student learning of mathematics. The study may contribute to the body of
research about teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom. Additionally, teachers’ perceptions regarding their preparedness to instruct mathematics and the factors that influence the practices selected for mathematics instruction in the elementary classroom were examined. At the time of the study, the 21 participants were classroom teachers who teach mathematics from kindergarten through fifth grade at primary or intermediate level elementary schools. The participating teachers served in one of two participating school districts located in Central or South-Central Pennsylvania.

Data from three collection methods: (a) Likert scale response statements, (b) researcher created open-ended response questions, and (c) optional participation in a one-to-one personal interview were used. Using a Google Form, the open-ended response questions provided an opportunity for participants to elaborate on the factors that influenced their Likert scale responses. In addition, participants could choose to take part in a 12-question personal interview regarding the factors that influenced the instructional practices they select for teaching mathematics. The data collected by this study were organized and analyzed, and then compared to the research provided in Chapter Two. Chapter Four will discuss the data collected from the research instruments used in this study.
Chapter Four – Results

This qualitative study examined how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematics instruction in the elementary classroom. The three research questions used in this study were the basis for the data that were collected. Table 4.1 is a design matrix showing the alignment of this study’s research questions and the instruments used to collect data. A Likert scale questionnaire gathered data about teacher perceptions regarding the most effective instructional practices to teach mathematics and teacher preparedness to instruct mathematics in the elementary classroom. Three open response questions aligned with the researcher-designed questions for this study; these responses provided data that expanded participants’ Likert scale responses, additional clarification, triangulated data, and verified questionnaire response intent. Voluntary participant interviews provided data regarding teacher perceptions about the factors that influence the practices selected for mathematics instruction in the elementary classroom.

Table 4.1

Design Matrix for Research Questions

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Questionnaire</th>
<th>Open- Responses</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom?</td>
<td>Section Two 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23</td>
<td>Question: 1</td>
<td>Interview</td>
</tr>
<tr>
<td>What are teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom?</td>
<td>Section One 1, 3, 4, 5, 6, 7, 8, 9</td>
<td>Question: 2</td>
<td>Interview</td>
</tr>
<tr>
<td>What are teacher perceptions regarding the factors that influence the practices selected for mathematics instruction in the elementary classroom?</td>
<td>Question: 3</td>
<td>Question(s): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
<td>Interview</td>
</tr>
</tbody>
</table>
Results of Research Question One

The first research question collected data about teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom. This question was addressed using a 23-item questionnaire and open-ended response items. These instruments asked participants to identify the mathematical instructional practices used for instruction and their beliefs about how to instruct mathematics effectively. The mathematical instructional practices used in the questionnaire were based on the Eight Mathematical Teaching Practices and productive beliefs teachers should implement as identified by NCTM’s *Principles to Action: Ensuring Mathematical Success for All* (2014). Participants shared their perception of the effectiveness of practices and instructional beliefs by selecting whether they strongly agreed, agreed, disagreed, or strongly disagreed with implementing a particular practice or belief.

Twenty-one teachers completed the questionnaire composed of 23 Likert scale responses and three open-ended responses regarding the mathematical instructional practices used in the classroom and teacher beliefs about mathematics instruction. Each teacher selected one response indicating the level of their agreement with a statement.

**Questionnaire Section: Instructional Practices**

A response of strongly agreed or agreed for the first 17 statements would align with NCTM’s recommended Eight Mathematical Teaching Practices. Table 4.2 represents teacher perceptions of their use of effective mathematical instructional practices. The items presented were adapted from the mathematic practices presented in *Principles to Actions: Ensuring mathematical success for all* (NCTM, 2014, p. 10). When accounting for the strongly agree and agree to responses, 90% of the participants’
responses regarding the mathematical instructional practices they use aligned with those identified by NCTM.

**Table 4.2**

*Responses to Questionnaire Section One: Mathematical Instructional Practices*

<table>
<thead>
<tr>
<th>Items</th>
<th>Participant Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>1. I establish mathematics goals to focus on student learning.</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>2. I use learning progressions, an understanding of how students build on prior knowledge to understand to new concepts, to establish the goals for mathematics instruction.</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>3. I use mathematics goals to guide my instructional decisions.</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>4. I teach using mathematical tasks that promote reasoning and problem-solving.</td>
<td>3 (14%)</td>
</tr>
<tr>
<td></td>
<td>(14%)</td>
</tr>
<tr>
<td>5. I select tasks that promote student discussion of their mathematical reasoning and problem-solving process.</td>
<td>5 (24%)</td>
</tr>
<tr>
<td></td>
<td>(57%)</td>
</tr>
<tr>
<td>6. I select tasks that provide multiple entry points and varied solution strategies.</td>
<td>4 (19%)</td>
</tr>
<tr>
<td></td>
<td>(67%)</td>
</tr>
<tr>
<td>7. I use and connect mathematical representations to the concepts I teach.</td>
<td>8 (40%)</td>
</tr>
<tr>
<td></td>
<td>(55%)</td>
</tr>
<tr>
<td>8. I engage students in tasks that connect mathematical representations to concepts and procedures.</td>
<td>6 (28%)</td>
</tr>
<tr>
<td></td>
<td>(67%)</td>
</tr>
<tr>
<td>9. I facilitate meaningful mathematical discourse as part of instruction.</td>
<td>1 (5%)</td>
</tr>
<tr>
<td></td>
<td>(81%)</td>
</tr>
<tr>
<td>10. I provide opportunities for students to build a shared understanding of mathematical ideas by analyzing and comparing approaches.</td>
<td>4 (19%)</td>
</tr>
<tr>
<td></td>
<td>(57%)</td>
</tr>
<tr>
<td>11. I use purposeful questions that require students to explain and reflect on their answers as part of my mathematics instruction.</td>
<td>5 (24%)</td>
</tr>
<tr>
<td></td>
<td>(67%)</td>
</tr>
<tr>
<td>12. My instructional questions are designed to assess students’ reasoning and sense-making about important mathematical ideas and relationships.</td>
<td>4 (19%)</td>
</tr>
<tr>
<td></td>
<td>(76%)</td>
</tr>
<tr>
<td>13. My instructional questions are designed to advance students’ reasoning and sense-making about important mathematical ideas and relationships. *</td>
<td>3 (15%)</td>
</tr>
<tr>
<td></td>
<td>(70%)</td>
</tr>
<tr>
<td>14. I build procedural fluency from conceptual understanding. *</td>
<td>2 (10%)</td>
</tr>
<tr>
<td></td>
<td>(80%)</td>
</tr>
<tr>
<td>15. I provide my students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships. *</td>
<td>5 (25%)</td>
</tr>
<tr>
<td></td>
<td>(60%)</td>
</tr>
<tr>
<td>16. I assess student progress toward mathematical understanding with evidence of student thinking.</td>
<td>6 (29%)</td>
</tr>
<tr>
<td></td>
<td>(52%)</td>
</tr>
<tr>
<td>17. I adjust instruction continually in ways that support and extend student learning.</td>
<td>13 (62%)</td>
</tr>
<tr>
<td></td>
<td>(33%)</td>
</tr>
</tbody>
</table>

*Note. N = 21. Percentages may not add up to 100 percent due to rounding. * Does not total 21; one participant did not submit a response.*
**Questionnaire Section: Beliefs About Mathematical Instruction**

The next section of the questionnaire consisted of six statements of unproductive beliefs identified by NCTM’s *Principles to Action: Ensuring Mathematical Success for All* (2014). The data were collected from responses to questions 18 through 23. A response of strongly agreed or agreed would align with beliefs that are unproductive for mathematics instruction. Table 4.3 represents teacher beliefs about effective mathematical instruction. When accounting for the strongly disagree and disagree responses, 82% of the participants’ selections regarding their mathematical instructional beliefs aligned with those identified by NCTM as productive. Item 18 had the lowest alignment for productive belief, with 58% of participants indicating disagreement with the statement: Mathematics learning should focus on practicing procedures and memorizing basic number combinations. The highest alignment with productive mathematical instructional beliefs was for items 19 and 22.

**Table 4.3**

**Responses to Questionnaire Section Two: Beliefs about Mathematical Instruction**

<table>
<thead>
<tr>
<th>Unproductive belief item</th>
<th>Participant Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics learning should focus on practicing procedures and memorizing basic number combinations</td>
<td>1 (5%) 8 (37%) 10 (47%) 2 (11%)</td>
</tr>
<tr>
<td>Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.</td>
<td>1 (5%) 14 (63%) 6 (32%)</td>
</tr>
<tr>
<td>Students can learn to apply mathematics only after they have mastered the basic skills.</td>
<td>1 (5%) 7 (32%) 11 (53%) 2 (11%)</td>
</tr>
<tr>
<td>The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use information to solve mathematics problems.</td>
<td>2 (11%) 10 (47%) 9 (42%)</td>
</tr>
<tr>
<td>The role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests.</td>
<td>1 (5%) 12 (58%) 8 (37%)</td>
</tr>
<tr>
<td>An effective teacher makes mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.</td>
<td>1 (5%) 1 (5%) 15 (74%) 4 (16%)</td>
</tr>
</tbody>
</table>

*Note: N = 21. Percentages may not add up to 100 percent due to rounding.*
Instructional Practices Open-ended Response

The first open-ended response of the questionnaire asked participants to share what they perceived to be the most effective instructional practices to teach mathematics in the elementary classroom. Participant responses aligned to the following mathematical teaching practices defined by NCTM (2014): (a) establish mathematics goals to focus learning, (b) implement tasks that promote reasoning and problem solving, (c) use and connect mathematical representations, (d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking (p. 10). Some responses were more detailed than others. Twenty responses had elements that could be aligned with at least one of the eight practices. The intentions for a portion of one of these twenty responses was vague and could not be aligned with mathematical practices. The detail of one response not aligned to any of the mathematical practices stated only, “vocabulary and basic number sense” as the most effective instructional practices to teach mathematics in the elementary classroom.

Mathematics Goals. Five (24%) respondents provided comments that related to the importance of establishing mathematics goals to focus learning for students. These five individuals referred to the importance of practices that build upon a clear understanding of what students should be learning in a lesson and an understanding of how that goal aligns with an appropriate learning progression (NCTM, 2014). One of these teachers stated, “I explain my methods, strategies, and uses in regards to real life. I
explain why it is important for my kids to learn this. I also tell them where it will lead them. They will need to know this information for the future.”

The Promotion of Reasoning and Problem Solving. Four (19%) of the questionnaire participants provided responses that discussed the importance of implementing tasks that promote reasoning and problem solving and pose purposeful questions. Responses aligned to this practice referred to mathematical tasks that promote multiple ways to approach and solve a problem. A comment provided by a respondent declared that during mathematics instruction, “Learners are able to tackle real-life challenges and complex situations that require them to think critically and problem solve practical and logical solutions.” The other response aligned with this practice outlined their plan for effective instruction stating, “The basic steps to teach problem-solving are: what information does the problem give me, what information do I need to find, what's a strategy I can use to solve the problem, attempt solving, and check work.” The third participant stated, “In math... problem-solving...even if they can do simple computations, being able to decide how to solve a problem in math is the most important area I spend my instruction on.” A fourth teacher declared, “As we model and practice solving problems, students are encouraged to share different ways they approach and solve problems. This provides students with a variety of skills to use when approaching a math problem.”

Mathematical Representations. The concept of using and connecting mathematical representations was found in seven (33%) of the participants' responses. Responses included mention of practices that made use of student activities such as making drawings and using manipulatives as ways to help students bridge concepts,
procedures, and tools in order to solve mathematics problems (NCTM, 2014). Mathematical representations were the practice mentioned more often by participants when responding to this open-ended response question. One respondent expressed, “Good mathematical instruction involves use of manipulatives to build concrete experiences, use of drawings to represent ideas, modeling of a variety of problem-solving strategies, as well as discussion of how you arrived at solutions.” A few participants listed what they perceived to be effective instructional practices; however, these were not specifically named by NCTM (2014) as effective practices. These included: “Hands-on activities and games” and “tactile/kinesthetic and visual presentation/practice”

**Mathematical Discourse and Pose Purposeful Questions.** Five (24%) participants mentioned facilitating meaningful mathematical discourse and questioning as effective instructional practices. Teachers listed the practices and structures they implement to help students establish a shared understanding of the mathematical ideas that comprise a learning objective. One of these teachers responded, “…we use a good program, providing many opportunities for students to practice taught skills and strategies. We hold many productive math conversations one on one, in a small group, and the whole group to share our thinking.” A second participant disclosed, “I feel the most effective instruction is during small group instruction. I feel the students can get instruction on their level.” Another respondent mentioned guided math groups as a way to help students share and compare mathematical ideas and, “Student collaboration and generating questions to resolve a problem.”
**Procedural Fluency.** Building procedural fluency from conceptual understanding was referenced in four (19%) of the open-ended responses; one of these participants explained:

The most effective instructional practices start from a concrete example/discussion of the concept, then transition to the representative, then the abstract. The conceptual understanding from this will allow students to comprehend algorithms and other strategies instead of just memorizing. In addition, I think of the content that we teach to be mostly teaching foundational skills and conceptual understandings that the students can then use as a tool kit to approach a problem.

