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An Exploration of Mathematical Mindset of Female Novice Early Childhood Teachers

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Katherine C. Swire

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The members of the committee appointed to examine the dissertation of Katherine C. Swire find that this dissertation fulfills the requirements and meets the standards of the Hood College Doctoral Program in Organizational Leadership and recommend that it be approved.

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Jennifer Locraft Cuddapah, Ed.D., Chair Date

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Francis (Skip) Fennell, Ph.D., Member Date

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Christy Graybeal, Ph.D., Member Date

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DEDICATION

This dissertation is dedicated to the first doctoral cohort at Hood College. Your friendship and support meant everything to me. In particular, I dedicate this work to my friend DeVeda, who sat next to me for every class, invaded my space, laughed with me, pushed and pulled me forward and allowed me to do the same for her. In addition to my cohort members, this dissertation is dedicated to my family: my grandchildren who will see me graduate, my children who attended my defense and cheered me on, and most importantly, my husband, who did the grocery shopping and laundry while I wrote. Remember that age is only in your mind, and anything is possible.

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To the students I encounter every day. Thank you for reminding me of my why.

An Exploration of Mathematical Mindset of Female Novice Early Childhood Teachers

Katherine C. Swire, DOL

Committee Chair: Jennifer Locraft Cuddapah, Ed.D.

ABSTRACT

Beliefs about mathematical ability and skills in learning mathematics are sparked from students' earliest school experiences. Early childhood teachers need to feel confident about their skills in teaching mathematics in order to improve student achievement as well as serve as role models for the next generation of elementary teachers. This qualitative study examined the connections between mathematical mindset and self-efficacy of nine female early childhood teachers and their mathematics instruction and students' mathematics achievement. Novice teachers' responses to interviews, a survey, their journal entries, and participation in a focus group were examined to understand their perceptions and beliefs about mathematics instruction and abilities. Student achievement data for mathematics were also analyzed for each teacher participant. Individual and cross participant analysis resulted in four salient findings: (1) Novice teachers wanted to give their students a different mathematics experience than the one they had; (2) A variety of factors impacted novice teachers' instructional experiences and influenced their mindset; (3) Novice teachers held an unconscious bias related to gender and mathematics; and (4) Although novice teachers stated they have a growth mindset, their actual mindset is not indicative of being fully growth-oriented. Implications for future practice and research include considering the path to growth mindset as being one that evolves over time, and novice teachers require induction and other professional development supports to build capacity. Growth mindset, particularly in mathematics, has an impact on the self-efficacy of teachers who, in turn, impact their students.

CHAPTER 1: INTRODUCTION

Fifteen years into my teaching career, I became a specialist in teaching elementary mathematics. My job was to support mathematics understanding and instruction for teachers in Kasey County (pseudonym). After ten years, I still had concerns that teachers were uncomfortable teaching mathematics. Instruction and student achievement were not improving significantly. These concerns led me to examine how novice teachers can be better mentored to bolster their confidence and mathematics competency, leading to better outcomes in early mathematics education. Teachers with a growth mindset about mathematics can encourage the same in their students. Novice teachers who develop a growth mindset classroom where mistakes by students and the teacher are allowed, where students can explore concepts and discuss their findings with others, where the concrete development of skills occurs regularly, will encourage students to develop a growth mindset about mathematics.

Who Teaches Mathematics to the Youngest Learners?

In the United States novice elementary teachers, as they begin teaching mathematics, enter into a teaching context for which they may not be prepared, filled with inconsistencies in how males and females perform on the same tasks. Teachers hone their craft over many years but formalize their teaching style within the first few years of teaching (Anderson, 2017; Cuddapah & Burtin, 2012; Ward, 2015). Good teachers are crucial for student achievement but need professional training in subject matter and teaching pedagogy (Ingersoll, 2012). A teacher's experience in the classroom is significant, and novice teachers have a steep learning curve within their first three to five years of teaching (Darling-Hammond, 2010; Ingersoll, 2012).

Elementary school teachers do not typically have degrees in content areas (TIMSS, 2015). Their degrees are typically in education. They are prepared as generalists responsible for

instruction in many subject areas. The Trends in International Mathematics and Science Study (TIMSS) found that 73% of the U.S. teachers involved in the study majored in primary education but had no degree or certificate in mathematics. Students who had teachers without mathematics degrees had only average mathematics achievement scores (TIMSS, 2015). In contrast, students who had teachers with a degree in education *and* mathematics scored above the international average in achievement by 32 points (TIMSS, 2015). Teachers who have a more extensive educational background in mathematics are more likely to have their students achieve at a higher level than those without such a background.

A novice teacher is defined in the literature as one who is new to teaching (Ingersoll, 2012). A novice teacher may have entered the profession through an accredited teacher preparation program or an alternative program (Cuddapah & Burtin, 2012; Darling-Hammond, 2016). This study examined the mathematical mindset of novice teachers, categorized as those in their first five years of teaching. Many novice teachers begin their careers at schools with high poverty levels, a high percentage of students who speak different languages or need academic support through interventions or special education (Darling-Hammond, 2006). Rather than implementing routines that are part of their repertoire, expert teachers spend time teaching and learning about student understanding, misunderstandings, and students' needs. Novice teachers, in contrast, spend much of the first year learning how to set routines and encourage learning (Darling-Hammond, 2016).

Many U.S. post-graduate teacher certification programs require coursework in reading but not in mathematics. This lack of training puts novice teachers at a deficit when confronted with the challenge of teaching continuously evolving curricula and multiple mathematics topics within a grade level. Using the international average TIMSS score of 500, fourth grade students

of teachers in the United States with five years or less years of experience have an average student achievement score of 530. However, teachers in the United States with twenty or more years, have an average score of 544. (TIMSS, 2015). Not surprisingly, the teachers with more experience had a higher percentage of students scoring in the proficiency range (35% vs. 21%). With more teaching experience comes higher self-efficacy, especially among teachers with more than five years of experience (Banilower et al., 2013).

Seventy-seven percent of elementary teachers in the United States are female (NCES, 2015). In addition to lacking a mathematics background, female elementary teachers may also have a deficit in their mindset about teaching mathematics (Beilock, Gunderson, Ramirez & Levine, 2010). If they were educated by a mathematics-anxious female teacher, they, too, may exhibit mathematics anxiety. Beilock et. al (2010) maintain that more teacher courses or professional learning can mitigate the effects of a mathematics-anxious teacher. Student achievement for girls can be affected by the mathematics-anxious teacher (Beilock et. al 2010). A Conference Board of the Mathematical Sciences (CBMS) report titled *The Mathematical Education of Teachers II* describes the understanding of mathematics that elementary teachers need (CBMS, 2012). Instruction for teachers is required based on how mathematical concepts build over the years from elementary school, through middle school, to high school (CBMS, 2012). The report recommends that novice teachers should not only study the mathematics they teach but also consider the connections between pre-K mathematical concepts and concepts taught beyond the fifth grade (CBMS, 2012).

Novice teachers at the elementary school level bring another piece to the puzzle of lower proficiency levels in mathematics achievement. While fourth graders in the United States achieved at thirty-nine points above the international TIMSS average, thirteen countries scored

higher and the gap between the highest achieving countries and the next level of achievement remained at twenty-three points from the 2011 data (TIMSS, 2015). Novice teachers are new to the craft of teaching and still learning the skills needed in the classroom. Beginning teachers are faced with simultaneously learning the overall craft of teaching and mathematics content while clarifying their beliefs about mathematics education (Guillaume & Kirtman, 2010). Elementary teachers in grades kindergarten through second grade have significant potential to directly affect the mathematical beliefs of young students (Wheeler, 2016). Young students can learn mathematical thinking and primary grade teachers can support and enrich this learning for all students (Wheeler, 2016). Putting these disparate pieces together adds to the understanding of the mathematical mindset and instructor efficacy in teaching mathematics to young students.

The lack of familiarity and comfort many elementary teachers have with mathematics content may contribute to their students struggles with mathematics. Results from TIMSS (2015) indicate that students in the fourth grade in the United States, where many elementary teachers do not have extensive preparation in mathematics nor a degree in mathematics, do not do as well mathematically as students of the same age in top scoring TIMSS countries. These countries had more elementary teachers, than in the United States, with either a degree in education and mathematics or solely in mathematics (TIMSS, 2015). Overall t 4^{th} grade achievement scores in mathematics of students from Singapore, Hong Kong, Korea, Chinese Taipei, and Japan were 53 to 84 points higher than for students in the United States (TIMSS, 2015).

Considerations of Gender

Not only does the preparation of the teacher have an impact on student achievement in mathematics, but also the connection of gender and mathematics. The TIMSS (2015) data indicated that female students scored substantially lower than their male counterparts, the

average scores on the 4th grade math assessment showing a statistically significant difference between the boys' average score (543) and the girls' (536)average score. The gender difference was statistically insignificant (TIMSS, 2015). The Organisation for Economic Co-operation and Development (OECD, 2018) noted similar results for fifteen-year-old students. However, there were statistically significant differences between results for boys and girls, with boys outperforming girls, particularly at higher-achieving levels (OECD, 2018). The overall fifteen-year-old student achievement in the United States compared to other countries shows a flat trend with the United States already below the average score of 489 for OECD countries at 478 (OECD, 2018).

The National Assessment of Educational Progress (NAEP) notes that the level of proficiency in mathematics has remained around 40% in U.S. public schools from 2017 to the present (National Center for Education Statistics [NCES], 2019). A gender gap between males and females in fourth-grade mathematics has remained the same from 1990–2017 (NCES, 2019). The scale scores of 242 (male) and 239 (female) indicate a statistically significant difference between males and females, with males scoring higher than females (NCES, 2019). Given that novice teachers at the early childhood level are overwhelmingly female and given the discrepancy in mathematics achievement for male and female students, it is important to acknowledge gender in the context of any study on mathematics, self-efficacy, and teaching. Although their gender and their experiences learning and teaching mathematics as females was not the focus of this research, it should be noted that all nine participants were female.

Theoretical Framework

As I sought to explore the experiences of female novice early childhood teachers with mathematics instruction, I was drawn to two concept which influenced my theoretical framing—mindset and self-efficacy. Dweck (2006) defines *mindset* as growth or fixed, that is, the belief that one is either born with a set intelligence (fixed) or can enhance the intellect with more learning (growth). Dweck (2006) suggests that the "*view you adopt for yourself* profoundly affects the way you lead your life" (p. 6). A fixed mindset believes that one is born with intelligence cannot be changed; a growth mindset, in contrast, believes that new ideas can be learned or that working harder improves overall abilities (Dweck, 2006).

Dweck's work helps with understanding how a teacher's beliefs influence actions in general, but it is Boaler's (2016) work that took Dweck's framework and applied it specifically to mathematical beliefs in students. Boaler (2016) suggests ways for teachers to foster a growth mindset and notes that mistakes are essential for learning to occur in mathematics. She further explains that a person with a growth mindset increases brain activity and learning when a mistake is made and is more likely to go back and correct the mistake (Boaler, 2016). This is an essential concept for instructors to understand when teaching students.

Boaler's (2016) mathematical mindset work provides a framing for how to help teachers facilitate learning for their students, and as such, it is really about having a growth mindset about *students*. For this study, because I wanted to explore novice teachers' mindset, I sought another link that would help me understand their own mindset and what influenced it. Bandura (1982) talks about self-efficacy, and when taken in conjunction with the mindset concepts, the theoretical framing is rounded. According to Bandura (1982), self-efficacy is concerned with how a person "deal[s] with one's environment" in a way that is not passive or without agency,

but “rather, it involves a generative capability in which component cognitive, social, and behavioral skills must be organized into integrated courses of action. For novice teachers, their self-efficacy is important because they must feel a general sense of capability for what they are required to know and do. Teachers’ self-efficacy can be influenced, and they may improve their ability to teach mathematics if they feel they have mastered the subject and have been successful in teaching mathematics. Bandura (1977) determined that performance accomplishments inform one’s self-efficacy. As teachers’ mindsets about mathematics move toward a growth mindset, their self-efficacy about mathematics instruction improves (Boaler, 2016).

Problem Statement

Early childhood teachers, the majority of whom are female, enter the classroom with a general background in the multiple content areas they will teach. Typically, these teachers have taken some math classes in college but not necessarily in the specific concepts they will be teaching. They may perceive their skills in the teaching of mathematics to be less effective than in other content areas they teach, and this may be unconsciously shared with students, especially girls (Beilock et al., 2010; Dowker, Sarkar, & Looi, 2016; Geist, 2015).

A growth mindset in mathematics, or “mathematical mindset,” may improve elementary teachers’ self-efficacy around mathematics instruction. Novice teachers, within their first five years of teaching, are also susceptible to the stressors of the job and may leave the profession (Darling-Hammond, 2012; Ingersoll, 2012). The cycle continues with female teachers feeling less than proficient in the classroom and translating that sense of inadequacy (consciously or unconsciously) to students, particularly girls, some of whom become female teachers with lowered self-efficacy related to mathematics.

Novice teachers may struggle to incorporate strong mathematics instruction within a generalist view of the classroom, since early childhood teachers must teach multiple subjects. Although mathematics is important, many teachers need to prepare at least four or five different lessons in various content areas, which may impact instruction. Mathematics may take a backseat to language arts or a social-emotional curriculum. The teacher has competing priorities and must choose on her own or be forced by the school's administration or teammates to adjust and find time in the day for all these subjects.

In an era of accountability and assessments, novice female teachers may feel pressured to teach in a certain way. If the administration, teammates, and the school system are all pushing for high student achievement, novices may feel there is no time to stop to discuss mathematics within lessons they are teaching. They may want to spend time exploring big ideas and concepts in mathematics, but the push for students to do well particularly, on end-of-year state or district-mandated assessments may feel insurmountable. Novice teachers do not yet have the experience to prioritize or incorporate multiple concepts into the lessons. Presenting novice teachers with a curriculum and assessments that are structured in a linear, timeline-driven way do not allow teachers to expand student thinking (Darling-Hammond, 2010; 2016). This level of accountability or structure can inhibit the level of instruction in the classroom. Instruction becomes, "Do the problem like this. Get this answer. Let's move on." Teachers feel less sure of their own instruction, especially if they do not agree with a constraining structure. These feelings can impact teachers' self-efficacy and growth mindset about teaching mathematics.