The participants with responses aligned to this practice discussed the importance of students establishing an integrated approach that combines an understanding of mathematical concepts and develops procedural fluency to support learning (NCTM, 2014). A participant referred to National Research Council’s report, Adding it Up (2001), which encompass NCTM’s eight mathematical teaching practices stating:

I believe that most effective instructional practices encompass the five strands of mathematical proficiency (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition). They are interwoven and interdependent - not a one-dimensional trait nor a process that focuses on just one or two of the strands, but powerful, organized, structured understandings that lead to deeper connections.

**Productive Struggle.** Supporting productive struggle in learning mathematics was mentioned in three (14%) of the responses. NCTM (2014) proposed that effective
mathematics instruction should “embrace a view of students’ struggles as opportunities” (p. 48) to build on mathematical concepts and help students bring personal meaning to their learning. One participant elaborated:

The most effective instructional practice in the elementary classroom has nothing to do with math, in my opinion. Being able to read your students’ faces and body language during a lesson is the most important practice. If during a math lesson, I look out across my 4/5 grade students and see fear or confusion, I know I need to take a step back and help them feel more comfortable with manipulating numbers. I feel it is important for my students to be okay playing with numbers and trying new ways of manipulating numbers.

Another participant stated, “I think students need to have productive struggle in math and discussion” adding “…they do need to have an understanding of basic facts as they move forward, but they can still progress without mastery.”

**Student Thinking.** Eliciting and using evidence of student thinking was referenced in three (14%) of the participants’ answers. One of these participants stated, “Justifying and explaining reasoning is more important than the actual answer.” Some of these responses mentioned strategies to assess student understanding. The second participant listed, “Self-discovery, cooperative learning, and guided practice” as structures they use to informally collect evidence of student learning. The final response aligned with this practice provided the steps taken for mathematics instruction and assessing student learning as a cyclical process listing: “Modeling, practice, reteach if needed, problem-solving/application, enrichment, assessment, repeat as needed.”
Results of Research Question Two

The second research question of this study addressed teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom. Data to address this question were collected from the responses of 21 participants during their completion of the demographical information section of the questionnaire and the submissions to the second open-ended response question. These data provide details related to participants’ preparedness to teach elementary mathematics by providing information about years of teaching experience, mathematics coursework, and professional development. Participants’ mathematics coursework and their Likert statement responses concerning effective mathematical instructional practices and beliefs were analyzed to provide data on preparedness to instruct mathematics in an elementary classroom.

Demographic Data

As displayed in Tables 4.4 – 4.6, participants provided their years of mathematical teacher experience, current grade level assigned to teach mathematics, and teaching certification. For this study, as shown in Table 4.4, participants represented a range of years of teaching experience with a majority group of nine (43%) participants representing 6-15 years. Teachers with 0-5 years had the smallest number with two (9%) participants.

Table 4.5 displays demographic data regarding participants’ current grade assigned to teach mathematics. Eight (32%) of participants currently teach mathematics in a fourth-grade classroom. Fifth grade teachers made up the second largest
representation. One first-grade teacher and two kindergarten teachers participated in the study.

**Table 4.4**

*Demographic Data: Participants’ Years of Mathematics Teaching Experience*

<table>
<thead>
<tr>
<th>Number of Years</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>2 (9%)</td>
</tr>
<tr>
<td>6-15</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>16-25</td>
<td>6 (29%)</td>
</tr>
<tr>
<td>26 or more</td>
<td>4 (19%)</td>
</tr>
</tbody>
</table>

*Note. N = 21. Percentages may not add up to 100 percent due to rounding.*

**Table 4.5**

*Demographic Data: Participant Current Grade Assignment to Teach Mathematics*

<table>
<thead>
<tr>
<th>Grade Taught</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>2 (8%)</td>
</tr>
<tr>
<td>First Grade</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>Second Grade</td>
<td>3 (12%)</td>
</tr>
<tr>
<td>Third Grade</td>
<td>4 (16%)</td>
</tr>
<tr>
<td>Fourth Grade</td>
<td>8 (32%)</td>
</tr>
<tr>
<td>Fifth Grade</td>
<td>7 (28%)</td>
</tr>
</tbody>
</table>

*Note. Number of participants = 21, number of responses = 25. Four participants indicated an assignment to teach more than one grade level.*

Table 4.6 displays demographic data for participants’ current certification. Four of the participants indicated they held more than one teacher certification; however, none of the participants indicated that they held a specific mathematics certification. One participant indicated that their only certification was in Middle-Level Science (grades seventh through ninth grade). Teachers holding a certification in Elementary Education K-6 (kindergarten through sixth grade) had the largest percentage (40%) of participation in this study.
Table 4.6

Demographic Data: Participant Current Certification

<table>
<thead>
<tr>
<th>Certification</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Education K-8</td>
<td>3 (12%)</td>
</tr>
<tr>
<td>Elementary Education K-6</td>
<td>10 (40%)</td>
</tr>
<tr>
<td>Grades 4-8 (4-6, Mathematics 7-8)</td>
<td>0</td>
</tr>
<tr>
<td>Grades Pre-Kindergarten – 4</td>
<td>7 (28%)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (20%)</td>
</tr>
<tr>
<td>Specific mathematics certification</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Number of participants = 21, number of responses = 25. The other certifications were Middle-Level Science 7-9, Special Education K-8, and Special Education K-12. Four participants held more than one teaching certification.

Teacher Preparedness

The data presented in Table 4.7 reports participants’ undergraduate-level and graduate-level mathematics coursework. One participant indicated that they did not have mathematics coursework during their pre-service training. Nine teachers reported that they had one to two mathematics courses at the undergraduate level and 11 teachers reported that they had three to four mathematics courses at the undergraduate level. Twelve participants had no graduate-level coursework in mathematics and nine indicated that they had at least one course in mathematics beyond their graduate-level studies.

Table 4.7

Mathematics Coursework Taken by Participants

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Number of courses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Undergraduate level (pre-service)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Graduate level</td>
<td>12 (57%)</td>
</tr>
</tbody>
</table>

Note: N = 21. Percentages may not add up to 100 percent due to rounding.

Table 4.8 presents data about participants’ preparedness to teach mathematics by displaying a comparison of the amount of their mathematics coursework and questionnaire responses about effective mathematics instructional practices. Considering
participants’ undergraduate-level coursework and response agreement with questionnaire items 1 to 17, the one participant who did not indicate that they had taken courses in mathematics had 100% alignment. The 95% average alignment of responses for the nine participants who had taken one to two undergraduate mathematics courses was higher than the average response of 85% for the eleven participants who took three to four undergraduate courses. The average response agreement alignment for the 12 participants who had taken no graduate-level coursework was 85%. Participants who had taken at least one graduate-level mathematics course had a higher average response agreement than those participants who had none. The response agreement for the six participants who had taken one to two graduate-level mathematics courses was 98%. The remaining groups, who had taken three to four, or more than four, mathematics courses, had a response agreement of 100%.

Table 4.9 compares the amount of participants’ mathematics coursework and their responses about NCTM’s beliefs about teaching and learning mathematics (2014). This data presents a congruence of participants’ beliefs between effective mathematics instruction and their preparedness to teach mathematics. The beliefs about mathematical instruction questionnaire items were stated as unproductive beliefs. Using a Likert scale response, participants’ disagreement with an item indicated that the belief was considered unproductive (NCTM, 2014). Across all levels of coursework, responses to items 18 and 20 had the lowest alignment with productive beliefs. Examining the number of undergraduate-level coursework and productive beliefs, the one participant who had taken no undergraduate-level courses in mathematics averaged the same 83% alignment as the nine participants who had taken one to two undergraduate mathematics courses.
The eleven participants who indicated they had taken three to four undergraduate courses in mathematics had an average of 82% positive alignment with productive beliefs for instruction. Considering the number of graduate-level courses in mathematics, the responses were evenly split for the one participant who had taken more than four mathematics graduate-level courses with half of the responses aligned with productive beliefs. Six participants indicated they had taken one to two graduate-level courses in mathematics and their average alignment of 84% was higher than the 75% response alignment for the two participants who had taken three to four graduate-level courses. The 12 participants who had taken no graduate-level courses averaged an 82% alignment with beliefs that were productive for teaching and learning mathematics.

Table 4.10 displays data regarding participants’ perception of their preparedness to instruct mathematics in an elementary classroom through professional development opportunities centered on mathematics. All participants indicated that they were provided professional development opportunities in mathematics that were endorsed by their school districts. Sixteen (76%) participants shared that for the past five years there have been four or more of these district provided opportunities for professional development for them in the area of mathematics. When asked the number of mathematic professional development opportunities (for example, conferences or workshops) they had in the last five years pursued on their own, independent of a school district, 13 (62%) of the participants reported that they had not personally pursued professional development opportunities focused on mathematics. Seven teachers shared that they had one to two professional development opportunities not provided by their school district, no teacher reported undertaking three to four independent professional growth opportunities. One
teacher had personally pursued more than four professional development opportunities in mathematics.

Table 4.11 displays the alignment of participants’ preparedness with professional development opportunities centered on mathematics and their beliefs about how mathematics is taught and learned. The items provided in the questionnaire were referred to as unproductive beliefs according to NCTM’s *Principles to Actions: Ensuring mathematical success for all* (2014). The three participants who had one to two district-endorsed professional development opportunities had an average alignment of 78% with productive beliefs about mathematics instruction compared to an average alignment of 81% for the 16 participants who had more than four professional development opportunities in mathematics that were provided by their school districts. Two teachers indicated participation in three to four district-provided opportunities and their responses were 100% aligned with productive beliefs. When asked their degree of agreement with the mathematical instructional belief items, the 13 participants who had not pursued professional development on their own averaged an 85% alignment with beliefs that were productive. Averaging an 88% agreement alignment, seven respondents shared that they had one to two mathematical opportunities on their own. The one participant who personally pursued more than four professional development opportunities independent of their school district had a productive belief alignment average of 33%.
Table 4.8

Participant Amount of Mathematics Courses Compared to NCTM Instructional Practices

<table>
<thead>
<tr>
<th>Items</th>
<th>Undergraduate-level courses</th>
<th></th>
<th>Graduate-level courses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 courses</td>
<td>1-2 courses</td>
<td>3-4 courses</td>
<td>0 courses</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>1. I establish mathematics goals to focus on student learning.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>2. I use learning progressions, an understanding of how students build on prior knowledge to understand to new concepts, to establish the goals for mathematics instruction.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>3. I use mathematics goals to guide my instructional decisions.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>4. I teach using mathematical tasks that promote reasoning and problem-solving.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>5. I select tasks that promote student discussion of their mathematical reasoning and problem-solving process.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>6. I select tasks that provide multiple entry points and varied solution strategies.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>7. I use and connect mathematical representations to the concepts I teach.*</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>8. I engage students in tasks that connect mathematical representations to concepts and procedures.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>9. I facilitate meaningful mathematical discourse as part of instruction.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>10. I provide opportunities for students to build a shared understanding of mathematical ideas by analyzing and comparing approaches.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>78</td>
</tr>
<tr>
<td>11. I use purposeful questions that require students to explain and reflect on their answers as part of my mathematics instruction.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>12. My instructional questions are designed to assess students’ reasoning and sense-making about important mathematical ideas and relationships.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>13. My instructional questions are designed to advance students’ reasoning and sense-making about important mathematical ideas and relationships.*</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>14. I build procedural fluency from conceptual understanding.*</td>
<td>1</td>
<td>100</td>
<td>8</td>
<td>88</td>
</tr>
<tr>
<td>15. I provide my students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.*</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>16. I assess student progress toward mathematical understanding with evidence of student thinking.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>17. I adjust instruction continually in ways that support and extend student learning.</td>
<td>1</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
</tbody>
</table>

Note. N = 21. Percentages may not add up to 100 percent due to rounding. *Reflects one participant did not submit a response.
### Table 4.9

**Participant Amount of Mathematics Courses Compared to Unproductive Beliefs about Mathematical Instruction**

<table>
<thead>
<tr>
<th>Unproductive belief items</th>
<th>Undergraduate-level courses</th>
<th>% of Participant disagreement with unproductive belief item</th>
<th>Graduate-level courses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergraduate-level courses</td>
<td>0 courses</td>
<td>1-2 Courses</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>18. Mathematics learning should focus on practicing procedures and memorizing basic number combinations</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>19. Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.</td>
<td>1</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>20. Students can learn to apply mathematics only after they have mastered the basic skills.</td>
<td>1</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>21. The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use information to solve mathematics problems.</td>
<td>1</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>22. The role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests.</td>
<td>1</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>23. An effective teacher makes mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.</td>
<td>1</td>
<td>100</td>
<td>8</td>
</tr>
</tbody>
</table>