Novice, female, early childhood teachers who with low self-efficacy related to mathematics instruction are susceptible to choosing not to spend as much time on teaching math as on other, favored topics about which they feel more competent. This choice can lead to mathematics

instruction for students that is disjointed or incomplete. Students could begin to follow the teacher's lead and feel that mathematics is a subject that can be put to the side and pulled out when there is time. Teachers who model, whether consciously or unconsciously, insecurity around mathematics and/or the teaching of mathematics convey to their young students powerful messages that can be replicated and perpetuated. There is a need to determine where teachers link their self-efficacy to mathematics instruction and where improvements can be made in self-efficacy and developing a growth mindset. Teachers appear to draw experiences from their childhood and college instruction. If that premise is true, then administrators, college professors and school-based teammates must ensure that good mathematics instruction occurs. This in-depth case study of early childhood, female teachers focused around their mathematical mindset provided one means of exploring this link between self-efficacy, growth mindset, and mathematics.

Purpose of Study

The purpose of this qualitative case study was to explore how the mindset and self-efficacy of early childhood, female teachers impacted their mathematics instruction and to determine what other factors, if any, impacted them. This study sought to inform understanding about how the mindset translates into the classroom as teachers deliver mathematics instruction. Boaler (2016) pointed out that understanding mathematical content and having a mathematical mindset are essential for elementary teachers. She stated, "This is often particularly important for elementary teachers because many have, at some point in their own learning, been told *they* cannot do mathematics or that mathematics is not for them" (p. 8).

Qualitative methods allowed me to listen directly to novice female teachers and hear their stories. In their words, I could hear and share what impacted their thinking and beliefs about

mathematics. The one-on-one interviews and the focus group structure allowed for questions to be asked based on responses and were not limited solely to a more structured, closed response survey. A qualitative approach allowed for nuances of nonverbal responses as well. Facial responses such as a slight smile or laugh allowed me to see and better understand what these new teachers meant with their verbal responses. In some cases, I asked for clarification of those nonverbal responses, which added to the story each teacher shared. The richness of the discussions and the shared experiences in reviewing student work or talking about a mathematics lesson improved the data collected and the findings from this study.

Research Questions

This qualitative case study sought answers to the following research questions for the following reasons:

RQ1: *How does a growth mindset and self-efficacy of early childhood teachers connect to mathematics instruction and a mathematical mindset?* Other researchers have looked at either mindset (Dweck, 2006; Suh, et al., 2011; Education week research center, 2016) or self-efficacy (Bandura, 1977, 1994; Hoy, 2000; Ozder, 2011). I wanted to explore the connection between the two concepts to look at early childhood teachers since they are the first mathematics teachers their students encounter. Female teachers' self-efficacy and mindset toward mathematics instruction can influence female students and the next generation of teachers.

RQ2: *What factors do novice teachers perceive as affecting their ability to teach mathematics to young children?* Researchers such as Darling-Hammond (2012) and Ingersoll (2012) have shared that an induction program can aid in the development of a positive mindset about teaching and improve the retention of teachers. I sought to determine, from the teacher

participants in my study, whether or not other factors influenced their daily mathematics instruction.

Overview of the Research Methodology

Through qualitative case study, nine novice female elementary teachers at the early childhood level were surveyed and interviewed about their mindset related to teaching and mathematics. Female teachers make up 94% of the teaching staff at the elementary school level (Banilower et al., 2018). Novice teachers are those who continue to learn about teaching and finding their own style until about their fifth year when teaching skills settle into a pattern, and I wanted to gather their perspectives about mathematics and teaching during this critical first-five year window. The elementary teacher participants worked in Kasey County. Teachers who fit the parameters of the case study (female, first five years of teaching, early grade levels) were asked to participate in an initial email survey, and any teachers who wished to continue the study were asked to indicate such willingness at the end of the survey and provided their name and email. Nine teachers out of 32 from across kindergarten, first, and second grades chose to continue with the study.

A mathematical mindset survey (Appendix A) was used to collect general data about each teacher's mindset about mathematics when they were students. The survey questions were taken from the work of Anderson et al. (2018). Responses to the survey statements focusing on mindset were completed on a Likert scale. The first sixteen questions were from Anderson et al. (2018), reflecting students' beliefs about mathematics. I asked respondents to consider their responses reflecting on their experiences first as a student. The remaining sixteen questions were adjusted from Anderson et al. (2018) to reflect statements about their experiences as a teacher.

The survey and initial interview questions went through a pilot study to determine their utility in this study.

Interview protocols (Appendix B) included self-anchoring items to determine mindset in practice. During the interview process, teachers were asked to identify factors that influenced their beliefs about mathematics and those supports they wish had been in place to sustain their teaching. Videos of mathematics lessons from a professional development module available to the researcher were used to co-observe a mathematics lesson with participants in a focus group. The participants were asked to reflect on the teaching observed in the video and share evidence they noted as indicating a growth mindset in mathematics. Anonymous student work was shared in the focus group to elicit additional responses about teaching and a mathematical mindset. Quarterly, participants were asked to complete a short, one-question journal entry to give respondents an opportunity to talk about mathematics throughout the year.

Students are examined on the skills taught in each quarter of the school year. Data were collected via the local school system assessment software. The skills build on each other over the course of the year, so cumulatively, the assessments should monitor the achievement of the essential curriculum in mathematics at each grade. As the school year progressed, student achievement data, as measured by local assessments, were gathered, and reported for the students of each teacher participant. Through the collected data from the teachers and the student data, connections between the mindset of the teacher and student success on the assessments were sought. After analysis, it was determined that the way student achievement is measured in Kasey County may not be a strong predictor of the mindset of the teacher due to the difficulty in determining just one factor as the major reason for student achievement. However, the achievement data provided some additional information related to the teacher participants.

Researcher Positionality

I am an educator with thirty-five years of experience and have spent ten years as a mathematics teacher specialist for Kasey County. My responsibilities, as a mathematics teacher specialist, included training teachers in the use of manipulatives for helping to develop mathematical concepts, problem solving, and other mathematical practices, questioning, flexible grouping, and modeling lessons that follow constructivist theory. In those ten years, I listened to many teachers share stories about how they were not good in mathematics. I observed several teachers cry in workshops as they recalled their early years spent in school and the time spent at the kitchen table trying to memorize math facts and failing the test at the end of the week. I wanted teachers to love mathematics, to find the joy in teaching mathematics to their students and to learn deeper ways to understand and appreciate mathematics by working with their students.

My experiences in mathematics instruction as a student were like what I saw and heard from the teachers I was supporting. The difference, I believe, can be traced back to two instances, early in my career. As a young adult, I had to take an exam as part of the interview process for a teaching position and my mathematics scores were higher than any other content. That was a surprise to me and I began re-thinking my abilities. My beginning teaching classrooms were in special education. The analysis that occurred when I reviewed student work led to a burgeoning passion for mathematics. After several years in the classroom, I became a mathematics and science teacher specialist. As my skills and understanding increased in mathematics, my excitement for teaching mathematics increased, and I began my journey to improve mathematics instruction. I did not want students or teachers in the elementary schools to see mathematics as difficult or boring.

Many teachers come to mathematics believing that instruction is about getting the right answer or just following the steps. Students need to understand the mathematics behind the equation. They need to know how to problem-solve and understand when to select an efficient strategy to help them. The algorithm becomes an efficient strategy when the concepts are clear, and students have had time to practice using the algorithm. The National Council of Teachers of Mathematics (NCTM) encourages teachers to engage student in mathematical tasks that promote problem solving and reasoning. The six guiding principles from NCTM identify the importance of a curriculum that develops important mathematics along coherent progressions (NCTM, 2014). Teachers must be learners and be able to teach mathematics with a focus on deep understanding to be effective. The Common Core State Standards for Mathematics (CCSS-M, 2010) are clearly articulated and outlined for teachers. Some of the most important standard statements come through the Standards for Mathematical Practice, which include "making sense of problems and persevering in solving them" (CCSS-M, 2010 p. 6).

Significance of the Study

Exploring the mathematical mindset and self-efficacy of elementary teachers continues to be an area worthy of research because the cycle has not ended. Female teachers, as a group, do not yet demonstrate strong self-efficacy toward teaching mathematics. From personal experience, the ability of an elementary teacher to teach mathematics comfortably and well has not changed significantly over the past five years or more. Students in preservice teacher education programs are expected to complete 12 credits in mathematics toward receiving a bachelor's degree in education (Maryland State Department of Education [MSDE], 2019). These 12 credits are all in mathematics content (e.g., a course in statistics) but are not all necessarily relevant to elementary mathematics education. For instance, my review has found that some of the required

mathematics courses focus more broadly on mathematics in everyday life (e.g., one such course was titled, “The Mathematics of Democracy”).Some courses focus more broadly on mathematics in everyday life or the mathematics of democracy.

Do novice teachers need additional support in mathematics? For example, studies have been conducted in which teachers have indicated that watching an experienced teacher would be helpful (Anderson, 2017). Such observations and mentoring are beyond student teaching or interning and would occur once the novice is in the classroom. However, if the experienced teacher also feels uncomfortable teaching mathematics, she may pass that mindset along to new teachers. Teachers in public schools have an elevated level of attrition within the first five years (Darling-Hammond, 2003; Ingersoll, 2012). If teacher effectiveness increases after the first few years of teaching, then administrators need to consider the supports needed to keep teachers in the profession. There is evidence that teachers who are better prepared tend to stay in teaching (Darling-Hammond, 2003, 2006).

The induction of new teachers takes on a new light when research indicates that novice teachers retain more information and become better teachers when immersed in an induction program (Ingersoll, 2012). Administrators should consider an induction program for the first few years of teaching as an opportune time to help novice teachers settle into best practices of instruction. Guillaume and Kirtman (2010) found that even at the preservice level, prospective teachers are entering the profession with beliefs about mathematics based on their experiences. If there is an opportunity for change in those beliefs, one should focus on that opportunity with the intent of improving student achievement in mathematics. Hattie (2012) noted that teachers have the most significant impact on student achievement. When teachers are interested in teaching, receive professional training, and are supported by others, there is a clear impact on the

performance of the school and students (Hattie, 2012). This study sought to inform understanding about a teacher's beliefs and self-efficacy about mathematics instruction that could be used in planning and implementing induction practices to support novices.

As noted earlier, the United States continues to lag behind other countries in mathematics achievement (TIMSS, 2015). Despite changes in standards, curriculum materials, an increase in the number of mathematics credits required at the preservice level, and professional development opportunities for teachers, results indicate that students are not receiving the instruction they require to advance their skills in mathematics. Therefore, I sought to explore how a mathematical growth mindset was linked to a teacher's self-efficacy in teaching mathematics with the goal of thinking about how to understand how to improve that teacher's effectiveness in teaching. Principals, assistant principals, teacher leaders and central office staff who share the responsibility for improving mathematics achievement may benefit from the results and recommendations of this study as they seek ways to enhance the effectiveness of elementary teachers and bolster mathematics achievement for all students.

Definition of Key Terms

The following operational definitions are used in the discussion of this research.

Growth vs. Fixed Mindset: a belief system that suggests that one's intelligence can be grown or developed with persistence, effort, and a focus on learning (growth) vs. a belief system that suggests that a person has a predetermined amount of intelligence, skills, or talents (fixed). (Boaler, 2016; Dweck, 2006; Ricci, 2015).

Mathematical Mindset: a growth mindset in mathematics, including strategies that support this concept in students (Boaler, 2016).

Self-efficacy: the belief that one's own efficacy is determined by the initiation of coping behaviors, the increase of effort, and the ability to persevere when confronted with obstacles and difficult experiences (Bandura, 1977).

Student achievement: a result gained by effort; the quality and quantity of a student's work (retrieved from https://www.merriam-webster.com/achievement).

Conclusion

This section presented an introduction to the research background information, major concepts involved in the study, the problem and purpose addressed, the researcher positionality, and the significance of this qualitative case study. The following sections outline the thesis and results obtained from this qualitative methods study. The next chapter, the literature review, is an overview of the relevant descriptive and empirical research. The literature review outlines the research currently available and situates this study. Then, the third chapter details the methodology of the study. Methodology was organized to share the components of my research. Chapters 4 and 5 take the reader into the thinking and words of a small group of early childhood female teachers in Kasey County. These novice teachers ranged in experience from a few months to a few years. They were open to sharing a variety of ideas through several research methods. The findings and results section became the voice of each teacher. Each shared her thoughtful responses to interview questions and engaged in a focus group where the interactions were less guarded and guided by responses from others. Short journal entries provided an additional window into each participant. Student data are included. The discussion of those responses and how the research questions are answered by the participants I conclude the dissertation with implications for the field of education and areas for continued research.

CHAPTER 2: LITERATURE REVIEW

A growth mindset affects the female novice teacher's instruction in mathematics. This mindset is also influenced by one's self-efficacy in teaching mathematics (Banilower et al., 2018). Teachers who have a growth mindset and high self-efficacy about mathematics instruction can motivate students to be excited about mathematics. However, female novice teachers at the early childhood level have additional stressors as they begin their careers. They juggle expectations of themselves and those of administrators, peers, families, and students. As they begin, they are pulling from a bare-bones repertoire of skills to engage and maintain the attention of students in the classroom. New teachers might try modeled lessons or activities observed from a veteran teacher where the new teacher had been an intern. Novices may draw upon experiences from college-level courses or from resources provided to them. Most novice teachers plan day-to-day. A planned lesson may not go well or stretch into another day. There is pressure to "cover" content as school systems push to show high student achievement.

Many female novice teachers leave the profession within their first five years of teaching. The number of teachers leaving is alarming, and the United States now finds itself in a teacher shortage (Cardichon et al., 2020; Darling-Hammond, 2003; Hong, 2010). Teachers who are comfortable teaching and can find the balance between expectations and reality become models for novice teachers. However, that experienced teacher may bring a fixed mindset about mathematics to the classroom. The novice teacher may not see teachers with a growth mindset about mathematics and that may lead her to question her own beliefs about mathematics instruction. Early childhood teachers need to experience and believe in the excitement of teaching mathematics to young children. They need to know that spending time in discussions, asking open-ended questions that may take more than one lesson to answer, and guiding students

toward discovery are valuable and worthwhile pursuits in the classroom. Those who support and encourage novice teachers need to allow those structures so that students and teachers can flourish.

In this chapter, selected descriptive and empirical literature is presented. The areas covered are around the main concepts influencing this study—growth mindset, mathematical mindset, teacher self-efficacy, and the connections to female teachers and students. It is important to know what other researchers have found and other writers have described in order to situate this case study research.