**Note.** N = 21. Percentages may not add up to 100 percent due to rounding.

### Table 4.10

**Participant’s Mathematics Professional Development Opportunities**

<table>
<thead>
<tr>
<th>Opportunity type</th>
<th>Number of opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>District endorsed professional development opportunities</td>
<td>0</td>
</tr>
<tr>
<td>Personally pursued professional development opportunities</td>
<td>13</td>
</tr>
</tbody>
</table>

**Note.** N = 21.
Table 4.11

Amount of Participants’ Professional Development Opportunities Compared to Unproductive Beliefs about Mathematical Instruction

<table>
<thead>
<tr>
<th>Unproductive belief items</th>
<th># of PD opportunities and % of Participant disagreement with unproductive belief item</th>
<th># District endorsed professional development opportunities</th>
<th># Personally pursued professional development opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-2 n %</td>
<td>3-4 n %</td>
</tr>
<tr>
<td>18. Mathematics learning should focus on practicing procedures and memorizing basic number combinations</td>
<td></td>
<td>3 67</td>
<td>2 100</td>
</tr>
<tr>
<td>19. Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.</td>
<td></td>
<td>3 100</td>
<td>2 100</td>
</tr>
<tr>
<td>20. Students can learn to apply mathematics only after they have mastered the basic skills.</td>
<td></td>
<td>3 67</td>
<td>2 100</td>
</tr>
<tr>
<td>21. The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use information to solve mathematics problems.</td>
<td></td>
<td>3 67</td>
<td>2 100</td>
</tr>
<tr>
<td>22. The role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests.</td>
<td></td>
<td>3 67</td>
<td>2 100</td>
</tr>
<tr>
<td>23. An effective teacher makes mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.</td>
<td></td>
<td>3 100</td>
<td>2 100</td>
</tr>
</tbody>
</table>

Note: N = 21. Percentages may not add up to 100 percent due to rounding

Preparedness Open-ended Response

The second open-ended response items of the questionnaire asked participants to consider the factors that contribute to their preparedness to teach mathematics in the elementary classroom. These data present themes from participants’ responses aligned with topics presented in Chapter Two of this study related to the following aspects of teacher preparedness: pedagogical content knowledge and mathematical content knowledge, pre-service teacher programs, and in-service professional development.

Pedagogical Content Knowledge and Mathematical Content Knowledge.

Several open-ended participant responses indicated an understanding of students’ mathematical thinking and the use of effective practices to teach mathematics as factors
that contribute to their preparedness to teach mathematics in the elementary classroom.

Eight (38%) participants indicated that their pedagogical content knowledge and mathematical content knowledge were factors that supported the instruction that they provided students. In discussing preparedness, one respondent explained:

Previewing the content, understanding the content by seeing how it connects to the previous information taught, experience...you just simply need to teach it over and over and over again before you are truly prepared. I have been teaching from the same book now for over seven years and I am still finding better ways to explain the concepts and relate or tie together concepts for better understanding that students are more apt to retain.

Another participant shared:

I look at the data I collect and formative information I gather from working with students and talking about the math with them to determine what instructional approach needs to be taken to continue their progression, but also what adjustments I might need to make to future lessons to provide the scaffolding they need to be successful. I also look at the learning goal for each lesson and what scaffolding I might need to do to support students who may struggle with the lesson. I look for ways I might make the lesson more engaging, or differentiated as well for students of all learning levels in the classroom.

One participant indicated the importance of pedagogical content knowledge and mathematical content knowledge as factors in their preparedness; but, they did not make known how that preparedness was achieved, disclosing:
Factors that contribute to my preparedness in teaching mathematics include: developing a deeper understanding as to how to assist students in thinking critically, struggling or grappling with ideas instead of jumping in and telling them what or how to do things, providing real-life purpose or understanding; why we are doing what we are doing or learning what we are learning, seeking better ways to enhance students' understanding, analyzing areas of student weakness and ways to facilitate learning to create meaning and form deeper connections; providing multiple opportunities for exploration and student-led conversation to enhance learning; and seeking appropriate materials - including digital and physical forms - for application of knowledge/skill.

Four (19%) participants’ responses reflected a lack of pedagogical content knowledge and mathematical content knowledge in their preparedness. One of these participants’ responses about the factors that contribute to their preparedness to teach mathematics was posed as a question asking, “Reading the manual?” One respondent shared that they considered what “they (students) will be tested on” as a factor that contributes to their preparedness to teach mathematics. Another participant whose response indicated a lack of pedagogical content knowledge and mathematical content knowledge in their preparedness stated:

Factors that contribute to my preparedness would be memories of my childhood fears related to math. I did not become a math teacher because of my love of numbers. I became a math teacher because that is what I was asked to do. I am always thinking to myself, "Why do we need to know this information or this step?" when I am looking at a math lesson.
One participant’s response implied that the lower level of cognitive demand for mathematics content in the elementary classroom was a factor for their instruction, as follows, “Since I teach elementary education, past work and training are sufficient in aiding me to teach the math concepts we cover.” This participant’s response did not mention an understanding of the elementary-level students’ mathematical thinking or the use of effective practices to teach mathematics.

**Pre-service Teacher Programs.** Pre-service teacher programs were discussed by four (19%) participants, a few mentioning specific aspects of their undergraduate degree coursework that supported their preparedness to teach mathematics. One participant expressed difficulty applying undergraduate coursework to their current position disclosing:

> In my undergraduate degree, I was taught best practices for teaching in a way that students will develop math sense, understand concepts, and can apply problem-solving skills. However, those best practices did not come with the accompanying resources/lesson plans/textbooks. I feel that I personally understand what good instruction SHOULD look like, but I feel underprepared to provide it based on the resources easily at my disposal.

Another teacher referenced the practices learned during their pre-service program stating, “I know from my preservice courses in college that concrete and pictorial representations are important. That hasn't changed in 27 years of teaching.”

**In-service Professional Development.** In-service professional development was mentioned by four (19%) participants as a factor that facilitated their preparedness. A participant’s response indicating that their understanding of effective instruction came
from the school district declaring, “We only know what’s most important because someone is coming and holding PD for us to learn it.” One teacher mentioned learning communities and district mathematics coaches as facilitators sharing, “My district’s math coaches provide excellent workshops that keep my instruction current and relevant.”

One participant indicated that a personal choice for professional development has been a factor in their effectiveness in teaching mathematics stating:

I also earned a STEM endorsement on my master’s degree that further opened my mind to the idea that math is a SOCIAL subject, pushing memorization of formulas and procedures does NOT equal effective teaching, fast fact reciting does NOT (always) equal conceptual understanding, and helping students learn that “struggle time” is where the learning happens. Good math instruction should help students learn to be problem solvers.

Another participant’s personal choice for professional development contributed to their ideas regarding effective instruction sharing, “I try to stay informed of the best practices through educational communities.”

Fourteen (67%) of the participants provided answers that did not indicate a formalized professional development plan. Some respondents’ statements exemplify the lack of a formal plan to extend knowledge of mathematics instructional practices. One participant shared, “I use my own trial and error of how I feel that math instruction should go. I also talk with my grade level teachers to brainstorm ideas on instruction.”

Another respondent stated that when they need instructional guidance they consult with a “colleague who really likes teaching math”, another respondent expressed that to grow
professionally they use their “many years of experience and willingness to continue to learn.”

**Results of Research Question Three**

The third research question examined what factors teachers perceive to influence the practices selected for mathematics instruction in the elementary classroom. One of the open-ended response questions and the 12 interview questions provided data about the teacher-identified factors, both the barriers and the facilitators, that influence the practices selected for mathematics instruction. Interview questions used the essential elements of a mathematics program identified by NCTM (2014): (a) access and equity, (b) curriculum, tools, and technology, (c) assessment, and (d) professionalism. These elements can be influenced by factors that are conceptual, pedagogical, political, and cultural.

**Open-ended Responses: Factors Influencing Instructional Practices**

The third open-ended response of this study’s questionnaire asked participants to share information about the factors that influence their selection of mathematical instructional practices used in the classroom. These data present themes from participants’ responses aligned with topics presented in Chapter Two of this study related to the factors, both barriers and facilitators, for the implementation of effective mathematics instructional practices in the elementary classroom. The essential elements of a mathematics program are identified by NCTM (2014) as: (a) access and equity, (b) curriculum, tools, and technology, (c) assessment, and (d) professionalism. Data collected from the third open-ended question include participants’ responses related to the essential
elements of a mathematics program and organized according to factors that are conceptual, pedagogical, political, and cultural.

**Conceptual Factors.** Conceptual factors impact a teacher’s ability to understand and apply theories of mathematical learning (Corkin et al., 2019). Professionalism is an essential element of a mathematics program that can be influenced by conceptual factors (NCTM, 2014). The area of professionalism was indicated in five (24%) of the responses. Professional development opportunities were cited as factors and ranged from those that were district, mathematics coaches, or mentor teacher provided. One of the participants stated,

The factors that influence the practices I select for mathematics instruction in my classroom include professional development experiences, research I have done on my own - my own learning and development, coaching opportunities provided by a district-hired curriculum coach, and some undergrad/graduate experiences.

Two participants indicated that the time constraint factor, for planning and delivering instruction, created an obstacle to the success of their mathematics program. One participant explained:

I often select practices that are most readily available, using the questions/examples from a textbook, and the manipulatives provided by the purchased program. I attempt to adapt those to provide more scaffolding or more problem solving, but planning time does not always allow for hours spent in improving the quality of my instruction. I have a more experienced coworker who has great problem-solving/math sense resources that I will use, but those are additional, not the core of my instruction currently.
**Pedagogical Factors.** A teacher’s ability to align effective mathematical instructional practices with curriculum materials and programs can be influenced by pedagogical factors. Curriculum, tools, and technology are essential elements of a mathematics program that can be impacted by pedagogical factors (NCTM, 2014). One participant’s open-ended response did not elaborate enough to interpret if the individual used students’ mathematics thinking and effective mathematical instruction, stating only, “I follow the curriculum pacing guide provided by my district.” The data collected during this study presents participating teachers divided on whether a district purchased mathematics program was a facilitator or obstacle to effective mathematics instruction. One respondent stated:

In my district, my practices for math instruction do not matter. We were instructed to teach the purchased math program as it is designed. We are not to vary from the program. This is extremely frustrating as the math program does not allow for students who experience extreme challenges in understanding number concepts.

A different participant, providing the point of view of the facilitator for the supportive nature of the district purchased mathematics program, stated:

My district provides a textbook series and its supporting materials. I know through workshops (also provided through my district's math coaches) that there are many online resources, such as Study Island, Exact Path, Khan Academy, and EdPuzzle, that can support and complement my classroom instruction. For me, the resource should be approved by my district.
When considering factors that influence their practice, six (29%) of the participants submitted responses that included curriculum, tools, and technology elements when discussing a purchased mathematics program, the district’s curriculum, and mathematical standards. One teacher mentioned manipulatives as a factor for mathematics instruction. Only one participant specifically mentioned technology as a facilitating factor.

**Political Factors.** Mathematics instruction and the availability of instructional resources to deliver effective instructional practices can be influenced by stakeholder groups, district politics, or policies (Corkin et al., 2019). Assessment is an essential element of a mathematics program that can be impacted by political factors (NCTM, 2014). The factor of assessment was discussed in one of the respondent’s answers. This participant stated, “Looking over the data that I collect as I instruct the class can help me determine what I will teach next and what learning methods I need to employ in order to help the students reach the learning goal of the lesson.” No participant indicated that large-scale testing was an influence regarding the mathematical instructional practices they selected. A participant included the word “standards” in a list of the factors that influence the practices selected for mathematics instruction in the elementary classroom.