Growth Mindset Theory

Dweck's (2006) theory of the growth vs. fixed mindset serves as the foundation for and is the main basis of the theoretical underpinnings of this research study. A growth mindset is defined as the belief that intelligence can be fostered and stretched through multiple experiences, which can affect everyday life. A fixed mindset, or the belief that one's intelligence cannot increase, also can influence daily activity. Dweck's (2006) theory suggested that a growth mindset allows for new ideas and experiences to increase beliefs about what it is possible to do or not do. Growth mindset activities lead to self-efficacy changes, which may inspire confidence in teaching mathematics or making decisions and learning from mistakes. Other researchers (e.g., Boaler, 2016; Ricci, 2015) have expanded Dweck's theory to include the thought processes in the classroom and in mathematics education.

Ricci (2015) concluded that parents, teachers, and students need to think about potential and hard work as indicators of success. Her research found that students in kindergarten, first and second grade did not display much of a fixed mindset. Kindergarteners showed no evidence of a fixed mindset, but as the grade level increased, so did the percentage of students who believed

they had a fixed level of intelligence (Ricci, 2015). Both Ricci (2015) and Dweck (2006) claimed that students and teachers who use a growth mindset to learn can become better at the tasks in front of them. One's self-efficacy toward teaching can affect the first few years of teaching. Experiences as an intern teacher then moving into one's own classroom can be a struggle. A novice teacher, especially a female novice teacher, can spend time believing that the first few years of teaching are hard, and that struggle may lead to an exodus from teaching (TIMSS, 2015). If one has a fixed mindset, the long hours, mistakes, parent phone calls, behavior management, and failed lessons could lead to a belief that teaching is not the right career (Darling-Hammond, 2010). Teachers with a growth mindset will see the need for valuing student ideas and move toward a student-led classroom versus the more traditional teacher-directed classroom (Anderson et al., 2018). As Dweck (2016) said, "Mindsets are just beliefs" (p. 16).

Students and teachers who pass through the educational system in the United States have come to believe that the right answer demonstrates intelligence (Dweck, 2006). A study by Dweck (2006) showed the power that one test can have on students' beliefs about themselves as learners. Even suggesting to a student that an assessment will indicate your intelligence can have a long-lasting impact. Students with a fixed mindset believed that a test in a closed box would measure their intelligence not only currently but in the future. This belief gave power to an unknown assessment. A poor grade is interpreted as failure and results in a belief that one is not smart. A teacher's words can have the same power over those beliefs (Dweck, 2006; Ricci, 2015). Teachers may have heard statements about their own abilities throughout school. Dweck indicates that once those beliefs are set, it can be difficult to change them. A simple statement or test from the primary grades in elementary school can be carried through life and have an impact on one's job, marriage, or education. Dweck also noted that a fixed mindset becomes protection

from demanding work. Students and teachers may decide that challenging work could lead to failure, and therefore are discouraged from trying. She also noted that college students exhibit this characteristic early in their college careers.

Mathematical Mindset

As the term implies, mathematical mindset is a growth mindset theory applied to mathematics. Boaler (2016) defines mathematical mindset as "knowing that the math is a subject of growth and their [students] role is to learn and think about new ideas" (p. 34). Boaler (2016) states that we are all learners of mathematics and that we are all capable of doing mathematics. She uses Dweck's (2006) mindset theory to talk about a growth or fixed mindset in mathematics. Boaler's position as a professor of mathematics in both England and the United States gave her access to Carol Dweck and a conversation about mathematical mindset. She engaged mathematics teachers and parents in an online course and found that adults carried trauma about mathematics into their learning. They believed that an aptitude for mathematics was something people were born with. Boaler (2016) also found that students continue to hear negative messages about mathematics from well-meaning teachers. The belief that all people can be strong mathematical students and learners of mathematics created new ways to think about teaching and learning to promote mathematical growth (Boaler, 2016).

In her recent research, Boaler (2016) found that student achievement in mathematics is strongly related to a growth mindset of the teacher and her students. A growth mindset allows students to experience mathematics through exploration of patterns or problem-solving, which encourages them to solve problems with or without an algorithm. Students begin to see themselves as good in mathematics and find strength in their work. Teachers need to work through mathematics in the same way, becoming students as they grapple with difficult

mathematics problems (Boaler, 2016). Instructors should be open to learning innovative ideas and ways to solve problems to teach students. Boaler (2016) states:

> Many of the elementary teachers I have worked with . . . have told me that the ideas I gave them on the brain, on potential, and on growth mindsets has been life-changing for them. It caused them to develop a growth mindset in mathematics, to approach mathematics with confidence and enthusiasm and to pass that on to their students. (p. 8)

It is not enough to talk about growth; the teacher must show it in her actions. In this study, the specifics around mathematical mindset for the novice teachers was important to explore. Desiring to understand the connections between growth mindset and mathematical mindset, I sought data to inform how these new teachers talked about themselves in terms of mathematics as well as teachers of mathematics.

Female Elementary Teachers, Self-Efficacy, and Mathematics Content Preparation

The most recent TIMSS (2019) study found that 90% of elementary mathematics teachers are female, and Banilower et al. (2018) noted that 94% of the mathematics teachers at the elementary level are women. Mathematics anxiety is prevalent among teachers of kindergarten through second grade (Geist, 2015), most of whom are female. The self-efficacy of female elementary teachers plays a crucial role in mathematics instruction (Beilock et al., 2010; Boaler, 2016). According to Bandura (1994),

> Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. (p. 71)

Bandura (1994) also notes that those with low self-efficacy in specific domains shy away from difficult tasks. Failure to do well in any area, including mathematics, leads to low aspirations, perceived obstacles, and the potential for unfavorable outcomes rather than a focus on how to perform successfully. Understanding one's ability in demanding situations allows one to practice being successful; one can predict the possible outcomes of a situation and learn strategies for being successful (Bandura, 1986). Gaffney (2014) maintained that teachers must learn the mathematical content for their beliefs to change. All teachers need to have a growth mindset and demonstrate that in the classroom (Suh, Graham, Ferrarone, Koepning, & Bertholet, 2011), yet, as Dweck (2006) points out, once efficacy beliefs are set, they seem difficult to change. Females may encounter their own fixed mindset about mathematics from earlier life experiences (Beilock et al., 2010). Having a growth mindset, and particularly around mathematics, would suggest that teachers can reframe their beliefs into practices that influence their self-efficacy which in turn can influence the students they work with.

Fewer than five percent of elementary teachers have a degree in mathematics or both education and mathematics content. In comparison, middle and high school teachers, are closer to fifty to eighty percent (Banilower et al., 2018). This could be because elementary teachers are subject area generalists, but the self-reported data does show a gap between the background knowledge of elementary teachers and secondary teachers. Ninety-two percent of elementary teachers have taken courses in mathematics for teachers while approximately half have taken mathematics courses such as college algebra or statistics. Although the Mathematical Education of Teachers (CBMS, 2012) recommends that elementary teachers have courses in number and operations, algebra, geometry, probability, and statistics, only seven percent of elementary teachers have had courses in each area (Banilower et al., 2018). Seventy-three percent of

elementary school teachers are comfortable teaching the mathematics involved in number and operations or general mathematics concepts. Fewer elementary teachers are comfortable with teaching content in measurement and data, geometry, and early algebra. Large numbers of teachers do not agree with recommendations to improve mathematics teaching. As many as 34% believe students should receive an explanation of a concept before exploring or using manipulatives as reinforcement of concepts instead of using them to develop the initial understanding (Banilower et al., 2018). As many as 82% of the elementary teachers surveyed felt that vocabulary needs to be introduced at the beginning of a lesson (Banilower et al., 2018). These practices are considered more traditional compared to reform-oriented beliefs.

Teachers need to understand the mathematics and pedagogy associated with their teaching responsibilities. This would include mathematics concepts, skills, and related pedagogy at grade levels before and after the grade they currently teach (CBMS, 2012). Recent reports strongly suggest, even require, that the college mathematics coursework for prospective elementary classroom teachers include content and pedagogy related to number and operations, algebra, measurement, data, and geometry (CBMS, 2012; CAEP, 2018).

In 2018, the Council for the Accreditation of Educator Preparation (CAEP) approved new standards for elementary level teacher preparation. As a part of CAEP accreditation, teacher preparation programs were required to include content knowledge and pedagogical skills. The CAEP elementary standards support the statements made in MET II (CBMS, 2012) about teacher preparation around mathematics. Teachers need to understand what they are teaching as well as how to teach the content. The new standards "require beginning K-6 teachers to possess a deeper content knowledge than previously expected…" (CAEP, 2018, p. 143).

As noted by Banilower et al. (2018), most elementary teachers do not feel they have a comfort level with teaching mathematical concepts outside of number and operations. Teachers need to study the mathematics that they will teach but also spend time understanding how to teach the mathematics (CBMS, 2012). Teachers should also have a strong understanding of the mathematics needed before and after the grade level they teach (CBMS, 2012).Teachers need to understand the mathematics and pedagogy associated with their teaching responsibilities. This would include mathematics concepts, skills, and related pedagogy at grade levels before and after the grade they currently teach (CBMS, 2012). Recent reports strongly suggest, even require, that the college mathematics coursework for prospective elementary classroom teachers include content and pedagogy related to number and operations, algebra, measurement, data, and geometry (CBMS, 2012; CAEP, 2018).

TIMSS (2019) supports this data as well and correlates it to student achievement on the TIMSS. mathematical assessments. Teachers with both a degree in mathematics *and* in education, have students who score higher on TIMSS (2015). In the United States, students who had a teacher with both a specialization or degree in mathematics and one in education had an average score of 537, which is 32 points higher than the international average. (TIMSS, 2015).

The MET II recommends that elementary teachers take 12 credits focused on the study of mathematics in their preservice preparation courses (CBMS, 2012). The authors also recommend that practicing teachers add to their knowledge by continuing professional development in mathematics (CBMS, 2012). The specific recommendations include courses that blend mathematics content and the pedagogy of teaching that content (CBMS, 2012). There should be an emphasis on the practices of mathematics as an elementary teacher and the opportunities to engage in doing mathematics (CBMS, 2012). The MET II also notes that teachers come to

preparatory classes with their own mindset and insecurity about teaching mathematics (CBMS, 2012). There may also be the belief in prospective teachers that learning more mathematics is not needed despite the complexity of the Common Core State Standards for Mathematics (CBMS, 2012), standards in English language arts and mathematics designed to ensure students are college and career ready when they graduate from high school in the United States.

Mathematics Anxiety

Descriptions of anxiety are common for people describing how they feel about mathematics, and these feelings influence mindset and self-efficacy (Anderson et al., 2018; Dowker et al., 2016; Stoehr, 2017; Tasdemir et al., 2019). Several researchers discuss mathematics anxiety as a variable in mathematics instruction (e.g., Anderson et al., 2018; Beilock et al., 2010; Dowker et al., 2016; Geist, 2015; Peker, 2016; Stoehr, 2017). Summarizing results of a study of Head Start teachers, Geist (2015) offered observations that are crucial for female teachers of mathematics. His findings suggest that teachers may rate their abilities in mathematics as lower because they are not confident in their abilities. Confidence increases as skill increases. Teachers claim that they are more confident in teaching mathematics in a preschool setting when they feel their skills are strong (Geist, 2015). Mathematics anxiety may cause anxious teachers to avoid mathematics, and this may impact their planning and classroom instruction (Geist, 2015). Beilock et al. (2010) state that "having a highly math-anxious female teacher pushes girls to confirm the stereotype that they are not as good as boys at math, which, in turn affects girls' math achievement" (p. 1861).

In contrast, Ma (2010) proposes that while elementary school teachers have anxiety related to mathematics, they also have positive attitudes about mathematics. Despite the positive attitudes, the results of Ma's study indicated that American teachers did not understand have the

content knowledge or pedagogical expertise to be effective. U.S. teachers, Ma maintained, were capable of doing calculations and giving explanations, but many did not have a conceptual understanding of mathematics (Ma, 2010). Yet, because they could do procedural steps in computation, they did not have anxiety (or perhaps even awareness) about their lack of conceptual understanding.

Dowker et al. (2016) found that mathematical anxiety can interfere with mathematical learning and self-efficacy. They also make a point that while anxiety may decrease as one ages, females tend to continue to rate themselves poorly in mathematics over time. The authors state that anxiety related to mathematics may be related to interacting with other people who model negative attitudes towards mathematics. Dowker et al. (2016) note that the possibility of confirming a stereotype may also contribute to anxiety about mathematics. Females may be anxious that their mathematics performance will confirm the belief in their students that females are less successful than males in mathematics. Of note is the idea that mathematical anxiety may interfere with working memory, which could impact success in mathematics (Dowker et al., 2016). Research from Beilock et al. (2010) confirms that female teachers show more mathematics anxiety than their male counterparts, and this mathematics anxiety can contribute to lower achievement in female students. “Girls who confirmed traditional gender ability beliefs had significantly lower end-of-year math achievement” (Beilock et al., 2010, p. 1961). More importantly is the idea that achievement results did not support this idea at the beginning of the year. There was no difference between boys’ and girls’ achievement (Beilock et al., 2010). The data from Beilock et al.’s (2010) study suggest girls’ mathematics achievement is tied to the mathematics anxiety levels of their female teachers.

Implicit Messages to Students

Interestingly, girls may report being better readers than mathematicians even though assessment scores do not support this belief (LeGrand, 2015). This suggests that female students' beliefs about themselves and their performance in mathematics may not only be negative but may also be inaccurate. These deeply held beliefs inform the resulting mindset and self-efficacy that future teachers from this group would bring to their students when teaching mathematics.

In this vein, Sun (2018) suggests that teachers send implicit messages to their students regarding a growth or a fixed mindset. Teachers may be using the language of a growth mindset but limit access to challenging problems. In some cases, only those students who complete assignments quickly have access to challenging problems instead of all students. The implication is that only some students can do complicated mathematics. Teachers may structure discussions in mathematics to lead children toward a correct answer or one strategy to solve a problem (Sun, 2018).

Butz and Usher's (2015) study asserts that teachers need to think about the messages, communicated verbally and through actions, they send to students, as such messages can impact students positively or negatively in the classroom. Encouragement from others and experiencing challenging mathematics while a student, can increase self-efficacy about mathematics. They found that a student's self-efficacy, whether high or low, was strongly influenced by the teacher. As Boaler (2016) suggests, "Teachers need to replace sympathetic messages such as 'Don't worry, math isn't your thing' with positive messages such as 'You can do this, I believe in you, math is all about effort and hard work'" (p. 105). By reframing the messaging, teachers are not only articulating a different belief system, but they are putting into action that very system. What

needs to happen in addition to this, however, is the matching of mathematical learning experiences that guide students through the skills and discussion reflective of growth mindset.

Impact of Growth Mindset on Student Achievement

Ultimately, if teachers want to see their students perform well in mathematics, they need to not only have the self-efficacy to plan and teach the material, but they also need the mindset about their students to make that happen. Research exists to connect growth mindset to student achievement. Hanson, Ruff, and Bangert's (2016) research suggests a connection between the school level (elementary versus secondary) that impacts the growth mindset of an entire school. They define a school growth mindset as "the belief in their teachers' ability to help all students grow and learn" (p. 204). They suggest that a school-wide growth mindset encourages students to attempt more challenging work, which results in improved student achievement (Hanson et al., 2016).

Guerra and Lim (2017) found that the teacher provides the classroom environment where students may solidify beliefs that will be difficult to change later. Students learn about success based on the expectations set in the classroom (Guerra and Lim, 2017). Anderson et al. (2018) state that "mathematics anxiety has been shown to reduce performance and to be passed on from teachers and parents to students" (p. 2). They propose that teachers need to change their views about learning, and that will improve teaching (Anderson et al., 2018). They also advise that teachers who do not change their teaching around mindset may be impacting student achievement (Anderson et al., 2018). Teachers are sending the message to try hard but not showing how that can be done (Anderson et al., 2018). Anderson et al.'s (2018) research shows a statistically significant, positive correlation between a changed teacher's mindset and student achievement.

Kohn (2015) suggests that mindset is not the only piece that impacts student achievement and success in school. He argues that Dweck is not an educator and therefore misses essential points related to instruction that may impact student success. He supports perspectives from authors like Anderson et al. (2018) and Geist (2015) around proper mathematics instruction but goes on to suggest that extrinsic rewards such as praise are not beneficial to students. Kohn (2016) also argues against productive failure, stating that students need to have experienced success prior to that failure. He states that education built on constructivist ideas is ignored when productive failure is used. He affirms that students can only have productive failure if they have also experienced success. Boaler (2016), Geist (2015), and Anderson et al. (2018) have all expanded Dweck's (2006) original ideas on mindset to include strategies for teachers and students to improve instruction in mathematics and student achievement.

Hatcher (2018) suggests that professional learning to understand a growth mindset has an impact on classroom instruction. If teachers are made aware of their mindset toward mathematics through professional learning, they change their instruction to allow for student errors and the use of those errors for instruction. Hatcher (2018) also found that students were more open to sharing their mistakes with the class as part of their learning. By positively impacting classroom instruction, students are better positioned to perform well in mathematics.

Novice Teachers and the First Few Years

While much of the research on mindset and self-efficacy deals with teachers, studies looking specifically at the mathematical mindset of novice teachers are absent. Researchers have looked at elementary teachers' beliefs and mathematical anxiety (Hughes, Auslander, Stinson, & Fortner, 2018), students' mindset (Boaler, 2016; Hatcher, 2018), preservice teachers (Bentley, 2018) and early career teachers (Sweeny, 2013). The focus has not been on the mathematical

mindset of novice teachers at early childhood grades. Considering the number of years of experience the teacher has in the classroom is an important factor and influenced this case study design.

In 2008, the United States had a higher number of new teachers than in past years (Ingersoll, 2012). This increase changed the teaching demographics to be weighted to new teachers. In 1998, most teachers had an average of fifteen years of experience; by 2008, one-quarter of the teachers had less than five years of experience (Ingersoll, 2012). However, of that one quarter, 40-50% leave in or after their first year of teaching (Ingersoll, 2012). High turnover means that students could have a novice teacher for more than one year throughout their elementary career. To address the turnover, it is common for schools and districts to provide induction programs (Bransford & Darling-Hammond, 2012; Fry, 2009).

Induction programs, experiences provided for novice teachers to introduce them to the teaching profession, are meant to provide new teachers with the supports they need to begin their careers successfully. Because these programs can include mentoring from an experienced teacher, professional development, or access to other new teachers (Bransford & Darling-Hammond, 2012), induction programs, like student teaching, have the possibility of influencing self-efficacy and mindset (Hoy, 2000). Both provide an opportunity for novice teachers to understand their self-efficacy and capability as a teacher. Hoy (2000) found that teachers with high self-efficacy can withstand the pressures of the first years of teaching. They see themselves as successful and view teaching in a more positive light (Hoy, 2000). Preservice teacher education programs, including student teaching, provide an opportunity to develop this sense of successful teaching (Hoy, 2000). However, many preservice teacher programs are intended for immersion into teaching. This immersion may overwhelm the novice teacher and create lowered

self-efficacy. Hoy (2000) found that preservice teachers may lower their standards so that they are successful. This feeling of not quite meeting rigorous standards may carry over into the first years of teaching (Hoy, 2000). New elementary teachers at the primary grades may not feel they are prepared to instruct the rigorous mathematics expected (Hoy, 2000). If, as Hoy suggests, self-efficacy is easier to improve early in learning something new, then the first years of teaching are critical. Attention to the novice teacher may allow for a change in beliefs and abilities related to mathematics instruction (Hoy, 2000).

In the first year of teaching, the novice teacher is focused on survival (Liston, Whitcomb, & Borko, 2006). This shifts about mid-year to a focus on instruction and student achievement (Liston et al., 2006). By the fourth year, research indicates that a teacher has achieved some mastery or expertise in instruction (Darling-Hammond, 2003; Darling-Hammond, 2010; Liston et al., 2006). Novice teachers are building on their college teacher preparation courses to gain experience and expertise or self-efficacy in teaching (Liston et al., 2006). Routine tasks that experienced teachers have learned to efficiently conduct are not yet routine for the novice teacher. Time and energy are consumed by these tasks as well as the instructional tasks related to student achievement (Liston et al., 2006). The typical day for a novice teacher can be exhausting until these tasks become secondary to instruction (Liston et al., 2006). As Liston et al. (2006) note, "the feelings that attend small moments of success are related to a sense of efficacy, which in turn is associated with a teacher's effectiveness and commitment to teaching" (p. 354).

Darling-Hammond (2010) maintains that teacher training in college should be based on professional standards. She encourages the use of teacher induction programs and that alternative paths to teaching should involve training in education, not just a short-cut to the classroom. Darling-Hammond's (2010) research also found that teacher effectiveness improves after the

initial three years of teaching, indicating that the first three years are crucial to forming effective teachers. She lists several factors that are critical to effective teachers, including teachers who have expertise in teaching and in the content they teach.

Anderson et al. (2018) recommend a professional learning model called the "Mathematical Mindset Approach." The Mathematical Mindset Approach is based on four principles of professional development: content focused, active learning and inquiry, coherence with state standards, and building a community of learners (p. 3). Anderson et al. (2018) found that administrators should participate in the same professional learning as the teachers and are vital in supporting teachers as they change the look and sound of the mathematics classroom. This study also supports the idea that changing the teacher mindset improves instruction and student achievement (Anderson et al. 2018).

Auslander, Smith, Smith, and Hart (2016) discovered evidence that prospective teachers need a deep understanding of content knowledge and the complexities of teaching elementary mathematics. A typical mathematics course for prospective teachers did not prepare them for the reality of teaching young children and may have provided a false sense of belief about their ability to teach mathematics. Prospective teachers who can watch and discuss students' abilities in mathematics indicated they were more comfortable teaching mathematics and felt they were able to expand students' knowledge (Auslander et al., 2016). These prospective teachers expressed their desire to match what they learned in an alternative mathematics course to their elementary education courses. They emphasized sense-making, problem-solving, and a classroom environment that supported discourse (Auslander et al., 2016). The authors emphasized the importance of helping prospective teachers see the relevance of their own learning and how that learning is applied in the classroom.

Giles, Byrd, and Bendolph's (2016) research further support this idea. They found that teacher efficacy can be strengthened in preservice programs, and those teachers' self-efficacy improved when they had the opportunity to present mathematics concepts in a constructivist manner, asking students to be actively involved and to make sense of their own learning. The support during field experiences played a critical role in this increase. Fry (2009) stated in her research that novice teachers need a growth mindset to help support them in their first few years. She found that even without a formal induction program, teachers with the mindset to be successful and persevere in finding supports are successful and may tend to stay in the profession after the first few years. Gresham and Burleigh (2018) echo this finding. Preservice teachers reduced their mathematics anxiety when they received instruction in a constructivist way. They also found that instruction in correct mathematics vocabulary was helpful to preservice teachers. The authors conclude that self-efficacy in mathematics instruction increases when the preservice teacher feels competent and understands the mathematics being taught (Gresham & Burleigh, 2018).

Math Curriculum Changes, Mindset and Self-efficacy

In the United States, 41 of 50 states have moved over the past eight years to incorporate the Common Core State Standards in mathematics (CCSS-M) into their curricula (CCSS, 2010). These rigorous standards were designed to address a concern about the superficiality of mathematics teaching in the United States (CCSS, 2010). The CCSS-M standards shifted thinking about mathematics toward more rigorous, focused content, and led to assessments that measure conceptual understanding and reasoning (CCSS, 2010). Focusing on fewer topics, considering topics across grade levels and pursuing conceptual understanding, procedural skills, and applications are an attempt to move from expectations focused on covering material to those

that require a deeper understanding of the content (Alberti, 2012). For grades kindergarten to second, this means a focus on the skills associated with addition and subtraction (Alberti, 2012). Considering topics across grade levels requires teachers to understand their own curriculum while thinking about content at the previous and next grade levels (Alberti, 2012). While the term "rigor" may suggest making mathematics harder, the Common Core State Standards in Mathematics define rigor as understanding the conceptual background the mathematics content, having some procedural understanding and then the ability to apply the information (Alberti, 2012). Teachers may find the change to understanding the concepts in mathematics more challenging than they experienced in their own education where getting the right answer may have been the norm (Anderson et al., 2018).

Gujarati (2013) found that new teacher beliefs may have an inverse relationship to mathematics instruction. She found that teachers who had negative mathematics experiences worked harder to ensure a positive mathematics experience for their students. The teacher must be open to her reflection and see the need for change. An essential activity in this study is the use of an autobiographical journal of one's mathematics history. Gujarati (2013) proposes that during preservice, teachers reflect on their own mathematical journeys to understand and be prepared to change their students' journeys.

Tasdemir's (2019) research concludes that there is no significant gender difference related to self-efficacy in teaching mathematics. He acknowledges, however, that several studies do support a gender difference. Of additional significance in Tasdemir's study is the finding that teacher self-efficacy rises as the grade level taught rises. He posits that as the mathematics increases in difficulty, the teacher will take additional mathematics courses. Tasdemir maintains that age makes a difference in the self-efficacy of mathematics teachers. Teacher candidates over

age 22 (beyond their first year of teaching) had higher self-efficacy scores. He also found that teachers with higher student achievement than their peers in mathematics had higher self-efficacy, stating that "This may be a reflection of the positive attitude of the teacher candidates who have high level of mathematics achievement and see themselves as academically competent in dealing with mathematical concepts, trusting their abilities" (p. 78).

Bauml's (2015) work indicates that the prevalent use of curriculum and pacing guides also influences teacher efficacy. She acknowledges the usefulness of these resources for new teachers but stresses that teachers may feel the need to veer away from these guides to support students' learning. Bauml (2015) found that "new teachers can and do carry out principled resistance to curricular mandates according to their understanding of students' needs and their deeply held convictions about what is best for the children in their classrooms" (p. 404). She found that novice teachers were more concerned when they fell behind a pacing guide but were more likely to follow through with their beliefs if they felt supported by colleagues. Cruz, Wilson, and Wang (2019) asserted that elementary school teachers' mathematical dispositions are lower than their counterparts at the secondary level. The years of experience for teachers also affect mathematical dispositions. The authors found that the lack of mathematics courses for preservice teachers plays a role in teachers' beliefs about mathematics. Their research supports the suggestion that the age of the teacher may have an impact on her beliefs about mathematics and self-efficacy for teaching mathematics. More positive mathematical dispositions and self-efficacy towards teaching mathematics were indicated in preservice teachers who were in the 22-25 year age range. Younger preservice teachers had slightly less self-efficacy toward teaching mathematics. Older preservice teachers also had a lower self-efficacy, which the researchers attributed to those teachers being out of school for several years (Cruz et al., 2019). The authors

suggest there could be an optimum age range where self-efficacy is highest possibly due to more confidence and positive feelings towards teaching mathematics. The influence of prior mathematics teachers also has an impact on preservice teachers Cruz et al., 2019).This finding "seems to confirm the impact that mathematics teachers can have upon future teachers by influencing their beliefs about mathematics and about themselves as doers and teachers of mathematics" (Cruz, et al., 2019, p. 16).

Conclusions

Growth mindset has been researched and communicated in the field of education. The theory of the growth mindset has been applied to teachers of mathematics and how mindset can foster a growth mindset in students. The teacher's mindset has been primarily discussed as self-efficacy or teacher success related to having a mathematics background and set of content skills. A teacher's mindset has also been explored related to mathematics anxiety and being a female teacher at the elementary level and appears to have a self-perpetuating cycle.

The literature about teachers and their mindset focuses primarily on upper elementary to secondary levels. While some research indicates interest in the early childhood or primary grades (e.g., Geist, 2015; Anderson et al, 2018), most of the focus is on the anxiety associated with teaching mathematics and not specifically the teacher's mindset. Dweck's (2006) research shows that many people have a growth mindset but continue to harbor a fixed mindset in certain areas or experiences, fluctuating between growth and fixed. However, mathematics achievement, instruction, and general ability in mathematics are noted as areas of a fixed mindset for many primary-grade teachers. People claim to have a growth mindset, but their actions may counter those words. Teachers may try lessons and open-ended problems that suggest they have a mathematical mindset, but when the focus changes to a new curriculum or different expectations,

teachers may revert to a fixed mindset. Elementary teachers are typically examined as a group, so examining the subset of primary teachers and their beliefs is an additional area of study.

In the next chapter, the study's methodology is described and explains the details of this qualitative case study design. Understanding the mindset of novice female teachers requires more than numbers. While the initial survey conducted for this research allowed for teachers to opt into the study and provided a baseline for each teacher's beliefs about her mindset, a study that focused on a survey alone would not facilitate the surfacing of rich, detailed statements and beliefs. Anonymous surveys allowed the teachers to express beliefs and concerns, but direct interviews and a focus group allowed me to go deeper with their beliefs. A qualitative study allowed additional questions and probe into responses to understand how teachers felt about mathematics instruction and their self-efficacy in teaching mathematics. Surveys and interviews were conducted, and student data were collected to look for evidence of how a growth mindset or a mathematical mindset supports the development of students in mathematics. The methodology allowed for identification and analysis of factors that influenced these novice teacher participants. This is described in depth in Chapter 3.