**Cultural Factors.** Cultural factors are barriers or facilitators that are created outside the classroom but can affect the effectiveness of mathematics instruction (Corkin et al., 2019). Access and equity, an essential element of a mathematics program, can be influenced by cultural factors (NCTM, 2014). Cultural factors may include cultural exclusion, poverty, students’ mathematical identity, and parent and student perceptions of mathematics instruction.
Eleven of the 21 responses (52%) mentioned cultural factors. One participant mentioned classroom demographics as a factor, referring to the number of students receiving learning support or gifted services, sharing, “The factor that influences my practices is the demographics of my class. I have EL (English learners) students, learning support students, and possibly enriched students. I need (the practices) to be sure my preparedness and practices align with each learning need.” Four (19%) participants referenced classroom dynamics, student relationships with one another, and student behavior as factors that influence the practices chosen to teach mathematics. Five participants (24%) provided responses focused on students as a factor in their selection of mathematics instructional practices. Responses mentioned factors such as “student readiness” and “student needs/strengths.” One of these participants stated, “I need them (practices) to be engaging for my students, challenging but not too challenging, needs to meet the needs of ALL students, shows multiple perspectives, leads to discussion and good math arguments!” Another participant shared, “Students’ prior knowledge can sometimes affect the way I guide the instruction in the classroom.” A participant shared obstacles for mathematics instruction centered on students stating factors of “student strengths and weaknesses, factors that might impede instruction (ex. learning disability, behavioral issues)” as influencers for the practices they select. When providing an open-ended response, no participant referenced factors influenced by cultural exclusion, poverty, COVID-19, student mathematical identity, or parent perceptions when considering mathematical instructional practices in their elementary classroom.
**Participant Interview**

Two participants who originally volunteered to answer the questionnaire and the open-ended responses took part in a 12 question interview. The interview intended to submit data about teacher-identified factors that influenced the practices selected for instruction in the elementary mathematics classroom. As presented by the open-ended response data of this study, the interview data also revealed that factors for effective mathematics instruction are influenced by conceptual, pedagogical, political, and cultural matters. Interview questions were developed using the essential elements of (a) access and equity, (b) curriculum, tools, and technology, (c) assessment, and (d) professionalism identified as the essential elements of a mathematics program by NCTM (2014). An additional researcher created question addressed teacher perception of the factors that resulted in the mathematical success of students. Questions were posed in a pattern that asked participants first to identify factors that were facilitators and then identify factors that were obstacles.

**Access and Equity.** Question one asked participants to consider their mathematical instruction practices and identify the factors that facilitate equity and access for students. Both interviewees referred to structures provided as part of the school district’s mathematics program as a facilitating factor for providing equity and access. Interviewee two stated:

The school district model for math instruction is a shorter direction to the whole class and then smaller group instruction with kids being collaborative. I'm not always successful at implementing that every day the way it technically should look, but because I know that that's the goal. That's what I'm striving for. I think
that is more beneficial for my kids, especially from an equity and access standpoint. I know who my lower kids are and who my higher kids are.

Interviewee one explained that technology helps to customize instructional content for students sharing details about one program the teacher uses for practicing problems “…after every single question, it will tell them if they're right or wrong. If it's wrong, it will tell them why. There’s like a little box that will give them a hint.” Referring to student absences resulting from the COVID-19 pandemic, this teacher shared that technology made learning accessible, “When there are quarantines, computers are a really nice way to get kids practicing the skills I need them to.”

Question two asked what factors are obstacles to equity and access for students. Interviewee one shared that the staff working as assistants in the classroom often don't have the MKT to support the learners at the appropriate level of learning. Although the mathematics program can be a facilitator, this teacher shared that it can also be an obstacle to equity and access due to its rigid nature and repetitive routines that can result in student boredom and an inability to respond to individual student needs. Interviewee two shared a similar response regarding the mathematics program being an obstacle to access and equity for mathematics students:

The program that we have been provided to use that was like supposed to use as a school; it’s not terrible. It, you know, it's like pretty OK. However, my ideals of what it could look like are better than what it is, but because of the time it would take to do the prep that would make it go into a deeper level of knowledge or the things that would make it more accessible to my English language learner students make the kind of additional pressure on top of the core math book that
we were given as a grade level. As a newer teacher, I am scrambling just to get anything done, and so frequently, I fall back on the program.

Curriculum and Instruction. Question three asked participants about the factors that facilitate high-quality mathematics instruction. Interviewee one discussed curriculum and the structure of mathematics teaching, mentioning guided math and rotating students groups through three different stations. One example of the station work used was a video made for each topic that students can view independently; another station was instructional time with the teacher. Interviewee two focused most of the response on the guidance they received from a grade-level colleague:

She understands a lot of those things that I desire to be doing really effectively. I get stuff from her all the time, but it's not like every single day; every single lesson I teach is high rigor and high-quality. It's kind of just like, let me sprinkle in that higher quality higher-level thinking.

Question four asked about the obstacles to high-quality mathematics instruction for students. Interviewee one shared that student grit and lack of perseverance are obstacles to high-quality mathematics instruction, stating that students “...want me to sit next to them and walk them through every single thing. They will literally just say, ‘I am dumb,’ ‘I don't get it,’ or ‘I can’t,’ and this is for all levels of learners.” This interviewee mentioned the COVID-19 pandemic in the discussion of obstacles to high-quality instructions but indicated concern that due to the pandemic, students are being passed along despite their lack of mathematical understanding, sharing:
I think a lot of these kids were given information or given a grade or given whatever they needed to make it look like they understood, and then that was it. I thought about it, and some of the kids were never forced to work yet.

Interviewee two shared that their teaching knowledge of different methods to help the students approach the work of mathematics is an obstacle stating, “Sometimes I do feel like I'm stuck, and I'm like OK I've been trying to explain this principle, and I don't know what else to do. So that sometimes is a struggle.” This teacher continued by explaining:

My teacher training was heavily focused on inquiry-based methods, and I felt really that was beneficial because I feel like I have a strong grasp of the fact that for kids the standard algorithm does make sense if you ground it in the concrete, then the representational, and then the abstract process of teaching. But I feel like it (teacher training) underprepared me because it doesn't match any of the resources I'm using. So I'm trying to take resources that are very explicit with direct instructions and apply the math practice that kids understand a standard algorithm way much more if you ground it in stuff they do understand. I feel like I'm trying to marry those two things, and I feel like I just can’t. I think that is where I feel like planning and preparation are what I'm lacking. If I had one million years, I could take the math test and the math problems that I've been given in the textbook, and then I could do it this cool fancy, new-fangled way that I learned in college, but I don't have time.

**Tools and Technology.** Question five asked participants the factors that facilitate the use of mathematical tools and technology. Interviewee one shared that each student having a technology device was a facilitator allowing the teacher to enhance instruction
using web-based tools such as Edpuzzle and Nearpod. Interviewee two also mentioned the benefits of technology for mathematics instruction, referring to the use of screening tools that help address students’ needs stating that with the use of these digital tools, “I can go back and look at that data and kind of see where they're getting stuck or see where there are holes.” This teacher shared that the district’s mathematics program came with manipulatives; the mathematics coaches in the school district helped support the implementation of these teaching tools.

In response to question six about the obstacles to using mathematical tools and technology for students, both interviewees agreed that there are too many technology resources from which to choose and that technology is often overused by the teacher. Interviewee two explained:

I think that I tend to fall back on that (use of technology) more frequently than I would like because I do meet with math groups, but it's not every single kid every single day. So there are some kids who were just spending a large chunk of their math time on that technology which I think is beneficial, but I don't think it's as beneficial as if I didn't have the technology and I was prioritizing making sure I got to see all the groups.

Interviewee one discussed that obstacles to using manipulatives as a tool for instructions are lacking of training and knowledge of how to use them. No training has been provided. The obstacle of time was identified as a barrier to using mathematical tools and technology for students during both interviews, A teacher shared that there is not enough time to figure out how to use the available instructional technology and tools. Interviewee one shared, “There is never enough time in a teacher’s day, never.”
**Assessment.** Question seven required participants to share the factors that facilitate the use of assessment. Both interviewees mentioned using common assessments across an entire grade level as a benefit. These assessments were part of the mathematics program, but a few were developed by curriculum committees. Interviewee two shared that these common assessments are “...important so that we can have a standardization of everybody having the same expectations and standards.”

Question eight addressed obstacles to using assessment as part of effective mathematics instruction. Interviewee one discussed relying more on formative assessments to collect data on students' understanding of mathematical concepts than on data from common district assessments, stating:

Those (common) tests we're told we are not allowed to modify, and we just print them out and give them. I think it stinks because I feel like I should be able to decide for my kids, like use my professional judgment to box in something for them or provide a tool like for the learning support kids.

Interviewee two expressed frustration with a district-mandated common assessment responding:

It (the test) does show me which kids need more help, but it doesn't show me where they need their help. It's not an error analysis. It's just “this kid got five problems done in two minutes” and “this kid got 60 problems done in two minutes.” One of those kids needs more help, but then you're like, OK, and then what? Are they struggling because they're still using their fingers to count? Some of that I can see visually, but it's not all anecdotal.
Interviewee two expressed that compared to English language arts (ELA), mathematics did not have enough assessment opportunities explaining:

In ELA, we have a plethora of resources that we can use to screen and then progress monitor and then do interventions for kids with reading, and I only have the math test, and I've got the formative assessments that I give during the week.

**Student Mathematical Success.** Question nine addressed the factors that facilitate the students' mathematical success, and the two interviewees referenced student perceptions of ability in their responses. Interviewee one emphasized the importance of building student confidence in their mathematical identity, stating:

Confidence. They have to be told they can do it, and then they are more apt to be successful. I have multiple students. I say, “Wow, you're such a mathematician.” They honestly are like, “me?” and “OK, yeah.” I believe that they may work harder.

This interviewee elaborated on small group instruction and peer interactions as other factors that can facilitate mathematical success for students sharing:

I do think that working one on one or a small group as possible is very helpful. It is easy for a group of five or even like six sometimes. Even for a kid at the back of the room who appears to be working but not really engaged. When the test comes, they get something wrong, and I am like, “How did you miss that?” It is because they're just cruising. So I feel like I like that one-on-one or just like close check-in is helpful to support. Confidence and peer coaching -I think peer coaching is amazing.
Interviewee two mentioned the use of Responsive Classroom (2022) and the Growth Mindset (Dweck, 2006) as helpful tools for creating a classroom culture conducive to student success. This interviewee provided an example of this culture, stating:

There isn't shame or embarrassment if a kid makes a mistake. That not only makes it so that the kids are making mistakes and learning, but it makes the lesson go a lot faster. I'm not just like sitting there, and there's crickets because even if the kids don’t really know an answer, they'll still raise their hand, right? So I have people to call on.

Interviewee two continued:

I feel like just the culture of mistakes is useful and a beneficial part of life. It’s to the point where I'll make a mistake, and my kids will be like, “You're not perfect either. You make mistakes too.” And I say, “You are correct.”

Question ten addressed the obstacles to the mathematical success of the students. Interviewee one discussed factors of poverty, parental support, and student trauma as obstacles. This teacher stated:

We have pretty, really low income (families) and not a whole lot of parental support. I can tell you every single child in my class this year has a high ACE (Adverse Childhood Experiences) (Centers for Disease Control and Prevention, 2022) score. They have trauma. I think kids have so many other things to worry about or think about or go home to that they can't even worry about the math. It isn’t that they don’t care about math because they can't care, like they're too worried about what’s next.
Interviewee two discussed their ability to increase student engagement as an obstacle to students’ mathematics success, sharing:

I do think that one of my current biggest issues is engagement. Having a shorter lesson and then going to small groups does help with that. I'm not expecting seven and eight-year-olds to sit there and stare at me for forty-five minutes. When I am doing lessons that is problems in the book, that's not nearly as engaging as some of the more hands-on, get up out of your seat activities.

**Professionalism.** Question eleven asked participants what factors facilitate professional growth. Professional growth can come from district-provided opportunities or pursued by the individual independent of a district initiative. Interviewee one shared that experience; teaching the same content material every year has helped their professional growth, stating:

I am able to see how the topics connect, and I also feel like I'm much better at answering the question, “Why do we need to know this?” because a lot of kids at the beginning of my career would ask why we need to learn this and I honestly didn't know. I was like, I don't know because it is in the book and I have to teach it.

The second interviewee again referred to colleagues as facilitators, this time related to the professional growth sharing:

I have my co-teacher and grade level teachers who are good at what they do. Literally, sometimes I just walked into a teacher’s room at the end of the day, and I'm like, ‘Hey, I can't figure out how to get my kids to do regrouping with double-
digit addition. They're (the students) not grasping the concept of using the manipulatives, and it's not working for some of my kids.

Colleagues support the teacher by providing examples of how they teach the concept so that the teacher can go back to the classroom and use another method. Interviewee two concluded the answer by expressing, “I feel so lucky to be on the team.”

Question twelve of the interview asked about the obstacles to professional growth impacting the effective teaching and learning of mathematics; once again, time was a factor. The interviewee discussed access to many resources and ideas about what is a best practice. Interviewee one shared that there is not enough time to figure out the best instructional practices for students, especially if you have a family, concluding by stating:

All the new teachers that come in (the district), I guarantee you do not have a special team that's going through teaching them how to use the manipulatives, math books, or the math program. I have so many different things that I want to use, but I don't know how to schedule them into 90 minutes.

Interviewee two expressed that they lack the pedagogical knowledge to teach children effectively as a new teacher. They disclosed:

More often than not, when I watch other teachers teach, when I observe them in order to be a better teacher, I technically knew what was a good way to teach a concept, but I just don't have it in my bones, right? Like that's not the way that I automatically come out when I'm doing a math lesson. It's not something that is innate because I've done it and done it and done and done and done. I feel like each time I teach a lesson, I’m just winging it. Even if I have a really good lesson plan there's a level of like I have never taught this before being so new.
Sharing that their school district provided professional development opportunities that include the observation of experienced teachers, interviewee two added the difficulty with applying what is observed into their practice sharing:

So I do really enjoy watching other teachers teach different content, and I have gotten a lot of benefit from that. That is something that my school district does help with, but when I have to put it into my practice, I think that is the harder step in the process.

Interviewee two shared that district-wide professional development does not often emphasize mathematics even when there are opportunities that offer teacher choice. The interviewee doesn’t prioritize going to the mathematics professional development because there are other more pressing aspects of teaching.

**Summary**

Chapter four presented data from 21 elementary level teachers of mathematics who volunteered to answer Likert-scale and open-ended response items. Two of the participants volunteered to participate in a 12-question interview. All questions were related to the study. The purpose of this study was to examine how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematical instruction in the elementary classroom. Chapter four presented themes related to the three researcher-designed questions that guided this study. In addition to a summary of the research and results of this study, Chapter five will provide recommendations for further related research.
Chapter Five – Discussion

Summary of the Study

The purpose of this qualitative research study was to examine how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematical instruction in the elementary classroom. Twenty-one kindergarten through fifth-grade public school teachers participated in this study. Participants are teachers from two suburban school districts in Central and South-Central Pennsylvania. The participants completed an online questionnaire and a series of open-ended questions using Google Forms. Open-ended questions provided clarification for participants’ questionnaire response intent. An interview was presented as an option for participants during the completion of the questionnaire tool; two participants volunteered to take part in individual interviews using the remote web-based video-conferencing format, Zoom. Data analysis in this study examined the triangulation among the information gathered from questionnaire data, open-ended response items, and interviews. Summarized and reported in Chapter Four, data were analyzed for themes, patterns, and discrepancies related to the three research questions of this study and the literature. Chapter Five will discuss findings and inferences related to the study.

Summary of the Results

Data were collected for this study using a questionnaire focused on teacher preparedness to instruct mathematics in the elementary classroom. Likert scale questionnaire statement responses gathered data about teacher perceptions regarding the most effective instructional practices to teach mathematics. Answers to the three open-ended questions provided data that expanded participants’ questionnaire responses.
Voluntary participant interviews contributed to data regarding teacher perceptions about the factors that influence the practices selected for mathematics instruction in the elementary classroom.

**Teacher Perceptions Regarding the Most Effective Mathematics Instructional Practices**

The first research question of this study collected data about teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom. Analysis of the responses to the instrument’s items revealed themes related to these teacher perceptions. In examining participants' item responses for section one of the questionnaire regarding their mathematical instructional practices, this study found a 90% alignment between the participants’ responses and the effective instructional practices identified by NCTM (2014).

An evaluation of the Likert scale response data found that 100% of the participants strongly agreed or agreed with the instructional practice to establish mathematics goals that focus on student learning. This practice included using learning goals and progressions to understand how students build on prior knowledge in order to learn new concepts and guide instructional decisions regarding mathematics (NCTM, 2014). Despite participants’ strong agreement with this area, the researcher’s further analysis of data from the questionnaire, section one, found responses that indicated a discrepancy for some practices that help support the establishment and use of mathematics goals. One example of the misalignment related to practices that facilitate meaningful mathematical discourse (NCTM, 2014). The discrepancy included the item with the highest individual discrepancy for five (24%) participants who disagreed with
the practice to provide opportunities for students to build a shared understanding of mathematical ideas. The researcher discovered other individual item discrepancies for instructional practices that may contribute to the establishment of mathematics goals to focus instruction. Another example included the four (19%) participants’ responses indicating that they disagreed with the mathematical instructional practice to assess student progress toward mathematical understanding with evidence of student thinking. A related discrepancy was noted in the four (19%) participants’ responses who disagreed with selecting tasks that promoted student discussion of their mathematical reasoning. These data led the researcher to surmise that although all participants agreed with the practices to establish learning goals and progressions to guide instructional decisions, one-fifth to one-fourth did not connect the use of evidence of student thinking to these practices. Additionally, these participants did not view a shared understanding of ideas or meaningful mathematical discourse as practices that contribute to instructional decision-making or as ways to assess students’ progress toward and achievement of mathematics learning goals.

The researcher observed a discrepancy when comparing the Likert scale effective practice data to the responses provided for the first open-ended question. Instructional practices with the highest participant agreement data for effectiveness using the Likert scale responses were mentioned as often in the open-ended responses as items with the lowest participant agreement data. For example, despite 100% of participants’ Likert scale responses indicating agreement with the instructional practice to establish mathematics goals that focus on student learning, only five (24%) respondents provided open-ended responses that could be related to that practice. The researcher noted a similar
discrepancy when comparing the participant Likert response data (95%) and open-ended response data (14%) for practices linked to adjusting instruction to support and extend student learning. The researcher inferred participants did not prioritize the instructional practices they knew to be effective, as indicated in the Likert scale responses, when discussing their classroom practices in the open-ended responses.

The comparison of data collected from questionnaire sections one and two supported the researcher’s inference that participants did not prioritize the instructional practices they knew to be effective in their classroom instruction. The average agreement for participants’ responses about productive beliefs for mathematical teaching and learning was almost 10% lower than the average agreement with participants’ responses about effective mathematics instructional practices. The researcher suspected that there might be a discrepancy between what instructional practices teachers know to be effective and how they believe that practice should be implemented in an elementary classroom.

The Likert scale responses in the second section of the questionnaire were referred to as “unproductive beliefs” in NCTM’s Principles to Actions: Ensuring Mathematical Success for All (2014). Participants’ disagreement with an item indicated that the belief was considered unproductive. The highest areas (95%) of alignment for productive beliefs were participants’ strong disagreement or disagreement with the statements: (1) students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems, and (2) the role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests (NCTM, 2014). Responses to the first
open-ended question contributed to these research results when participants shared what they perceived to be the most effective instructional practices to teach mathematics in the elementary classroom. When responding to this first question, using and connecting mathematical representations was a practice most often referenced. Student participation in mathematical instruction was a theme that the researcher noticed in participants’ answers. Seven (33%) of the open-ended responses mentioned the importance of modeling, hands-on activities, games, tactile/kinesthetic materials, and visual representation as part of the practices for instruction. One participant wrote, “As we model and practice solving problems, students are encouraged to share different ways they approach and solve problems. This provides students with a variety of skills to use when approaching a math problem.”

The lowest area (58%) of alignment for productive beliefs were with participants who indicated strong disagreement or disagreement with the statement: that mathematics learning should focus on practicing procedures and memorizing basic number combinations. This indicated to the researcher that almost half (42%) of the participants held a belief that was unproductive for teaching and learning mathematics. The productive belief considers the focus of mathematics learning to be problem-solving, reasoning, and mathematics discourse as the practices to develop student understanding of concepts and procedures (NCTM, 2014). The researcher noticed a discrepancy when comparing these data and Likert scale data regarding effective practices. Despite data that participants (42%) held an unproductive belief about the focus of mathematics learning, participants’ Likert scale data indicated they knew what practices were effective. Ninety-five percent of the participants agreed or strongly agreed with the practice of
implementing tasks that promote reasoning and problem solving, and 86% regarded facilitating meaningful mathematical discourse as an effective practice (NCTM, 2014). These data contributed to the researcher's suspicion that there might be a discrepancy between what instructional practices teachers know to be effective and how they believe that practice should be implemented in an elementary classroom.

**Teacher Perceptions Regarding their Preparedness to Instruct Mathematics**

Demographic data and data from the second open-ended response question were used to evaluate teacher perceptions of their preparedness. The researcher examined teacher preparedness responses (years of teaching experience, certification, coursework, and professional development) to extend participants’ Likert scale responses for effective mathematics instruction and productive beliefs about teaching and learning mathematics.

**Alignment of Preparedness to Effective Practices.** The data revealed that the agreement alignment for effective practices decreased with the number of undergraduate courses participants took. The researcher speculates that the number of pre-service undergraduate courses in mathematics did not necessarily result in a teacher’s implementation of effective instructional practices. For example, when comparing undergraduate coursework and response agreement with Likert scale questionnaire items related to effective mathematics instructional practices, the one participant who indicated that they had not taken any mathematics courses agreed 100%. There was an average agreement of 95% for the nine participants who had taken one to two undergraduate mathematics courses, compared to the average agreement response of 85% for the eleven participants who took three to four undergraduate mathematics courses. It is important to
note that participants did not indicate if mathematics coursework was explicitly related to their teacher certification.

Considering graduate-level work, the researcher noticed alignment between teacher preparedness and practices. The data indicated that participants who took at least one graduate-level mathematics course had a higher average response agreement with effective mathematics practices than those who had taken none. The average response agreement was 85% for the 12 participants who had taken no graduate-level coursework and 98% for the six participants who had taken one to two graduate-level mathematics courses. The remaining groups, who had taken three or more mathematics courses, had a response agreement of 100%. These data indicated to the researcher that graduate-level mathematics coursework might provide teachers with instruction related to effective mathematics instructional practices.

Alignment of Preparedness to Productive Beliefs. In examining the alignment of participants’ mathematics coursework and NCTM’s (2014) beliefs about teaching and learning mathematics, the researcher saw data with disproportionate results. The participant who had no undergraduate-level courses in mathematics averaged the same 83% agreement with productive beliefs for instruction as the nine participants who had taken one to two undergraduate mathematics courses. The remaining eleven participants had an average of 82% response agreement with productive beliefs for mathematics teaching and learning. The researcher surmised that the number of courses taken did not increase the participants’ understanding of productive mathematical beliefs. This trend continued for graduate-level coursework; the participant who had taken more than four mathematics graduate-level courses had responses that were 50% aligned with productive
beliefs. There was an average agreement of 84% for the six participants who indicated they had taken one to two graduate-level courses in mathematics and a 75% response agreement for the two participants who had taken three to four graduate-level courses. However, the 12 participants who had taken no graduate-level courses averaged an 82% concurrence with productive beliefs for teaching and learning mathematics. This relationship between decreasing alignment for productive beliefs and graduate-level coursework indicated to the researcher that mathematics coursework at any level might not provide teachers with instruction related to productive beliefs about teaching and learning mathematics.

When aligning teacher preparedness related to mathematics professional development opportunities and Likert scale responses related to productive beliefs about how mathematics is taught and learned, the data revealed that district-endorsed opportunities (conferences, workshops, and training) may provide teachers with instruction related to beliefs. The 13 participants whose sole professional development was provided by their school district averaged an 85% agreement with productive beliefs. Participants who took part in two district-endorsed professional development opportunities had an average agreement of 78%. Participants who had more than four professional development opportunities in mathematics approved by their school districts had an 81% response alignment for productive beliefs for teaching and learning mathematics. However, the researcher found that professional development in mathematics pursued by participants independent of their school district did not increase the likelihood of a positive relationship with productive beliefs. For example, there was a productive belief average of only 33% for the one participant who personally pursued
more than four professional development opportunities independent of their school district. Based on these data, the researcher surmised that professional development in mathematics advocated by a school district provided teachers with instruction related to productive beliefs about teaching and learning mathematics.

Data from teacher mathematics professional development opportunities linked to the Likert scale responses suggested to the researcher that district-endorsed professional development opportunities instructed teachers about productive beliefs for mathematics teaching and learning. However, in-service professional development was mentioned in only four (19%) participants’ open-ended responses as a factor that facilitated their preparedness. In addition, 14 (67%) participants did not mention a formalized professional development plan related to mathematics instruction. Based on these data, the researcher speculated that professional development that is supported by a school district might be a factor for teacher preparedness of which teachers are unaware is helpful to improving the effectiveness of their mathematics instruction.

The researcher discovered that teacher preparedness in pedagogical and mathematical content knowledge had the most references in the second open-ended response. Eight (38%) of the participants’ answers implied the importance of their knowledge of effective practices to teach mathematics and understanding students’ mathematical thinking as factors for their preparedness. However, there were conflicting opinions about how a scripted mathematics program works in conjunction with this knowledge. In discussing preparedness and the use of a scripted mathematics program, one respondent explained:
In my current school district, we use a math program that I do NOT like because I cannot figure out the “why” to many of the lessons. I just don't understand why they have to make things more confusing in many of the lessons. I have super low students (below grade level in reading, writing, and math) in my classroom, so I end up redoing most of the lessons so that students can understand the vocabulary and the basic steps.