CHAPTER 3: METHODOLOGY

While growth mindset and the mathematical mindset of students has been studied, the area of the teacher mindset in mathematics has not yet been fully explored (Anderson et al., 2018; Boaler, 2016; Dweck, 2006). This descriptive case study (Merriam, 1998) is intended to advance the understanding of the mathematical mindset of teachers at the early childhood level. The purpose was to examine the mindset related to mathematics, or the mathematical mindset, of primary grade, female teachers within Kasey County. The study sought to address the questions of how a growth mindset, mathematical mindset, and self-efficacy linked to the teaching of mathematics. The study also looked at possible factors novice teachers perceived as influencing their abilities to teach mathematics to young children. This chapter provides details about the research methods used in this study, including the research design, site, participants, interview format, and procedures used for data collection. Data analysis methods are described as well as the procedures used to ensure the validity and credibility of the data. This descriptive case study used multiple data sources that provided a piece of the puzzle contributing to understanding the mindset of teachers when teaching mathematics. Multiple sources assisted in the analysis and process of triangulation of the study's data (Merriam, 1998). Multiple data sources were used to explore the research questions. Using a baseline survey, two face-to-face interviews, a focus group, quarterly survey entries, and student achievement data, I reviewed and analyzed the data to develop the findings.

Miles, Huberman, and Saldana (2014) note the strength of qualitative research as putting the reader in the situation; it becomes real and is set in concrete examples. Qualitative data becomes a "focus on *naturally occurring, ordinary events in natural settings*" (Miles et al., 2014, p. 11). Maxwell (2013) describes qualitative research as a design that is interconnected and ebbs

and flows with the data. The researcher must be flexible and not have preconceived ideas of how the research will proceed. With the research questions guiding the work, the methods provided the support for getting answers to those questions, supporting the validity of the study (Maxwell, 2013).

Research Design

A case study can be defined by "delimiting the object of study, the case" (Merriam, 1998, p. 27). My case study focused on Kasey County school system. Kasey County is situated in the middle of a state with 664 square miles, more than 6500 businesses and over 1300 farms. Over 255,00 people live in Kasey County which places it as the sixth largest population in the state. The median household income is $88,502. One of the largest industries in Kasey County is educational services at a little over 22%. Professional and scientific businesses make up about 17% of the industry. Kasey County includes three higher education institutes along with a variety of private and special education schools. The most recent operating budget sits at $637,141,096 million with the county contributing $295.6 million, $302.3 million from the state, $21.8 million from federal funds with the rest of the funding coming from the previous year's budget and various fees, tuition and interest. More than 42, 000 students are enrolled in Kasey County with a 95% attendance rate and a 91.95% graduation rate.

The Kasey County public-school system is of a fairly generous size (42,000+ students) with demographics as follows: White: 60.4%. Hispanic/ Latino: 16.5%. African American: 12.1%. Asian: 5.4%. 2 or more races: 5%. American Indian/Alaskan Native: 0.3%, and Pacific Islander/Native Hawaiian: 0.2%. Approximately 10% of the students receive special education services, 6% are English Learners, and 26% receive free or reduced-price meals. Kasey County has 36 elementary schools, several of which receive Title I funding, a federal program providing

funds to schools with high numbers of economically disadvantaged students. Kasey County includes 2,900 teachers and consistently outperforms other nearby counties on Advanced Placement and SAT exams at the secondary level. Kasey County schools have consistently received the United States Department of Education's national Blue Ribbon Schools of Excellence Award. Teachers, who were in their first five years of teaching, were invited to participate in the study including those teachers starting a second career as a teacher.

A descriptive case study was chosen to consider the idea of a mathematical mindset and how it might impact classroom instruction. A descriptive case study allowed me as the investigator to consider the background and reasons for a problem or situation (Merriam, 1998), in this case, mathematical mindset. In thinking about the mathematical mindset of a novice teacher, I wondered about how a mindset would be conveyed in interviews, how it would appear in the classroom or how a teacher would perceive her early experiences as influential to her teaching. This case study sought insight into those ideas.

A case study allowed me to study a "complex social unit consisting of multiple variables" (Merriam, 1998, p. 41). I collected data that could improve the way novice teachers think about mathematics. A secondary hope was that readers gain insight into ways novice teachers think about mathematics and perhaps how they themselves think about mathematics. As I was the primary instrument of data collection and analysis, there were limits to the case study design (Merriam, 1998). However, I maintained awareness of these limitations and address them more specifically later in this chapter.

Researcher Positionality

Miles et al. (2014) describe the researcher as the instrument of the work. A strong observer who has familiarity of the case under consideration can bring validity and reliability to the research (Miles et al., 2014). Merriam (1998) states the "researcher is the primary instrument for data collection and analysis" (p. 7). In a qualitative study, the researcher can adapt and adjust the data collection based on the responses from participants (Merriam, 1998). As the researcher for this study, my background and experience as well as my biases are shared.

I have been an educator in Kasey County for 35 years. For 10 of those years, I have been a mathematics teacher specialist working with novices. I know many teachers and administrators throughout the school district. I used this prior experience and strength in my interviewing opportunities and developing a rapport with the participants. Patton (2015) and Merriam (1998) describe the importance of the researcher being empathetic. I had to be a good listener and create an atmosphere of trust (Merriam, 1998). The one-on-one interviews allowed for establishing rapport, and I found that I looked forward to the interview discussions, which reminded me of my times as a mathematics teacher specialist.

Mathematics is assessed in many ways within Kasey County, and student achievement in this area is assessed at least annually. Teachers are expected to give quarterly assessments in mathematics and post their data in a software program that allows Kasey County to gather data about student growth. Mathematics is one area where Kasey County has not yet met expectations set by the county and the state. Improvements have been noted, but there are still not consistent upward trends in mathematics achievement. As a current administrator in Kasey County, I am responsible for reviewing and analyzing data, working with teachers to improve the mathematics

achievement of their students, and reporting to county officials about the progress or lack thereof on the mandated Kasey County assessments.

As the researcher responsible for this study, I acknowledge that I have a strong background in and passion for mathematics instruction. I am also experienced in working with novice teachers to improve their mathematics background. I had early experiences with qualitative research methods through my doctoral program. In considering my biases, I developed open-ended questions and multiple opportunities for novice teacher participants to share their thoughts with me. As my interviewing skills improved, I learned to be sensitive to the data collection, as described by Merriam (1998). I was the filter for the data and was cognizant of biases as they shaped my findings (Merriam, 1998).

My individual experiences and identity as an educator are part of this research. During my time as a mathematics teacher specialist, and in subsequent years as an administrator, I experienced teacher discussions and mathematics lessons that were of concern. I heard teachers, especially women, say they were not good in mathematics and wondered about the role model students saw. I wondered about the effect of a mathematics-anxious teacher on the students. As an administrator for the past ten years, I wondered what role I could play in supporting teachers that would be different from what I saw in my previous role. I knew that I wanted to see if there was a way to break the cycle of female teachers continuing to believe that they do not have strength in mathematics and passing that belief along to the next generation of female students. I acknowledged that I wanted mathematics instruction to improve and for all students and teachers to love mathematics, but I hoped to learn more about how a teacher's growth mindset can promote better mathematics instruction and how that might impact student achievement. My

researcher identity memo, notes jotted while I developed my study, allowed me to clarify my thoughts and beliefs further.

Data Collection Methods and Procedures

This case study sought answers to two research questions:

1. How does a growth mindset and self-efficacy of early childhood teachers connect to mathematics instruction and a mathematical mindset?
2. What factors do novice teachers perceive impact their ability to teach mathematics to young children?

Several data sources from my participants informed the analysis that helped me answer these questions. Table 1 provides an overview of the main research components. Maxwell (2013) defines triangulation as "using different methods as a check on one another, seeing if methods with different strengths and limitations all support a single conclusion" (p. 102). My research study involved multiple methods of data collection. After a description about the sampling and participants, the data sources and collection procedures are explained.

Table 1

Research Matrix

Research Questions: What Do I Need to Know?	Why Do I Need to Know This?	Participants	Data Collection Methods: What Kind Of Data Will Answer These Questions?	Data Analysis
How does a growth mindset and self-efficacy of early childhood teachers connect to	• Female teachers are predominant at the elementary level and are the models for mathematics	• Primary grade (K–2) teachers within the first five years of teaching	• Surveys • Interviews • Focus group • Journal entries, quarterly • Student work	• Survey results • Audio taped/transcribed interviews and focus group • Coding

Research Questions: What Do I Need to Know?	Why Do I Need to Know This?	Participants	Data Collection Methods: What Kind Of Data Will Answer These Questions?	Data Analysis
mathematics instruction and a mathematical mindset?	understanding for students. • They may have developed a fixed mindset about mathematics as a student and may inadvertently replicate it.		• Video of 1st grade mathematics lesson • Student data from quarterly mathematics benchmark assessments	• Re-reading of data
*What factors do novice teachers perceive as affecting their ability to teach mathematics to young children**?***	• Teachers may have a growth mindset but as novices feel inhibited by multiple pressures and expectations as they navigate teaching			

Participants

Nonprobability sampling or purposeful sampling was used to determine which teachers were selected to participate (Merriam, 1998). This type of sampling allowed me to "discover, understand, and gain insight and therefore . . . select a sample from which the most can be learned" (Merriam, 1998, p. 61). The selection criteria included all novice, female teachers working at the elementary level, grades K–2 in Kasey County. These teachers were from Title One schools, non-Title One schools, relatively small rural schools (200–300 students); and larger, more urban schools (600–1000 students). The variety allowed for more discussion and sharing of ideas in the study. Those who were newly employed as teachers in a second career

were included in the initial sample. Teachers who left teaching and returned as non-tenured teachers were not selected to receive the initial survey. The list of teachers fitting the criteria was requested from Kasey County through a Freedom of Information Act (FOIA). In Kasey County, there are approximately 3000 teachers. The final sample for this study was determined from the 31 respondents who completed an initial survey and then the nine who indicated a willingness to participate further. Participants were asked to be part of the study over the course of one school year (October to June). The length of the study allowed for data collection over time rather than a one-time picture of teachers' thinking. Details about the participants informing this case study are shared in Table 2.

Table 2

Study Participants

Pseudonym	Current Grade	Grades Taught Previously	Years of Experience	Tenure (T)/ Non Tenure (NT)
Lea	Kindergarten	none	first year	NT
Michelle	Kindergarten	none	first year	NT
Nicole	Kindergarten	Second	four years	T
Shirley	Kindergarten	Special Education, 5th	four and a half years	T
Antonia	First	Third	two years	NT
Caroline	First	none	first year	NT
Laura	First	Second	five years	T
Louise	First	none	first year	NT
Loree	Second	Kindergarten	three years	T

Institutional Review Board approval was sought and granted by Kasey County and the college. An additional, in-person interview was requested by Kasey County's System Accountability and School Improvement Office to ensure the confidentiality of the participants and to review the remuneration being offered to participants. Once approval was granted, I used

the list of 304 novice teachers provided by Kasey County through the FOIA and sent out a 32-question survey in Google Forms (Appendix A). Two potential respondents were excluded from receiving the survey since I had evaluative responsibilities for them. Of the remaining respondents, some emailed me directly and shared that they did not fit my parameters either due to their years of experience or a grade level error. Of the original 304 surveys sent to teachers working in grades K-2, 31 teachers responded to the survey. Of those responses, nine teachers indicated a willingness to continue with the larger study.

Survey responses were collected in a spreadsheet for later analysis. This survey was piloted with experienced teachers in grades K–2. The pilot responders provided feedback on the length of time to complete the survey and the clarity of the question wording. The first 16 questions asked teachers to respond to their experiences as a mathematics student (Anderson et al, 2018). The second 16 questions were similar and developed from those questions but asked the participant to respond as a teacher. I adapted the second set of questions. Respondents to this initial survey were anonymous unless they chose to continue in the study. Participants could opt out of completing the survey at any time, including whether to complete the survey. At the end of the survey, participants were asked to continue in the study and provide their email address to be contacted.

If teachers chose to continue in the survey, I used the email addresses they provided to contact them. I had hoped to select a minimum of ten participants in order to have six continue to completion; however, only nine participants chose to continue beyond the initial survey. They ranged in experience from first-year teachers up to one teacher who was entering her fifth year. Four teachers were new to teaching, one had two years of teaching experience, one had three years of teaching experience, one had four years of teaching experience, and the last two had

four-and-a-half and five years of teaching experience, respectively. Four teachers were in kindergarten, four were in first grade, and one was in second grade. One worked in a charter school, which in Kasey County is part of the public-school system. All nine teachers were asked to continue with the study. Eight out of nine (89%) of the teachers participated in all data collection activities (Table 2). There were times when one or two teachers did not participate due to health or previous responsibilities. One participated through the initial interview and focus group only.

Data Collection

Once the teacher participants opted into the study, they were asked to participate in an initial interview (Appendix B). Teachers chose a pseudonym for confidentiality in the study. Participants were interviewed individually by me at a place of their choosing. The interview was recorded, and informed consent was obtained (Appendix G). The semi-structured interview allowed for related questions to be asked of all participants but allowed me to ask additional questions as necessary. Merriam (1998) notes that the semi-structured interview "allows the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic" (p. 74). As part of the ten-question interview structure, respondents were asked to create benchmarks for each end of a self-anchoring scale designed to engage them in considering their teaching now and in the future. Since the participants defined each end of the scale, I gained further insight into their thinking about mathematical mindset and mathematics instruction. These initial interviews occurred in November and December 2018. The interview questions were also piloted with an experienced teacher and a novice teacher to determine the suitability of the questions for addressing my research goals.

Participants were then asked to be part of a focus group. The participants gathered as a group at a local college in December and were asked to respond to a videotaped mathematics lesson and student work (Appendix C). The videotaped lesson was not from any teacher in the local school system. As a Kasey County administrator, I was able to access an online system called *Teachscape* that included a variety of videotaped lessons. Focus group members watched a first-grade mathematics lesson deemed proficient by the Danielson (2013) Framework for Teaching rubric. The videotape was 12 minutes long. Once viewed, participants were asked to discuss the lesson with probing questions from me and additional questions asked as needed to keep the discussion moving. As the facilitator of this portion of the data collection, my focus was on the discussion and probing for further ideas. Participants had varying levels of experience with the rubric but had time to review it and ask questions before applying it to the observed lesson as part of the discussion. Additionally, participants were asked to review student work from a first-grade class in my school. I selected first-grade work because it was close to what each teacher would expect from students. The kindergarten teachers would see evidence of student thinking beyond what their students might be demonstrating but recognize the concepts that were taught prior. The second-grade teacher would see the first-grade work and know what the expectations were for second grade. The teachers decided what, if anything, could be determined about the teaching in the classroom based on the students' work. All discussions were recorded, transcribed, and stored on a password-protected flash drive.