An examination of the open-ended response data suggested to the researcher that mathematics coursework at the pre-service and graduate level may not prepare teachers to instruct mathematics effectively. Four (19%) participants mentioned specific aspects of their undergraduate degree coursework that supported their preparedness to teach mathematics. Contained in those four responses was evidence of a discrepancy between how teachers were trained to teach mathematics and how they instructed mathematics, referencing an incongruity between effective instruction and the lack of resources to deliver that effective instruction. One participant responded, “I feel that I personally understand what good instruction SHOULD look like, but I feel underprepared to provide it based on the resources easily at my disposal.”

*Teacher Perceptions Regarding Factors that Influence Effective Practices in Mathematics Instruction*

Data from the third open-ended response question and interviews were used to examine perceived factors for instruction which can be barriers or facilitators. The researcher discovered themes that were influenced by factors for effective mathematics instruction that could be categorized as conceptual, pedagogical, political, or cultural. In examining participants’ open-ended responses, the researcher identified factors that are
considered conceptual. Five (24%) of the responses referenced ideas associated with professionalism. Participants identified their professional development, mathematics coaches, and mentor teachers as facilitators for the knowledge of effective instruction. These data support NCTM’s (2014) identification of professionalism as an essential element for a successful mathematics program. However, the researcher observed that 75% of the participants did not mention professionalism as a factor that influences their mathematics instructional practices. The researcher connected these data and the previously discussed data that teachers are not aware district-endorsed professional development in mathematics can advance their productive beliefs about teaching and learning mathematics.

Six (29%) participants submitted responses that mentioned pedagogical factors as essential elements of the curriculum. These responses discussed a purchased mathematics program and a district’s curriculum. Some participants viewed these as facilitators, while others viewed them as obstacles to implementing effective mathematical instructional practices. Though tools and technology are identified by NCTM (2014) as essential elements of a mathematics program, two responses mentioned tools as a factor for mathematics instruction.

Political factors may impact how a school district conducts mathematics instruction (Corkin et al., 2019). However, when examining the third open-ended question response, the researcher found minimal references to this factor. District curriculum and standards were each mentioned once. One participant specifically mentioned district-approved instructional material as a factor stating, “For me, the resource should be approved by my district.” Although NCTM (2014) considers
assessment an essential element of a mathematics program, one participant referred to the use of assessment as a tool to measure student progress toward a learning goal as a factor influencing their mathematics instructional practices. The researcher noted that no participant response indicated that large-scale testing influenced the mathematical instructional practices they selected.

In examining the third open-ended question, themes related to culture were the most frequently identified. Eleven of the 21 responses (52%) cited the influence of culture on effective instruction. Access and equity were themes often implied when the researcher categorized items associated with culture. Five participants (24%) provided responses that referenced to classroom dynamics, student relationships with one another, student behavior, student readiness, and student needs/strengths. Respondents did not indicate if these were obstacles or facilitators for effective instruction, only that they influenced the practices that the teacher selected. The researcher thought what was absent in open-ended responses related to culture was notable. No participant referenced cultural exclusion, poverty, COVID-19, or parent perceptions as factors influencing the mathematical instructional practices used in their elementary classroom. The researcher surmised that participants considered the culture within the classroom environment and student mathematical identity to be greater cultural factors than those outside the classroom setting.

Interview data provided additional details about the teacher-identified factors that influenced the practices selected for instruction in the elementary mathematics classroom. Two participants volunteered for the interview; the researcher asked questions regarding their perceived factors of influence for mathematics instruction. Interviewees were first
asked to identify factors that were facilitators and then to identify factors that were obstacles for each essential element of a mathematics program (NCTM, 2014). When responding to several interview questions, the interviewees sometimes referred to conceptual factors based on their understanding and application theories of mathematical learning (Corkin et al., 2019). These interviewees’ answers supported the researcher’s conjecture that district-provided professional development may be a factor for teacher preparedness that teachers are unaware is effective. When asked which factors facilitate their professional growth, interviewees discussed experiences teaching the content material and the opportunity to learn from other teachers as opportunities they value as professional opportunities. Neither interviewee mentioned a structured professional development plan related to mathematics when answering questions related to factors that influence professional growth. The interviews revealed that mathematics professional development is not an emphasis for their school districts. The interviewees stated that their school districts rarely prioritize mathematical growth in mathematics over other content areas and topics.

The researcher found that the interviewees mentioned the influence of pedagogical factors more often than other factors. Interviewees referred to these factors when answering questions about access and equity, curriculum, tools and technology, high-quality instruction, assessment, student success, and professionalism. Interviewee two described understanding what good instruction looks like, but they cannot consistently implement high quality due to their lack of experience. This interviewee also mentioned that an obstacle to effective instruction resulted from a difference between how they were trained to teach mathematics during their pre-service training and the
resources they were given to teach mathematics by their school district. The researcher linked this interview answer and questionnaire data responses related to teacher preparedness. These data suggest that regardless of the teacher's pre-service coursework, a teacher may not be able to implement the mathematics practices that they learned were effective during their teacher preparation due to the mathematics practices prescribed by school districts’ mathematics programs.

Access and equity, along with technology, were themes the researcher found in the interview data. Cultural factors influenced these themes. The interviewees shared extensively about the technology that provides opportunities to customize instructional content and make the material more accessible for students. Interviewees specifically mentioned the benefits of technology to reduce the disruption of learning during the COVID-19 pandemic, when learners could not attend school in person. Aligned with the open-ended responses, interview responses suggested the school’s mathematics program as a facilitator and an obstacle to implementing effective mathematical practices. Interviewees referred to their school’s mathematics program as a structure that is a facilitating factor for providing access and equity. They also explained that structure could also be an obstacle to instruction when the teacher needed to make accommodations to meet individual student needs.

**Limitations Found in the Study**

This qualitative research study employed an online questionnaire of nine items for demographical data, 23-Likert scale statement responses, and three open-ended response questions. Interviews were also used to collect data for this study. The data collected were based on teacher-reported information about effective mathematics instructional
practices and factors that influence the effectiveness of those practices; data are not based on the researcher’s direct observation. The data were collected from 21 participants from a possible pool of 200 participants from two school districts. Two participants volunteered to take part in the interview. This study was limited by the small number of teachers willing to share their knowledge of effective mathematics practices.

A further limitation was the COVID-19 pandemic that took place during this study. Participants’ responses related to effective instructional practices to teach mathematics in the elementary classroom may have been affected by the restrictive classroom environments implemented due to COVID-19 safety procedures. The Pennsylvania Department of Health, Centers for Disease Control, and Pennsylvania Department of Education required school districts to follow health and safety mandates. These mandates included wearing masks, social distancing, school closures, and quarantine periods. These restrictions may have created variables that influenced participants’ responses to the questions used to gather data for this study. During the pandemic, non-participants’ availability and willingness to participate in the study may have been affected.

**Relationship to Other Research**

This study examined how teachers’ beliefs, preparedness, practices, and external factors influenced the effective implementation of mathematics instruction in the elementary classroom. The results of this study supported the findings of Lee and Francis (2017) that, although teachers can observe and note students thinking, teachers do not use student thinking as part of the instructional practices they implement. Lee and Francis asserted that teachers need training on transferring understanding of student thinking into
instructional planning and practices for teaching. This study’s research revealed a discrepancy between what instructional practices teachers know to be effective and how they believe that practice should be implemented in an elementary classroom. Participants’ average response data for knowledge of effective mathematics instructional practices were almost 10% higher in agreement than the questionnaire response data about productive beliefs for mathematical teaching and learning.

This study also supported the findings of Corkin et al. (2019), Darling-Hammond et al. (2020), and Stoilesco (2016), which described constructivists' beliefs about how children learn best. This includes prior knowledge, cooperative learning, interactive problem solving, and student agency. Data presented in this chapter indicated that almost all of the participants (95%) believed it was helpful for students to have exposure to a variety of problem-solving strategies, not just standardized approaches, and viewed students as active agents in their learning process. Participants in this study affirmed this finding indicating they strongly disagreed with practices where the only role of the student is to memorize information presented by the teacher to be used to solve routine problems on homework, quizzes, and tests. The findings of Schoenfield (2020) indicated that inquiry-based effective mathematical classroom practices engage all students in productive activities and build upon prior student learning. Using and connecting mathematical representations were practices most often referenced in teachers’ open-ended responses in this study.

The results of this study that suggested participants’ preparedness to teach mathematics may not consistently be linked with the implementation of effective mathematical practices support Forrest and Hitt’s (2012) examination of pre-service
teacher preparation. Forrest and Hitt investigated pre-service mathematics teacher preparation and discovered little connection between the practices promoted during pre-service coursework and those utilized during the student teaching experience.

Participants in this study provided preparedness data related to professional development that showed school district-supported professional development such as conferences, workshops, or training in mathematics contributed to teachers’ productive beliefs about teaching and learning mathematics. This study supported the findings of Campbell et al. (2014), Spillanne et al. (2018), and Valoyes-Cháves (2019); those studies showed teachers looked to school leadership to implement reformed mathematics practices and suggested that providing professional development allows teachers to transform fixed beliefs about how mathematics should be taught.

Data collected in this study in open-ended responses and teacher interviews showed that professional development in the area of mathematics is often not a priority for school districts. This discovery aligns with Lee and Reeves (2012), who discovered that schools have responded to the increased accountability of high-stakes testing with a greater focus on instructional conditions for reading over mathematics. According to Lee and Reeves, mathematics instruction is given less priority than reading instruction in professional development, class time, and resources.

**Recommendations for Further Research**

The purpose of this qualitative study was to examine how teachers’ beliefs, preparedness, practices, and external factors influence the effective implementation of mathematical instruction in the elementary classroom. The focus of the study was limited to the perceptions of the teacher. This study did not include student, parent, or
administrator perceptions of effective mathematical instruction. Future studies may consist of an examination of the perceptions of these stakeholder groups regarding effective elementary mathematics instruction.

The data collected from this study concerning the mathematics professional development of teachers indicated that district advocated professional development in mathematics contributed to teachers’ productive beliefs about teaching and learning mathematics. However, these data also suggested that teachers may not be aware that district-endorsed professional development in mathematics can improve their productive beliefs about teaching and learning mathematics. It may be beneficial for future researchers to conduct a case study examining how future district-provided professional development influences teacher perception of mathematics instruction. A case study would allow a more in-depth analysis of how professional development advances teachers’ productive beliefs and their implementation of effective mathematical instruction in the elementary classroom. The qualitative data collected about the influence of district-provided professional development in mathematics instruction would allow the researcher to gather data about areas of strength or need to support school districts' goals of student mathematics achievement and high-quality mathematics instruction.

Data collected from this study suggested to the researcher that teachers do not connect their beliefs about productive student opportunities for mathematics learning with their implementation of effective instructional practices. A future study could examine the discrepancy between what instructional practices teachers know to be
effective and how they believe that practice should be implemented in an elementary classroom.

The data in this study were collected during the COVID-19 pandemic. The researcher mentioned the effect of the COVID-19 pandemic as a limitation of this study. A future study could examine how mathematics instruction and students' mathematics achievement were affected by the classroom environment created due to COVID-19 safety procedures, including wearing masks, social distancing, and quarantine periods.

**Conclusion**

Educational reform in the United States related to elementary-level mathematics instruction and the goal to increase student achievement in mathematics has focused on teacher effectiveness (Hiebert & Morris 2012). Research suggested that elementary teachers' mathematical practices for instruction are based on their perceptions about teaching mathematics and their beliefs about how mathematics is learned (Park et al., 2016). Teachers’ practices may be influenced by conceptual, pedagogical, political, and cultural factors (Corkin et al., 2019). Elementary teachers’ preparedness to teach mathematics can also affect the practice they implement (Harris and Jones, 2017). The purpose of this qualitative research study was to provide insight into how teacher perceptions of the most effective mathematics teaching practices; teacher beliefs about how mathematics is learned; teacher preparedness to teach mathematics; and external factors influence teaching and learning in the elementary mathematics classroom. This insight was based on the data collected from demographical information and Likert scale response statements, the researcher designed open-ended response questions, and interview questions. The study was conducted in two suburban school districts in Central
and South-Central Pennsylvania. Twenty-one kindergarten through fifth-grade teachers from both school districts participated in this study. Throughout this study, participant perceptions were collected. The anonymity and confidentiality of the participants and associated school districts were maintained during this study. Using the three research questions of this study, the researcher made conclusions based on participants’ perceptions that revealed themes, patterns, and discrepancies in the data collected.

The study results revealed that 90% of participants’ responses aligned with effective mathematical practices and also found that an average of 82% relationship existed between participants’ responses and their productive beliefs for mathematical teaching and learning (NCTM, 2014). Data from this study suggested that participants’ responses about mathematics instruction had a 10% higher average alignment for effective practices than participants’ responses concerning their productive beliefs related to mathematics instruction. In addition, a comparison of data collected from questionnaire sections one and two suggested to the researcher that instructional practices that participants knew to be effective were not implemented as part of classroom instruction. For example, the researcher discovered that although 100% of participants agreed with the practices to establish learning goals and progressions to guide instructional decisions, participants’ responses did not consistently indicate that teachers value evidence of student thinking to assess students’ progress toward those learning goals. Research in this study indicated that participants did not seem to view student discussion of mathematical reasoning and evidence of student thinking as sources for instructional decision-making or as a way to assess students’ progress toward mathematics learning goals. Based on these data, the researcher suspected a discrepancy
between what instructional practices teachers know to be effective and how they believe the practice should be implemented in an elementary classroom.

The researcher noticed that the number of participants’ undergraduate coursework did not contribute to teachers’ knowledge of effective practices. For example, the teacher with no undergraduate mathematics courses had 100% response agreement with effective practices versus the teachers who took three to four pre-service mathematics courses and had 85% response alignment with effective practices. However, the researcher found evidence that participants who took at least one graduate-level mathematics course had a 10% higher average response agreement with effective mathematics practices than those who had taken none. The researcher surmised that the number of pre-service undergraduate courses in mathematics did not increase a teacher's knowledge of effective instructional practices. However, any number of graduate-level mathematics courses did appear to increase the likelihood of a teacher's perception of their knowledge of effective mathematics instructional practices.

There were contradictory results when considering data for teacher preparation and data about their beliefs about teaching and learning mathematics. Data from this study suggested that as the number of mathematics courses for a teacher increased, their agreement with productive beliefs for mathematics instruction decreased. These findings indicated to the researcher that the number and level of mathematics coursework might not result in teachers’ development of productive beliefs about teaching and learning mathematics.

The researcher found that the influence of pedagogical factors were named in 29% of the participants’ open-ended response and were the most often mentioned factor
in the interviews. These data revealed that teachers understood the necessity for high-quality instruction but struggled to implement it. Consequently, data of this study suggested that neither school districts nor teachers are aware of the influence district-provided professional development in mathematics has on knowledge of productive beliefs about teaching and learning mathematics. The researcher in this study noted that 75% of the participants did not include professionalism as a factor of influence in their instructional decision-making. Only 19% of the participants specifically mentioned professional development as a factor that supported their preparedness. A finding suggested by this study is the perception that professional development in mathematics is often not a priority for school districts. Despite what participants reported regarding professional development, the study did collect data indicating that district-provided professional development in mathematics supported teachers’ understanding of productive beliefs about teaching and learning mathematics. There was an 85% agreement with productive beliefs for participants whose only professional development was district provided.

Although culture was the most often identified factor (52%) in responses to the third open-ended question, participants made no mention of cultural exclusion, poverty, COVID-19, or parent perceptions as factors influencing mathematical instructional practices. Instead, participants named student relationships, student behavior, student readiness, and student needs/strengths as cultural factors. Based on the details provided in this open-ended response, the researcher surmised that participants perceived the culture within the classroom environment and student mathematics identity to be greater cultural factors than those outside the classroom.
The information collected from this study contributed to the body of research regarding instruction in the area of mathematics instruction in the elementary classroom. The study examined teachers’ beliefs, preparedness, practices, and factors that influence the implementation of effective elementary mathematics instruction. The development of teachers’ knowledge of effective mathematics instructional practices and productive beliefs can be developed through opportunities provided by their school districts; it may not depend on teachers’ undergraduate or graduate-level coursework.

The results of this study indicated to the researcher that teachers need support to bridge their knowledge of effective mathematics instruction and productive beliefs about mathematics learning to the practices they implement in the classroom. Implications from this study include the benefit of collaboration between school districts and teacher preparation programs in order to connect undergraduate coursework to the daily instructional practices expected by a school system. A further implication is for school districts as part of the hiring process for elementary teachers. Interview questions based on this study’s instruments would assess a candidate’s knowledge of effective practices and productive beliefs for teaching and learning mathematics.

In addition to a structured professional development plan to support mathematics instruction, a consideration for school districts is a balance of professional development for teachers in mathematics and other content areas. Schools and their established systems for teaching mathematics will continue to adapt to reform initiatives, navigate social changes, and respond to events such as pandemics. These external factors can be facilitators or obstacles that have an ongoing influence on school systems. No matter the impact of external factors, it is essential for school districts to look at building the
capacity of classroom teachers to influence the effectiveness of mathematics instruction and the success of students’ mathematics learning.

Teachers perceive the culture within the classroom environment as a factor affecting student success in mathematics, over political factors, such as large-scale testing. These cultural factors are ones the teacher can directly influence more than those factors that occur outside the classroom. Schools can further support effective mathematics instruction by assisting teachers’ efforts to create a safe and productive mathematics classroom that fosters a community of learners. Understanding teacher perceptions concerning effective instructional practices and productive beliefs, their preparedness to teach mathematics, and the factors that influence teaching and learning advances the goal to increase student achievement in mathematics.
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Appendix A
Formal Request to Engage in a Research Study

July 7, 2021

Dear [School District],

I am writing to request permission to conduct a doctoral study in the [School District]. I am currently enrolled in Immaculata University’s Educational Leadership program and am in the process of writing my dissertation. My study is tentatively entitled “Teachers’ Perceptions of the Most Effective Mathematical Instructional Practices Used in the Elementary Classroom.” I am at the beginning stages of the doctoral process. I anticipate that my study will occur during the fall or early winter of this upcoming school year. My research will be qualitative, collecting surveys and possibly interview data from elementary math teachers. The purpose of my study is to examine teachers’ perceptions of the most effective instructional strategies used in the elementary classroom. The study will explore instructional practices used in the math classroom, teachers’ preparedness to teach mathematics, and variables on the selection of math instructional techniques.

As part of the study, I request permission to contact elementary mathematics teachers for grades kindergarten through fifth grade to invite them to participate in an electronic survey and follow-up interview in the Fall/Winter of 2021-2022. Teachers will not be contacted until this research study has been approved by the Immaculata University Research Ethics Review Board.

During this study, elementary mathematics teachers will be asked to complete an electronic survey consisting of Likert-style and open-ended questions. The survey will take approximately 20 minutes to complete. Participants will be presented with informed consent information before participating. Taking part in this study is entirely voluntary. There is no direct benefit anticipated, and participants are welcome to discontinue participation at any time. Participants may contact me with any questions or feedback at any time throughout the process. In addition to participation in the survey, I wish to interview any elementary mathematics teachers based on a participant’s desire for a follow-up interview as indicated in the electronic survey. Each interview will take approximately 30 minutes and will be based on the participant’s availability. Interviews will be conducted during non-instructional time. Participation will be on a voluntary basis, and subjects may withdraw from the study at any time. Confidentiality will be maintained during the entire study, and participants will remain anonymous.

Thank you for considering my request, and I look forward to discussing the possibility of the [School District]’s participation in this study. I may be reached by phone at (717) 717-881-1200 or via email at hdick@cysd.k12.pa.us. My advisor, Dr. Elizabeth Weber, may also be contacted by phone at 610-517-5232 or email at eweber1@mail.immaculata.edu. If you choose to grant permission, please provide a signed statement on district letterhead indicating your approval. This approval can be emailed to hdick@cysd.k12.pa.us or mailed to 2416 Clairian Drive York, PA 17403.

Your time and effort are greatly appreciated.

Sincerely,

Heather L. Dick
Immaculata University Doctoral Candidate

cc: Dr. Elizabeth Weber Committee Chair, Immaculata University
IMMACULATA UNIVERSITY RESEARCH ETHICS REVIEW BOARD
REQUEST FOR PROTOCOL REVIEW--REVIEWER'S COMMENTS FORM
(R1297)

Name of Researcher:  Heather Dick

Project Title:  Effective Elementary Mathematics Instruction: A Qualitative Study of Teachers’
Beliefs, Preparedness, Practices, and Factors that Influence Implementation

Reviewer’s Comments

Your proposal is Approved. You may begin your research or collect your data.

PLEASE NOTE THAT THIS APPROVAL IS VALID FOR ONE YEAR (365 days) FROM DATE
OF SIGNING.

Reviewer’s Recommendations:

___ Exempt
___ Approved
___ Expedited
___ Conditionally Approve
___ Full Review
___ Do Not Approve

Marcia Parris, Ed.D.
Chair, Research Ethics Review Board

December 9, 2021
Appendix C

Email Invitation for Study Participation

1145 King Road, P.O. Box 500, Immaculata Pennsylvania 19345-0500

Date: December, 2021

Dear Teacher,

I am currently engaged in a study about effective elementary mathematics instruction. As part of this research, I am asking for your participation in the study. To participate in this study, you should currently hold a position as an elementary teacher, kindergarten to fifth grade, and teach mathematics. This study will attempt to qualitatively describe how teachers’ beliefs, preparedness, practices, and external factors influence mathematics instruction.

There are two parts to this research project. You may choose to participate in the online questionnaire and/or an interview component of this study. Participants will be asked to complete an Informed Consent Form for each component. If you decide to volunteer, you will be asked to answer a questionnaire made up of 35 items. Nine questions gather demographical information related to your teaching preparedness. There are 23 Likert statement responses and three open-ended questions about the mathematical instructional practices you use in the classroom and your beliefs about mathematics instruction. The questionnaire is designed to be completed through the Web using Google Forms. Should this pose a problem, please contact me, and I will make arrangements to provide you with another method of participation. Your participation in the questionnaire is voluntary and should take no longer than 20 minutes. You may decline to answer any questions that you do not wish to answer, and you can withdraw your participation at any time by not submitting your response. At the end of the questionnaire, you will be asked if you would like to participate in an interview. The interview is voluntary. Interviews will be in-person or through zoom and arranged at a time convenient for you. The interview component is made up of 12 questions regarding factors you perceive to influence mathematics instruction and will take approximately 30 minutes. As a participant in the interview, you would be electronically recorded for the purpose of transcription accuracy and the researcher's use of anonymous quotes in the research summary. You may withdraw this consent at any time without penalty, at which point, the recording will be erased.

I welcome questions about this study, Effective Elementary Mathematics Instruction: A Qualitative Study of Teachers’ Beliefs, Preparedness, Practices, and Factors that Influence Implementation. Any questions you have regarding this research project can be directed to Heather Dick at 717-881-1200 or via email at hick@immaculata.edu. You may also contact my Dissertation Chair, Dr. Elizabeth Weber, at Immaculata University by calling 610-647-4400 or emailing eweber1@immaculata.edu.

It is important for you to know that any information that you provide will be confidential. All of the data will be summarized, and no individual could be identified from these aggregated results. The data collected from this study will be accessed only by the researcher and maintained on a password-protected computer database. This study has been reviewed and approved by the Research Ethics Review Board at Immaculata University. If you have any comments or concerns resulting from your participation in this study, please feel free to contact Dr. Marcia Parris at mparris@immaculata.edu or (610) 647-4400 Ext: 3210.

Please visit the Study Website at https://forms.gle/SFEdex3nCHITChm9 if you wish to participate. From the main page, follow the instructions provided. The first page of the online questionnaire is an Informed Consent Form. Please review it. Clicking “Yes” will indicate that you understand this consent form and agree to participate in this study, giving permission to the researcher to use the provided information in the final report. Clicking “Yes” will not waive any legal rights, and you may withdraw consent at any time. Thank you for considering participation in this study.

Sincerely,

Heather Dick

Phone: 610-647-4400 Ext. 3211 or 3212 Fax: 610-993-8580 www.immaculata.edu/graduatestudies
Appendix D

Informed Consent Form

Dear Teacher,

I am currently engaged in a study about effective elementary mathematics instruction. As part of this research, I am asking for your participation in the study. The questionnaire is made up of 35 items. Nine questions gather demographical information related to your teaching preparedness. There are 23 Likert scale response statements and three open-ended questions about the mathematical instructional practices you use in the classroom and your beliefs about mathematics instruction. Your participation in the questionnaire is voluntary and should take no longer than 20 minutes. You may decline to answer any questions that you do not wish to answer, and you can withdraw your participation at any time by not submitting your response.

I welcome questions about this study, Effective Elementary Mathematics Instruction: A Qualitative Study of Teachers’ Beliefs, Preparedness, Practices, and Factors that Influence Implementation. Any questions you have regarding this research project can be directed to Heather Dick at 717-881-1200 or via email at hdick@mail.immaculata.edu. You may also contact my Dissertation Chair, Dr. Elizabeth Weber, at Immaculata University by calling 610-647-4400 or emailing eweber1@immaculata.edu.

It is important for you to know that any information that you provide will be confidential. All of the data will be summarized, and no individual could be identified from these aggregated results. The data collected from this study will be accessed only by the researcher and maintained on a password-protected computer database. This study has been reviewed and approved by the Research Ethics Review Board at Immaculata University. If you have any comments or concerns resulting from your participation in this study, please feel free to contact Dr. Marcia Parris at mparris@immaculata.edu or (610) 647-4400 Ext: 3210.