A second individual, semi-structured interview was conducted after the focus group. These interviews were conducted in February 2019. Initial questions were set (appendix D), and additional questions were added based on responses to the first interview and the focus group discussions. This second interview allowed for more specific questions around ideas formulated

in the earlier data collection. Individual interviews were focused on specific responses from the teachers. This interview was also recorded, transcribed, and saved on a password-protected flash drive.

At the end of each quarter of the school year (October, January, April, and June), participants were asked to respond to a short journal entry about mathematics instruction in their classrooms (Appendix E). Responses were optional. Additionally, I obtained student assessment data from each teacher using the benchmark assessments required by the local school system (Table 3). The only data not available to me was from the teacher in the charter school. The charter schools do not use the same assessments as the rest of Kasey County, and the data are not stored in the same online system. Student data were added to the analysis of teacher mindset and student achievement in mathematics over the course of the year.

All data collected through the interviews, focus group discussion, and journal entries were transcribed using an online service (Rev.com) and then managed and coded using NVivo software. Coding and organizing the data allowed for the identification of information related to my research questions (Merriam, 1998). An open coding system was used to allow for reading and synthesizing the information into coding categories based on the data that appeared to be the most critical (Maxwell, 2013). I also used my notes and thoughts as a researcher in considering the data.

Data Analysis

My structure for reviewing and analyzing data was to first read the transcripts of the interviews, focus group, and quarterly surveys, highlighting interesting statements that I felt began to answer my research questions. Using NVivo software, I began to group similar statements together in nodes. My initial nodes were words and phrases related to the growth

mindset, mathematical mindset, self-efficacy, classroom instruction in mathematics, and student achievement. The growth mindset category grew so large that I began to sub-divide those quotes and data points into smaller groups around mindsets about mathematics, the growth mindset in general, growth mindset about self, and growth mindset about students. Teachers were frequently describing their students' mindsets, and those data points were used to support findings related to the teachers' own growth mindset about mathematics.

During the first set of interviews, I jotted a researcher memo about participants' high rankings of themselves from a year ago, today, and five years from now. I was surprised by how high they ranked themselves. These rankings were obtained from the self-anchoring scale each teacher created using the characteristics of the best and worst mathematics teacher. If zero was the worst teacher, then ten was the best teacher. Each novice was then asked to rank herself against that scale. In NVivo, I created a node to examine that data across the participant groups. The nine participants ranked themselves from a five to an eight for that time in the year; eight noted they would like to be at a nine or ten in five years. One participant hoped to be at an eight or nine in five years. The four teachers in their first year stated they wanted to go from a five or six to a nine or ten.

A category was created for first-interview responses related to participants' experiences in mathematics as a student. As the researcher, I noted the verbal responses and facial expressions from participants related to the characteristics of the best and worst mathematics teachers they had experienced. In at least one case, I noted aloud to the participant that she had smiled when sharing her experiences and I wondered if she was thinking about the teacher she was describing with the best characteristics. One of the interview questions asked participants about their courses in mathematics, and every one of them described a professor, teacher, or their

feelings about the class by the characteristics of the best and worst teacher. Most also expressed emotions related to the class. In most cases, participants smiled as they recalled positive experiences. In some cases, if the experience was negative, they talked about how they wanted to teach differently. Those data points were noted in a category called "experiences as a math student." As I posited in chapter two, female teachers may be in a cycle of feelings related to their ability to teach mathematics because they were also taught by female teachers with low self-efficacy for teaching mathematics.

The first interview also revealed some information from the first-year teachers about factors that might impact their instruction. As I listened and reviewed the transcripts, I noted some statements that related to support in mathematics from teammates or other staff members. There were also some statements about available supplies and the setup of the classroom. That became a category titled "benefits to novice teachers" as I continued to collect data.

The focus group was the most interesting data source for me. The participants were eager to meet each other and spent the first 10 or 15 minutes chatting and getting to know each other. Some had been together for training earlier in the day, so they compared notes about what they had learned. The group did an icebreaker activity designed to make them as comfortable as possible in sharing ideas within the group setting. Notes from the focus group experience reflected some findings I pursued in the second interview and member checks at the end of the school year. As participants reviewed student work from a first-grade class, several of them referred to the student as "he," although no demographic information was on the paper. I noted that as a follow-up question and designed part of the second interview to see if the teachers automatically called the student "he" when looking at student work. It was worth pursuing

because I wondered how this aligns with their mindset about mathematics and whether they were unintentionally perpetuating the idea that boys were better in mathematics.

Assessments in mathematics were noted several times in the first interview, which became a node in NVivo. I also incorporated questions about assessments in the second interview. I wanted to see if participants used assessments to gauge student achievement, how they determined groupings for mathematics instruction, and how they felt about the results. Assessments, as the participants discussed instruction, meant more than the quarterly or unit assessments. They used assessment in their classrooms and frequently determined which students were going to be instructed in a group based on exit tickets (quick mathematics problems or questions to gauge student understanding) or instruction from the day before. I had also noted some statements about individual students or groups being "low," and I wanted to pursue that idea with participants. Another node in NVivo was coded as teacher beliefs about mathematics. I then further subdivided that node into beliefs as a teacher and beliefs toward students, which further informed data on teachers' mindsets and self-efficacy in the findings. Both the first and second interviews added to this data point. Teachers were descriptive about their struggles to help their students learn. County assessments played a role in this code as well. Several times teachers referenced how students did and then reflected on whether they had adequately taught that strategy or skill for students to perform well on the assessments. Caroline talked about referring students to the student services team (SST) in her first interview. The SST is a process used to ask for additional strategies to try in instruction but is also frequently used by teachers as the first step to referring a child for special education.

Mathematics instruction was described in a variety of ways by participants. They shared ways they structure the lesson by working with a small group of students while other students

completed follow-up mathematics work or moved to a center or game activity. In listening to and reading their responses, I listed the ways they set up their lessons and some of the phrases they used to describe their planning for mathematics. I determined that in the classroom, usually whole group, discussions were held. I recorded the instructional strategies used or discussed then went back to determine who used those in either a positive or negative way.

Member Checks

Member checks were used after the school year had ended. Most teachers did not check email frequently during the summer, but four participants did respond to my request for additional information. The email was sent three times with a request for input. In those member checks, I asked for information related to gender in the focus group, why teachers preferred talking about other students' work and not their own students' work, and how many were switching grade levels next year. The discussion about students' work came from the focus group, and I used student work again in the second interview. In the focus group, one participant said she loved looking at student work when it was not her students. I thought this was interesting and possibly related to self-efficacy and mindset in teaching mathematics. I asked about the grade level moves based on responses in the first interview. As I listened to and re-read transcripts, I noted that most of the teachers who were not in their first year had switched grade levels at least once. Most noted how difficult it was to switch grade levels and the amount of learning they had to do to feel comfortable teaching a new grade. Those statements were analyzed and referenced when I noted a growth mindset and self-efficacy for specific teachers.

During the analysis of the data sets, I created tables to help organize the information. Those tables were used to support the assertions in the findings. The tables were organized by participant name, and quotes were extracted from NVivo to support what I saw in the tables. In

collating the data from the initial survey, the Likert scale has the extremes of one (strongly disagree) to five (strongly agree). Several of the statements in the survey suggest a positive belief about mathematics and others suggest a negative belief.

Participants were provided with remuneration for participating in the study. This remuneration included a gift card to a local store within the amount allowed by Kasey County. Each teacher's school also received a gift card and a copy of a book about the mathematical mindset for the professional library. Participants had access to me as a coach and mentor in mathematics instruction during this study. One benefit of participation in the focus group was the exchange of ideas and expansion of ideas related to mathematics instruction available in the focus group discussion.

Limitations of the Study

Through my role in the school system, I interviewed novice teachers within Kasey County, where I am an administrator. The participants were representative of the larger population of novice primary grade teachers. With a narrow focus, this study was limited to novice female teachers in Kasey County. Student data from the local school system allowed me to review accessible data for each teacher. Using their data allowed me to look for patterns in their interviews, focus group responses, and student achievement as measured by the local school system. Using Kasey County as the environment for my research permitted me to share results as part of the ongoing pursuit of high student achievement and permanent closing of the achievement gap (significant disparities between student groups and academic performance) within the educational system.

This study focused exclusively on female teachers. Since they are the majority of elementary teachers, their selection as the participants was reasonable. Surveying and

interviewing male teachers may yield additional data in a different research project. Additional limitations include the differences between novice and experienced teachers, which is not explored in this study. I chose to use a previously videotaped mathematics lesson for the focus group so that participants could focus on the instruction without concern about the teacher. I wished to observe actual lessons from the participants, but due to my role as an evaluator in Kasey County and the requirement to keep the subjects' participation confidential, this was not possible.

Administrators' perspectives were also not included in this study. Surveying and interviewing principals and assistant principals regarding teachers' mindset and self-efficacy may have provided additional data as next steps for this research.

Summary

My research questions were investigated through a qualitative study of nine female novice teachers at the primary grade level. Data were collected and analyzed and included surveys, interviews, and a focus group discussion of a videotaped math lesson and student work. Student assessment data were collected and used as part of the analysis regarding the stated teacher mindsets. To inform my analysis, researcher memos were written and consulted for the analysis. The following chapter provides a more detailed description of the data analysis and findings by each of these teacher participants.

CHAPTER 4: FINDINGS

This research study began with the desire to know more about mathematics growth mindset for novice, female early childhood teachers. Two research questions guided this inquiry:

1. How does a growth mindset and self-efficacy of early childhood teachers connect to mathematics instruction and a mathematical mindset?
2. What factors do novice teachers perceive impact their ability to teach mathematics to young children?

During and after data collection, analysis revealed the salient findings from the individual teachers and what was common across their experiences. A descriptive case study includes the "'thick' description of the phenomenon under study" (Merriam, 1998, p. 29). Nine novice early childhood teachers in Kasey County were participants within the study. The reader is invited into their classrooms and their beliefs about mathematics instruction as they share their ideas through their data. The teachers' words tell their stories and provide the context for understanding the analysis discussion.

The nine teachers, Lea, Michelle, Nicole, Shirley, Antonia, Caroline, Laura, Louise and Loree, are all within their first five years of teaching. Four teachers, Lea, Michelle, Caroline, and Louise were all in their first year of teaching. Of the remaining five teachers, Antonia had taught for two years, Loree was in her third year, Nicole and Shirley had been teaching about four years and Laura was in her fifth year. Those five teachers had all taught at least one other grade prior to the beginning of this study. Eight of the participants were typical-aged novice teachers in their twenties. Shirley was older; teaching was her second career.

In this chapter, the findings from each individual are shared first. The narratives are organized by grade level with kindergarten teachers first, then first-grade teachers and finally,

the second-grade teacher. Next, I describe the analysis process used to determine the four major findings related to growth mindset, experiences as a student and a teacher, factors that impact instruction and influence mindset and assessment results that drive instruction. Each of these findings is explained and supported with illustrative quotations. A summary is presented leading into a discussion and implications for novice, female early childhood teachers.

Lea

"Lea" was a new teacher working in kindergarten. We had met the year before when she was an intern in my school. Lea was working in a Title I school that had undergone a new construction project. A new school was built in 2014 on the grounds of the old school. Her school had 668 students with about 50% receiving free and reduced meals, almost 14% learning English as a second language, and 7.2% in special education. The student body was 6% Asian, 18.3% African American, 25% Hispanic, 40% White, and about 10% two or more races. There were four to five teachers per grade level team. This school housed an Advanced Academic program, and the teachers in the Advanced Academic program were listed as staff members on the appropriate grade level team.

On the initial mindset survey, Lea responded with expected ratings (Appendix A and Appendix F). Where one might expect a rating of strongly agree, that was her rating and vice versa. She had five neutral responses of "3" on statements such as: If students understand the math, they will get the answer quickly (statement 4 on the teacher section of the survey), and "my students like to solve complex math problems" (statement 16 on the teacher section of the survey). Lea and I chose to meet at my school for the first interview during a teacher workday around 10:00 in the morning. The building was quiet, with no students and teachers, who had

been given the option to work from home. Lea and I met in my office. My school was closer to where Lea lived, so she was able to go home and work after our interview concluded.

Lea had been working as a kindergarten teacher for three months when we began our interview. Lea had a degree in early childhood and elementary education, and her excitement for her job and children was evident in her initial responses. She shared with me that she had taken three courses in mathematics in college, with only one connected to teaching . Lea was my first interview of the nine participants. As she shared the characteristics of the best mathematics teacher, Lea stated, "The best math teacher is going to be positive and embrace struggle and not always getting things right, because in mathematics there's a lot of room for error and children often as soon as they make a mistake they want to give up and a math teacher needs to be encouraging and positive and embrace the struggle and the mess-ups because that's how you learn. And that's how you develop as a mathematician." She then described the worst mathematics teacher as being discouraging, teacher-centered, and not using manipulatives in class. She then amended her original description of the best also to include her facility with discussion and the use of manipulatives. On the self-anchoring scale (Appendix B), Lea rated herself a 6 with the hope of getting to a 9 or 10 in five years. She noted that being able to comfortably use manipulatives, experience, and promoting discussion in her classroom as avenues to becoming a better teacher.

Lea talked about loving math in elementary school and had a current love for the topic. Her experiences in elementary school included enrollment in a class for students gifted in mathematics that challenged her thinking. In middle school, her feelings changed, and she found that she hated mathematics. She had a different teacher every year and felt the lack of consistency contributed to her negative feelings. She also felt unprepared for the mathematics

required in high school. By the time she entered college and took mathematics courses, her positive feelings for mathematics returned. She shared that she was unable to take many electives because she was enrolled in a dual major program. She talked about her college professors: "I think when you're going through a college program to get an undergraduate [degree], sometimes you have teachers who have positive attitudes about math, and then there are teachers who tell you that math is their least favorite subject to teach." Lea then talked about her excitement for teaching mathematics. She said she could not wait to get to the mathematics block in her day and watch the various ways her students solved problems. She talked about meeting with her teammates and a math specialist weekly that helped with her planning and understanding of the mathematics concepts.

Lea also discussed changing her lessons as needed to meet student needs. She gave an example of a lesson she had taught where students struggled, so she stopped the lesson, gathered manipulatives, and began to use those to help with concept development. She noted differentiation of her lessons as a challenge but also a necessity for her students. Lea also talked about using assessments in lessons to determine if students truly understood a concept and if they needed something different in the next lesson. She gave students a visual they could use to let her know if they were understanding the independent work while she instructed a small group of students. At the end of quarter one, in the math journal entry, Lea stated, "My math data improved tremendously this quarter. As a whole kindergarten, we met our school goal for the amount of passing students. My personal goal was to have all my students meeting the expectation, and I had all of my returning students do that and one incoming student is approaching." I next saw Lea in our focus group in December 2018.

Lea was an active member of the focus group. She frequently spoke up and shared ideas. When the discussion centered on the videotaped lesson, Lea was quick to point out what she liked about the lesson. She talked about the students being used to act out the problem and that the students enjoyed being challenged by the question. She felt the teacher kept students focused by setting up the lesson so students did not know when they would have to conference with the teacher or respond to a question. She rated the teacher as a seven or eight and wanted her to be more enthusiastic about the lesson. She was disappointed the teacher had not set up success criteria or a learning goal so that the class could review either as closure for the lesson. As the participants reviewed student work in the focus group, Lea stated, "I love looking at student work, especially when it's not my kids." She questioned the other kindergarten teachers in the group about a problem-solving workmat that was part of the student work. She noted that her team expected students to respond in a complete sentence to indicate their understanding of the answer. Other teachers disagreed with this practice.

The second interview took place at the Staff Development Center. Lea was a member of the new teacher classes, so we met in between the activities in her sessions. The room was sparse, with only a small table and two chairs. We began by talking about how mathematics instruction was going. Lea related that most students had met the expected benchmarks on the assessments. Her students were showing her in class that they understood what was asked of them. On the quarter two assessment, she shared that having students build teen numbers with manipulatives went well in instruction, but students immediately drew pictures instead of using the manipulatives on the assessment. She also talked about what her administrators wanted in mathematics instruction, which she found difficult. Lea was expected to differentiate her instruction based on the Standards for Mathematical Practice. Instead of working on the same

standard with each group, she was expected to teach a different standard to each group. While Lea understood the necessity of using the standards, she found it hard to do, especially when her understanding of the standards was limited. She was able to convince her team and the administration that the kindergartners needed the standards in kid-friendly language, so the team worked to create those. Lea mentioned visiting classrooms as part of her first year. She shared the benefits of this practice as one where she could streamline her own teaching, but also noticed there were practices in other classrooms she did not want to replicate.

Lea responded to the mathematics journal at the end of quarter three and four. In those entries, she shared that it was necessary to meet students where they are. She had a student who was learning English and was excited when he was able to count to ten. She noted at the end of the school year:

> I have several students who have become so familiar with SMP's [Standards for Mathematical Practice] that they will shout out that they were being precise or arguing about their answer! This was refreshing to hear and see because in the beginning, I was worried about the students understanding the different SMP's. I have a newcomer with 0 English who repeats what I say in English. So with reading, he has picked up letter sounds and ID. But with math, he has had difficulty with number rec above 10 and switches from English to Spanish frequently. This has been an interesting two months with him, and the data does not reflect his growth, but he has come so far.

Lea's student assessment data indicated that her students met the expected proficiency mark on six of the nine assessments. End of year data were the least proficient for students. Only one interview assessment indicated students had met the expected proficiency level. Lea did participate in the member checks completed over the summer. For the question about gender, she

indicated she had a teacher in high school that told her it was always correct to use "he" when writing if there were no identifiers. I asked, in question two, why it was easier to observe student work that was from a different teacher. Lea's response stated that she does not want to critique her students. She knew her baseline data and where students had started. She would put pressure on herself to provide the best education for her students and to set them up for success so she would want feedback on how to help her students, not focusing on what they had done wrong. She also shared that her administration had talked to her about moving from kindergarten to first or second grade for the new school year, but she remained at kindergarten. Lea noted that her planning would change if she had to switch grade levels, but once she got to know her students, she would work to make the content and standards meet the needs of her students.

Michelle

"Michelle" was a first-year teacher, working in kindergarten when the study began. She taught in a classical charter school that is part of Kasey County's public school system. Her school is in a warehouse section of buildings on the eastern end of the county. The enrollment for the school is close to 400 students. About 45% of the students are White, and about 30% were African American. Thirteen percent receive free or reduced meals. There were two teachers per grade level, and instruction was provided from kindergarten through middle school (eighth grade). In responding to the survey sent to all female novice teachers in Kasey County, Michelle's responses were typical and like most other respondents. Various survey questions probing the growth mindset in respondents were ranked from 1 (strongly disagree) to 5 (strongly agree).

Michelle's response to question two was notable, where she indicated a "2" (disagreement) when asked whether math answers are either right or wrong. Michelle also

responded to question 15 on the survey with a "1" to "students need to know there is more than one way to solve a math problem." She also responded neutrally with a "3" to the statements "There are limits to how much people can improve their basic math ability" (student question), "I like to solve complex math problems" (student question), and "There are limits to how much my students can improve their basic math ability" (teacher question). These responses were considered in thinking about Michelle's overall mindset about mathematics. Michelle did not choose to leave any comments in the survey. Once she agreed to continue in the study, we scheduled her first interview with me, which allowed for more in-depth discussion.

My first interview with Michelle took place in her classroom. The classroom was set up like a typical kindergarten room: lots of color, small tables and chairs, a large rug for whole group work, and colorful posters on the walls. I met Michelle after school in mid-November 2018. She seemed excited to participate. We began our interview with a few questions and procedures before I turned on the recorder. I had a set of predetermined questions but also the leeway to ask questions as she responded. As we engaged in the questions, I could see Michelle's passion for her job and her enthusiasm for teaching young children. She shared that she loved math and that it had changed from when she was a student to more hands-on experiences and that she tried to allow that for her students. She felt like mathematics was harder for her growing up and stated, "my brain's more reading and history wired, but I've had some wonderful teachers that have helped me see how my brain works differently, which has been great" (first interview).

When asked to describe the characteristics of her best and worst mathematics teachers, Michelle noted that the best teacher was engaging and hands-on, while allowing exploration. The worst teacher taught via lecture or looked for only one answer. She wanted that teacher to use more resources from everyday life and help students see the connections in their lives rather than

an abstraction. As she subsequently used those characteristics to rate herself, she felt that within her first three months of teaching she was a seven or eight and hoped to get to a ten within the next five years. In speaking about her students, she talked about using real-life scenarios for mathematics instruction and helping students to connect to the world around them. She talked about using the whole body, "moving around, feeling things, touching things, moving things and their spirit" to help them understand mathematics. She noted that a growth mindset meant to her that "at the beginning of the year, children may come in as a blank slate, and some children may come in really advanced already, but either way we need to help those children grow in understanding."

Michelle went on to state that she does not want to give students paper or pencil until they are ready to perform on their own. She used the paper and pencil "so that they can show me they really learned what they did." When asked further about the structure of her mathematics lessons, Michelle noted that her school used a packaged program that included a workbook for students. She also shared that she used many mathematics centers to differentiate instruction. She wanted to ensure that she did not make a big deal about the "children who are really high level and are doing really difficult things." In talking about her experiences as a student, she related that "I was one of those students when I was little . . . it didn't always look like what the teacher wanted, and that was a big deal in a negative way." In the quarterly check done in November, Michelle noted that she did not feel that she had a concrete curriculum to follow and that she felt lost when planning. Few materials were provided for the curriculum she was using, so she was supplementing the curriculum with her own ideas. The focus group was the next opportunity to hear Michelle's ideas.

Michelle joined the focus group discussion in December on the campus of a local college. I had reserved a small study room and asked participants to join me after school. The conversation picked up by the time four participants were present. The generalized conversation was about the school where each person taught. A few of the teachers had been together for training earlier in the day, so they reviewed that training.

As the conversation flowed, Michelle shared the following information as part of the response to watching a mathematics lesson and looking at student work. She noticed that the teacher in the video did not use visuals and that students had to picture the problem in their minds. Michelle noted that manipulatives were not available in the whole-group portion of the lesson. She also made the statement that students with "no attention span, just listening to that question and then going back to their seats they could forget about it, whereas if she had like actual bracelets that she could take beads off and show her giving them away" to help students visualize the problem. She also felt the teacher was up in the front of the room too much and wanted to see more student-to-student conversation.

The focus group conversation allowed the seven participants who came to exchange ideas and offer clarification about what they saw and what was needed. The group was offered an opportunity to conduct second interviews during a class held in Kasey County for new teachers. A date was selected, and I set a specific time to meet with Michelle. Unfortunately, the weather was poor, so a second date was set for February.

The second interview for Michelle was held in the Staff Development Center for Kasey County. This setting was different from the first interview. I was able to find a table and two chairs in an empty classroom at the Staff Development Center. The setting for this second interview was not as welcoming as the teachers' classrooms or the room used for the focus

group. It seemed stark and, with several of the teachers planning to head to break-out groups for their class, the interviews sometimes felt hurried. The setting was not very inviting, but Michelle did not seem to mind. For this interview, I used a few predetermined questions, but also expanded the questions based on Michelle's data from the first interview, the quarterly surveys, and the focus group. I asked more questions about assessment in this interview and asked how she felt mathematics instruction was going at the time. I also included another review of student work based on the interactions I heard during the focus group.

Michelle stated that instruction was going well. She was seeing how what she taught earlier in the year was impacting student understanding now, at the beginning of quarter three. She said, "it seemed silly at the time to be breaking apart and putting together numbers so much, but now you can see how it has turned out in the end." She continued to talk about differentiation as a strategy that was working for her students. In looking at the student work I brought, she shared that she liked the way the teacher allowed students to solve the problems in diverse ways. She said, "I think that's important for kids to understand." In the charter school, letter grades are used for all students, including kindergarten. In the other public schools, kindergarten and first-grade students receive rubric letters indicating whether they are developing, approaching, meeting, or exceeding expectations. Michelle said, "People may think it's silly to put in grades so strictly for kindergartners, but it really does help you see how your kids are doing." She noted that she was required to give quizzes and assessments to indicate where students were working. When looking at student work, Michelle noted that a student who solved a problem by using dots probably did not know her math facts as well as those students who just wrote out the number sentence and gave an answer. She did stop and reflect that it was possible those students had manipulatives to help them solve the problem, but the work appeared to her as if the students

knew their math facts well. Michelle also responded to the quarter two check-in at the beginning of February. She noted that students were struggling with tens and ones and just beginning to understand that ten is one group of ten with multiple ones left over.

I want to end my description of Michelle with two notes of importance. The assessments used at the charter school are different from what Kasey County uses with the non-charter schools. I did not have access to those assessment results as part of the study. Secondly, I tend to check the agenda for Board of Education meetings monthly. During one of those checks, Michelle's name was listed as resigning from her position, effective July 1, 2019. I was unable to connect with her before the resignation became final, and the email address accessible to me all year long had been disabled. I do not know what precipitated the resignation.

Nicole

"Nicole" has taught for four years and was teaching kindergarten at the time of the study. Nicole has also switched grade levels over her four years and was teaching in a rural school in Kasey County. The school included a little over 250 students, 85% of whom were White. About 19% receive free or reduced meals. There were one or two teachers per grade level. In her first year of teaching, she taught second grade. Nicole was in her mid-twenties. On the initial survey, her responses were all in the typical, expected range. However, she had three responses at a neutral level (scored a "3") and did not respond to two of the statements. Two of the neutral responses and the two blank responses were part of the student section of the survey. Statements 2 and 11 were neutral. Nicole was asked to respond to the statement, "In math, answers are either right or wrong" and "If I put in enough effort, I can succeed in math." The blank statements were statements 13 and 14: "Math is a subject with lots of connections between ideas" and "It is really helpful to talk about math with others." The final survey statement scored as a "3" was in the

teacher section. Question 16, “My students like to solve complex math problems” was the statement Nicole also scored as a “3.”

Our first interview happened at the Staff Development Center in early December, prior to the focus group meeting. This was a mid-way point between our two schools and ensured that neither of us had too far to travel once the interview was ended. We were able to use a small room that was fully furnished with tables and chairs. The room was quiet and off to the side, so no interruptions happened. She noted that she was an early childhood teacher and the “younger they (students) are, I just think that they’re more willing, they buy into the little gimmicks that you can give them. They’ve still got that hunger for wanting to learn new things and not just, ‘I’m here because this is what I say I have to do.’ They enjoy it still.” There was a level of slight cynicism in the way Nicole responded to questions, but it was difficult to tell if that was related to the interview process or just a general response to teaching. She shared that the characteristics of the best teacher included one who was caring, adaptable, flexible, and loving. She added, with some prompting, that they are always floating around, looking for student work, wanting explanations and willing to help if the explanations don’t make sense. The best teacher will coach you through it, according to Nicole. A poor teacher always explained math the same exact way. They are not flexible; there was one way to do it. The teacher was cold and not personable. Then Nicole said, “He didn’t connect at all to his students. He was there to do the job, and it wasn’t about the students, it was just about the job.” This statement prompted a follow- up question a little later in the interview. I asked if Nicole had been speaking about a specific person when she gave the characteristics of the worse teacher. She responded,

> I always remember having a lot of positive experiences, even when I was struggling in math. There was one teacher in high school that I just couldn’t seem to click with to get

> the help that I felt like I needed. I had established other relationships [with] math teachers that I was able to go and get their help, and they were always more than willing to help when little Nicole couldn't get it.

We used Nicole's descriptions of the best and worst teacher and then she ranked herself. She gave herself an 8 and hoped to be a 10 in five years. She noted in this discussion that she was currently enrolled in an Elementary Mathematics Instructional Leader master's program in another local college. She related that the program "has really changed the way that I think about teaching math and strategies and ways to present concepts to students and having that collaboration. And, definitely, finding more ways to collaborate with other, especially kindergarten math teachers to see what they're doing, to figure out what works and what doesn't work." In discussing the master's program and the way she set up her classroom, Nicole talked about how she taught mathematics. She said she related mathematics situations to students' real life, encouraged talking, explanations of thinking, and learning from mistakes. She noted that "You don't have to be perfect, as long as you're learning and you're trying and happy." Nicole also noted that she felt modeling of concepts was important:

> You know, every day in my classroom, before we start something, I model exactly what they're gonna be doing, and then just really watching to see if whether they do how I did it, or whether they try to figure out another way that works for them. And then I always try to, if they figure out another way, highlight that and say, 'Everybody freeze, let's look and see what so-and-so did, they've got a really good strategy, let's watch to see what they did, to see if it works for you,' kind of thing.