Clicking "Yes" indicates that you understand this consent form and that you agree to take part in this study, giving the researcher permission to use the provided information in the final report. Clicking "Yes" will not waive any legal rights, and you may withdrawal consent at any time.

(select one)

- Yes
- No
### Relation of Research Questions to Questionnaire Items, Open-Response Questions, and the Literature

#### Interview Questions, and the Literature

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Instrument Questions</th>
<th>Research</th>
</tr>
</thead>
</table>
| **What are teacher perceptions regarding the most effective instructional practices to teach mathematics in the elementary classroom?** | 1. I establish mathematics goals to focus on student learning.  
2. I use learning progressions, an understanding of how students build on prior knowledge to understand to new concepts, to establish the goals for mathematics instruction.  
3. I use mathematics goals to guide my instructional decisions.  
4. I teach using mathematical tasks that promote reasoning and problem-solving.  
5. I select tasks that promote student discussion of their mathematical reasoning and problem-solving process.  
6. I select tasks that provide multiple entry points and varied solution strategies.  
7. I use and connect mathematical representations to the concepts I teach.  
8. I engage students in tasks that connect mathematical representations to concepts and procedures.  
9. I facilitate meaningful mathematical discourse as part of instruction.  
10. I provide opportunities for students to build a shared understanding of mathematical ideas by analyzing and comparing approaches.  
11. I use purposeful questions that require students to explain and reflect on their answers as part of my mathematics instruction.  
12. My instructional questions are designed to assess students’ reasoning and sense-making about important mathematical ideas and relationships.  
13. My instructional questions are designed to advance students’ reasoning and sense-making about important mathematical ideas and relationships.  
14. I build procedural fluency from conceptual understanding.  
15. I provide my students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.  
16. I assess student progress toward mathematical understanding with evidence of student thinking.  
17. I adjust instruction continually in ways that support and extend student learning.  
18. Mathematics learning should focus on practicing procedures and memorizing basic number combinations.  
19. Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.  
20. Students can learn to apply mathematics only after they have mastered the basic skills.  
21. The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use the information to solve mathematics problems.  
22. The role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests.  
23. An effective teacher makes mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.  

**Open-ended Question 1**

1. What do you perceive to be the most effective instructional practices to teach mathematics in the elementary classroom?

1. Amador and Lamberg (2013), NCTM (2014), and Remillard et al. (2019)  
5. Bolden and Tymms (2020), Clements et al. (2013), and NCTM (2014)  
7. Anderson et al. (2018), Clements et al. (2013), NCTM (2014), and Schoenfeld (2020)  
8. Anderson et al. (2018), Clements et al. (2013), NCTM (2014), and Schoenfeld (2020)  
10. Clements et al. (2013), Corkin et al., 2019; Darling-Hammond et al. (2020), Ottmar et al. (2014), and NCTM (2014)  
16. Lee and Francis (2017) and NCTM (2014)  
17. Lee and Francis (2017), NCTM (2014), and Schoenfeld (2020)  

What are teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom?

1. Years of mathematics teaching experience
2. Current certification
3. Specific mathematics certification
4. Number of undergraduate-level (pre-service) mathematics courses taken
5. Number of graduate-level mathematics courses taken
6. The number of mathematics professional development opportunities (for example, workshops, textbook, or program training) I have had in the last five years endorsed or provided by my school district
7. The number of mathematics professional development opportunities (for example, conferences or workshops) I have taken in the last five years that I pursued on my own, independent of my school district
8. Most of the mathematics professional development opportunities (i.e., conferences, workshops, or training) I have received are the results of opportunities that were: school district provided, personal choice or both

Open-ended Question 2

2. What factors contribute to your preparedness to teach mathematics in an elementary classroom?

What are teacher perceptions regarding the factors that influence the practices selected for mathematics instruction in the elementary classroom?

1. As you consider your mathematical instruction practices, what factors facilitate equity and access for students?
2. As you consider your mathematical instruction practices, what factors are obstacles to equity and access for students?
3. What factors facilitate a high-quality mathematics instruction for your students?
4. What factors create an obstacle to a high-quality mathematics instruction for your students?
5. What factors facilitate the use of mathematical tools and technology for your students?
6. What factors are obstacles to the use of mathematical tools and technology for your students?
7. What factors facilitate the use of assessment as part of your mathematics instruction?
8. What factors are obstacles to the use of assessment as part of your mathematics instruction?
9. What factors facilitate the mathematical success of the students you teach?
10. What factors are obstacles to the mathematical success of the students you teach?
11. What factors facilitate your professional growth toward the effective teaching and learning of mathematics?
12. What factors are obstacles to your professional growth toward the effective teaching and learning of mathematics?

Open-ended Question 3

3. What factors influence the practices you select for mathematics instruction in the elementary classroom?

What are teacher perceptions regarding their preparedness to instruct mathematics in an elementary classroom?

5. Harbin and Newton (2013), and Jao (2017)

Open-ended Question 2


What are teacher perceptions regarding the factors that influence the practices selected for mathematics instruction in the elementary classroom?

1. Corkin et al. (2019), Harris and Jones (2017), and NCTM (2014)
5. Corkin et al. (2019), Harper et al. (2021), Heyd-Metzuyanim et al. (2019), NCTM (2014), and Remillard et al. (2019)
6. Corkin et al. (2019), Harper et al. (2021), Heyd-Metzuyanim et al. (2019), NCTM (2014), and Remillard et al. (2019)
8. Amador and Lamberg (2013), Corkin et al. (2019), and NCTM (2014)
12. Corkin et al. (2019), NCTM (2014), and Park et al., 2016
Appendix F

Participant Questionnaire

Demographic Data

Directions: Please respond to the following questions about yourself relative to your current position as an elementary mathematics teacher.

1. Years of mathematics teaching experience
   - 0-5
   - 6-15
   - 16-25
   - 26 or more

2. Current grade level assigned to teach

3. Current certification
   - Elementary Education K-8
   - Elementary Education K-6
   - Grades 4-8 (4-6, Mathematics 7-8)
   - Grades Pre-Kindergarten – 4

4. Specific mathematics certification
   - I have a major degree in mathematics
   - I have a minor degree in mathematics
   - I do not have a mathematics specific degree

5. Number of undergraduate-level (pre-service) mathematics courses taken (please include teaching of mathematics coursework)
   - 0
   - 1-2
   - 3-4
   - More than 4

6. Number of graduate-level mathematics courses taken (please include the teaching of mathematics coursework)
   - 1-2
   - 3-4
   - More than 4

7. The number of mathematics professional development opportunities (for example, workshops, textbook, or program training) I have had in the last five years endorsed or provided by my school district
   - 0
   - 1-2
   - 3-4
   - More than 4

8. The number of mathematics professional development opportunities (for example, conferences or workshops) I have taken in the last five years that I pursued on my own, independent of my school district.
   - 0
   - 1-2
   - 3-4
   - More than 4

9. Most of the mathematics professional development opportunities (i.e., conferences, workshops, or training) I have received are the results of opportunities that were:
   - School district provided
   - Personal choice
   - Both
Appendix F

Participant Questionnaire

Mathematics Instructional Practice

Directions: Please respond to the following questions about the mathematical instructional practices you use in the elementary classroom. Indicate your level of agreement/disagreement with each of the following statements by selecting one of the Likert scale responses.

1. I establish mathematics goals to focus on student learning.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

2. I use learning progressions, an understanding of how students build on prior knowledge to understand new concepts, to establish the goals for mathematics instruction.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

3. I use mathematics goals to guide my instructional decisions.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

4. I teach using mathematical tasks that promote reasoning and problem-solving.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

5. I select tasks that promote student discussion of their mathematical reasoning and problem-solving process.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

6. I select tasks that provide multiple entry points and varied solution strategies.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

7. I use and connect mathematical representations to the concepts I teach.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

8. I engage students in tasks that connect mathematical representations to concepts and procedures.
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree
9. I facilitate meaningful mathematical discourse as part of instruction.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

10. I provide opportunities for students to build a shared understanding of mathematical ideas by analyzing and comparing approaches.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

11. I use purposeful questions that require students to explain and reflect on their answers as part of my mathematics instruction.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

12. My instructional questions are designed to assess students’ reasoning and sense-making about important mathematical ideas and relationships.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

13. My instructional questions are designed to advance students’ reasoning and sense-making about important mathematical ideas and relationships.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

14. I build procedural fluency from conceptual understanding.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

15. I provide my students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

16. I assess student progress toward mathematical understanding with evidence of student thinking.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

17. I adjust instruction continually in ways that support and extend student learning.
    ○ Strongly Agree
    ○ Agree
    ○ Disagree
    ○ Strongly Disagree

Appendix F

Participant Questionnaire

Beliefs About Mathematical Instruction

Directions: Please indicate your level of agreement/disagreement with each of the following statements about your beliefs regarding mathematics instruction in the elementary classroom.

18. Mathematics learning should focus on practicing procedures and memorizing basic number combinations.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

19. Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

20. Students can learn to apply mathematics only after they have mastered the basic skills.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

21. The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use the information to solve mathematics problems.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

22. The role of the student is to memorize information that is presented and then to use it to solve routine problems on homework, quizzes, and tests.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

23. An effective teacher makes mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.
   ○ Strongly Agree
   ○ Agree
   ○ Disagree
   ○ Strongly Disagree

Appendix F

Participant Questionnaire

Open-ended Response Questions

Directions: Please respond to the following questions related to your mathematics instruction.

1. What do you perceive to be the most effective instructional practices to teach mathematics in the elementary classroom?

2. What factors contribute to your preparedness to teach mathematics in an elementary classroom?

3. What factors influence the practices you select for mathematics instruction in the elementary classroom?
Appendix G

Interview Informed Consent

The following four questions are for the optional interview portion of the study. Please provide contact information only if you are willing to be interviewed as part of the study. The interview is voluntary. Interviews will be in-person or through zoom and arranged at a time convenient for you. The interview component is made up of 12 questions regarding factors you perceive to influence mathematics instruction and will take approximately 30 minutes.

By entering your name and email, your identity will be associated with the interview responses and known to the researcher. As a participant in the interview, you would be electronically recorded for the purpose of transcription accuracy and the researcher's use of anonymous quotes in the research summary. You may withdraw this consent at any time without penalty; at which point, the recording will be erased.

Any information that you provide will be confidential. All of the data will be summarized, and no individual could be identified from these aggregated results. The data collected from this study will be accessed only by the researcher and maintained on a password-protected computer database. This study has been reviewed and approved by the Research Ethics Review Board at Immaculata University. If you have any comments or concerns resulting from your participation in this study, please feel free to contact the Chair of the Research Ethics Review Board, Dr. Marcia Parris at mparris@immaculata.edu or (610) 647-4400 Ext: 3210.

1. Are you willing to participate in a short interview relative to your perceptions of the factors that influence the practices you select for mathematics instruction in the elementary classroom? (select one)
   a. Yes
   b. No

   ○ I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Chair of the Research Ethics Review Board, Dr. Marcia Parris at mparris@immaculata.edu or (610) 647-4400 Ext: 3210. (select one)
     a. Yes
     b. No

   ○ Your name:
   ○ Your email address:
Appendix H

Interview Instrument

Interview type: (in-person or zoom)
Time of interview:
Date:
Researcher:
Interviewee code:
Grade taught:

At the beginning of the interview, the researcher states: “By responding to the questions, you are giving your consent to participate in the research study. You may refuse to answer any question(s) for any reason and may stop participating in the study at any time for any reason without penalty. The data you provide will be recorded anonymously, and your participation and all responses will be held in the strictest confidence.”

Researcher introduction to interview: “Many factors influence the outcomes and success of mathematical instructional practices. Factors may be a facilitator (helpful) or an obstacle (harmful) to effective mathematics instruction. Considering your current mathematical instruction, please provide an answer to the following questions. Please respond to the following questions about the factors that influence the practices selected for mathematics instruction.”

1. As you consider your mathematical instruction practices, what factors facilitate equity and access for students?
2. As you consider your mathematical instruction practices, what factors are obstacles to equity and access for students?
3. What factors facilitate a high-quality mathematics instruction for your students?
4. What factors create an obstacle to a high-quality mathematics instruction for your students?
5. What factors facilitate the use of mathematical tools and technology for your students?
6. What factors are obstacles to the use of mathematical tools and technology for your students?
7. What factors facilitate the use of assessment as part of your mathematics instruction?
8. What factors are obstacles to the use of assessment as part of your mathematics instruction?
9. What factors facilitate the mathematical success of the students you teach?
10. What factors are obstacles to the mathematical success of the students you teach?
11. What factors facilitate your professional growth toward the effective teaching and learning of mathematics?
12. What factors are obstacles to your professional growth toward the effective teaching and learning of mathematics?