Nicole talked about her expectations for her students. She wanted students to take risks and expressed this as students who, "learn from their mistakes and having other people listen to their

mistakes and learn from them as well and choosing those students that I know that won't be ashamed to admit they made a mistake, because there are always students that are too afraid that they're incorrect, or made the same mistake, which is okay. I was that student; I didn't wanna be wrong." She noted that she had one student working above the level of the rest of the class and one working below. In her interview, other adults (instructional assistants) were in the classroom and able to provide some support for both students. Nicole noted that meeting the needs of everyone was difficult and that she appreciated the extra help. She also shared that the ability to spend more time on mathematics was an area she felt would help students but at the time she did not have extra time in her day for that instruction.

Nicole participated in the focus group discussion. She sat to the right of the large table in the meeting room and initially remained quiet for a portion of the group discussion. I wondered, with her expertise in mathematics and leadership, why she sat quietly. I was hoping she would jump in and add to the conversation about mathematics teaching. Once the videotaped lesson began, she listened for a while then added on to others' comments. About seven minutes in, Nicole shared her thinking about the level of teaching she saw in the videotape. She felt the teacher was distinguished in her teaching based on the rubric provided because the teacher provided an open-ended question for students that meant they were engaged and not "running around the room." A few minutes later, she noted that the teacher did not seem to be having fun and that she felt that was important for mathematics class. She also questioned how the teacher differentiated for students if they were all working on the same question. When I asked the group what the teacher could do differently, Nicole responded that there was no closure or reflection for students, and that was an essential missing piece.

Nicole's second interview took place at the Staff Development Center with several of the other participants. She chose to meet me there as we had done with the first interview. This time we met in the mostly empty classroom assigned to me for the evening. For this interview, Nicole and I were casually chatting before I began the interview and she was sharing some interesting student work with me. I showed her the recorder and asked if I could capture what she was saying. With her consent, we continued the conversation. The students in her class were in a unit about geometry, and she shared a story about a little boy who had drawn twelve smiley faces on his paper in response to drawing a geometric shape with that many faces. Nicole laughed and said the work was wrong but precious. As we moved further into the structured questions of the interview, Nicole shared that her students did a better job on the second-quarter set of unit assessments than the first. She noted that the wording of the questions was difficult for some students to understand and felt that affected the overall proficiency of the assessments. Nicole felt that her students understood the concepts, but she struggled with the county expectation of "being perfect" in responding to each question, with no room for error. She shared that several students in her classroom received speech services and the language expected on the assessment was difficult. She felt that with her observations of students and meeting with them in small groups, students were demonstrating they understood the concepts but could not clearly demonstrate that understanding on the assessments.

As we then discussed student work, Nicole shared that she would want to hear students explain their solutions to others. She felt that would add to the written work she was examining. She shared that, at times, students do a wonderful job of explaining their answer, but the answer is wrong and then she had students who insisted that their answer was right even when it was solved incorrectly. I asked how she knew that students truly understood the concept and were not

just copying an example she had presented. Nicole shared that "I always model a problem, and then I give them a similar problem. So, I know that they're just gonna be copying what I'm doing first, but then giving them that opportunity to do a similar problem to see how they solved it." We ended our second interview discussing equations and how Nicole and her teammates were going to work with students on what the equals sign meant.

Nicole provided quarterly comments at the end of quarters two and four. The quarter two comments were like what she shared in our second interview. She wrote that students performed well on quarter two benchmark assessments and that she encouraged more math vocabulary, which she felt benefitted students on assessments. She stated that she did not like the scoring on benchmarks and wanted the ability for students to make mistakes and still be meeting expectations. At the end of quarter four, Nicole wrote she had found more interactive games and tried to find ways to support students still struggling with concepts. She noted that kindergarten had not received intervention this year and that the team had to get creative to support struggling students. She felt that there was still work that needed to happen to prepare students for paper and pencil assessments in first grade. She and her teammates collaborated with first-grade teachers to discuss where students are at the beginning of the year and the gaps that kindergarten teachers needed to fill. The benchmark scores for Nicole's students supported her statements to me in her second interview; students scored around 70% percent (below-expected proficiency level) for quarter 2, but the other quarters were at the proficient level (Table 3).

Shirley

"Shirley," with four-and-a-half years of teaching experience was in her second career, her first career having been in business. Shirley, a kindergarten teacher, was a little older than the other participants in this study but shared similar viewpoints in her interviews. On the survey,

Shirley responded with numbers in line with survey averages. She had neutral responses (indicated by a "3") on four of the survey statements: statements 2, 6, and 12 on the student side of the survey and statement 5 on the teacher statements. Statement 2 asked the participants to respond to, "In math, answers are either right or wrong." Statement 6 indicated a response to "When I get a bad grade in math, I think I am not very smart in math." Shirley responded with a "3" to "I like to solve complex math problems." Number 5 on the teacher side asked participants to respond to "My students understand the reasonableness of their answers." That statement had a range of responses from the participants (Appendix F).

I first met Shirley at her school after work. She worked in a school that would be considered rural in Kasey County. Farmlands surround the school, but a recent housing development was being built across the street, so enrollment was increasing. The enrollment for her school was close to 500 students. White students comprised 77% of the student body, with about 20% receiving free and reduced meals. There were three to four teachers at each grade level. Shirley taught kindergarten but also taught special education and had changed grades every year of her four and a half years. Shirley seemed a little reserved during our first interview. I wondered if some of her responses were censored as she responded, perhaps looking for the expected or right answer. The first interview took place in November 2018. We sat at her group table, and as we chatted, she frequently referenced charts or examples in her classroom. She shared that she was excited to participate in the study and had participated previously in other studies. She was very soft-spoken and hesitated when responding to questions. Her second interview was more open. I share that discussion below.

One of the first questions I asked Shirley was about her experiences as a mathematics student, and she responded that "I was not very good at math. And the more that I've taught it, I

think the better I'm getting at math." Shirley shared that she had taken Calculus and Statistics in high school but felt that the expectations currently in Kasey County for meeting the essential curriculum based on the Common Core were demanding. Her movement among grade levels meant that she was relearning content each year. She also mentioned comparing herself to her sister, whom she characterized as "really good at math and quick with mental math." With the self-anchoring scale, Shirley placed herself at a five or six and hoped to be an eight or nine in five years. When asked how she could get to a ten, Shirley responded that staying in the same grade for two years would be helpful. Shirley noted that if she continued in kindergarten for the 2019–2020 school year that would be the first time she taught the same grade more than once. She noted, "Just having that prior knowledge and being able to continue to learn with the same grade-level skills" would add to her skill level. In discussing mathematics, Shirley felt that teachers' beliefs about mathematics "have to do with how they learned growing up, and if they were successful." We then discussed the characteristics of the best and worst mathematics teachers.

Shirley related that the best mathematics teachers had student-led discussions and had students wondering while understanding the problem-solving process through flexible thinking. She stated that problems should have a real-life context and that modeling of strategies is essential so students can pick a strategy that works best for them. Manipulatives and a variety of tools should be provided so that students can learn how to demonstrate their thinking and produce original ideas. Her worst-teacher characteristics included lessons that were teacher-directed, and those instructors being satisfied with one right answer. She added that the teacher would only model one strategy and not allow students to explore or discover their own strategies.

She also felt that poor teachers would not have or encourage the use of manipulatives or ask students to prove or justify their answers.

Shirley gave responses that sounded contradictory when discussing students and their participation in mathematics lessons. She said, in response to a growth mindset question, that the teacher should make sure that students keep trying and "persevering through the challenges" while making sure that students use what they know to find what they do not know. However, one response from Shirley indicated she has different expectations for, "my kids who have struggles and are still learning base skills, it's not necessarily that they can talk about it and explain it. I think that it's when they put effort into it. Because not all students are going to learn everything you teach them." Her words became stilted afterward. Shirley seemed a bit uncomfortable with her statement and hesitated to continue with some of the questions. Most responses became single words or short sentences. When I shifted to questions about the benchmark assessments, she began to respond with longer statements and seemed more assured in answering the questions.

Shirley was a participant in the focus group in December 2018. Shirley joined in the initial chat with others as they walked in. As the group viewed the videotaped mathematics lesson, she stated similar beliefs about her expectations from her first interview. She noted that in the video lesson, students were excited to respond to a challenge, and she liked that the teacher asked an open-ended question for students. She noted that the questioning from the teacher allowed students to take responsibility for choosing an appropriate tool. Shirley talked about scaffolding the problem for students. She mentioned the structure of a classroom mathematics lesson, including rotations to keep students' attention. She shared that first graders sitting at their desks for the videotaped mathematics lesson was "weird" and that her students only sit when

they are writing. Shirley also noted that she "was impressed that out of the gate they were, 'Oh that's a part-part-whole problem, that's how you label it.' I thought that she had set them up with that language and the knowledge." She felt that students should have a chance to work with partners to share their understanding. She said, "I just wonder what would happen if they would have worked with a partner to make their own problem and then given it to another group to solve."

Shirley felt the teacher in the videotape was not distinguished as a teacher because she was not "warm and fuzzy." She felt the teacher was matter of fact with students. The format of the lesson did not include small group instruction, and Shirley shared that she felt it was inappropriate for students that young to be sitting at desks and not interacting with each other as much as she expected. In this setting, Shirley was less reserved and was willing to chime in and share her opinions.

In our second interview, rescheduled from January to the middle of February, Shirley seemed more comfortable answering the questions. She smiled more and did not hesitate as often in responding. We again met in her classroom. She stated early in the conversation that she valued what she saw in the focus group setting and took the student work as an indication that her students could do more, especially with problem-solving work mats. When asked how mathematics class was going, she responded that the current unit was about geometry. She stated, "I think that's where there's an opportunity where my kids who necessarily don't have math skills like rote counting and one-to-one counting, they can still be successful." She felt that focusing on vocabulary for the unit was helping students. She indicated in the room where she had vocabulary posted and how she implemented that into her lessons.

Shirley shared that she used sentence frames, especially with her lower group, “to help them to be able to talk about what they’re thinking for the 3D shapes unit.” She shared that while she was excited that students were doing well with geometry, she still had students who struggled with number. She stated, “it’s tough, and I’ve tried things, I’ve tried to have them work with a partner every day to practice counting then just practicing with fun counters and things like that. But they’re still struggling, but it’s good to see that they don’t think negatively of that, you know what I mean? They’re just like, ‘Oh, we’ll try again’” (laughs).” Shirley noted that struggling students are always on her mind because of the possibility for a skills gap to develop. She also shared that she was concerned about the way she structured rotations. Students who were struggling did not have good role models for discussions except in the large group, and she worried that students were not getting all that they needed. Shirley mentioned a “hot seat” that she used in small group instruction for mathematics. Students receive targeted feedback based on their work in the group. She noted that sometimes her small groups are large, so she has a student on each side of her. Those students received feedback and shared their thinking with the teacher during that time.

Assessments are conducted as interviews in kindergarten in Kasey County and used after each unit. Shirley was concerned that students would not remember the mathematics vocabulary, like faces, for the geometry unit. Songs with key ideas are used with students to help them remember concepts. Shirley felt as if a focus on vocabulary was helping her students to be more successful. In the quarterly responses, Shirley noted that students had improved their number sense from quarter three to quarter four. She used drawing models as a focus and was excited when students could recreate a part-part-whole organizer independently. The data for the unit assessments were collected at the end of the quarters and collated. Shirley’s students were

proficient in each unit. Kasey County expects that 75% of the students will score 80% or higher on each unit. Shirley's students scored 81% or higher for the units.

Shirley responded to my member checks over the summer. When asked about gender assigned to student work, she stated, "Maybe we judged based on handwriting. Sometimes we think of bubbly writing as girls and the not as neat writing as boys? I am not sure." When asked why participants might have stated they preferred looking at student work that was not theirs, she wrote that "when you are analyzing student work of students you do not know or have a relationship with, it tends to be more objective. You don't relate their work to the progress they've made or what their 'typical' work is like. We do a lot of common scoring of assessments at our school where we shared and grade student work together to help minimize [subjectivity]." The final question was about switching grade levels, and Shirley indicated she was staying in kindergarten. She noted that focusing on common formative assessments with her team will help with pacing for the curriculum and unpacking the standards.

Antonia

"Antonia" was a second-year teacher in first grade at a new elementary school in Kasey County. She has taught more than one grade. The school where Antonia taught opened the year we met. It had an enrollment of 627 students, 70% whom received free or reduced meals, 27% English language learners, and about 11% of the students received special education. About 30% of the students are African American, 38% Hispanic, and 23% White. The school had targeted Title I support. The school, situated within city limits, was constructed to relieve overcrowding at several nearby elementary schools. The floor plan included a second floor, untypical of the older elementary schools in Kasey County.

On the initial survey, Antonia had typical responses for most of the questions. On question 12 of the teacher survey, most participants recorded a "1" or a "2." Antonia indicated a "4" for this, meaning that she agreed with the statement "Some students have a certain amount of math intelligence and I can't really do much to change it." With a similar statement on the student survey, Antonia indicated a "3." She also marked a "3" for question 16 in both the student and teacher sections of the survey. This statement is that either the participant or the students of the participant like to solve complex math problems.

Our first interview was in her classroom at her school. I enjoyed visiting the new school and took a few minutes to appreciate the floor plan and the classroom setup. Antonia had her room set up with desks and tables for instruction. The room was cheerful and full of "new." As we began to chat, Antonia shared that she had taught third grade the previous year in a different county but said she felt like a first-year teacher all over again due to the differences between counties and the different grade level. We talked about the characteristics of a good mathematics teacher, and she shared that the teacher should know her resources and her students. She emphasized that there was much differentiation in mathematics, from students who were very visual and required manipulatives to students who could do the mental mathematics and did not need manipulatives. She also talked about making mathematics engaging and allowing students to explore and make mistakes. She noted that her mathematics instruction was in the afternoon, and she had to work hard to keep her students engaged. She gave characteristics of the worst mathematics teacher, one she had had. The teacher just gave students the answer. Students were expected to complete a worksheet, and if they asked the teacher for help or clarification, they were given the answers to the problems. Antonia noted that it was worse than the teachers she had that were strict, hard, or just gave out worksheets.

Antonia then rated herself currently as a seven on the self-anchoring scale. She felt that she was a better teacher than the year before, where she rated herself lower than a five because she now had more flexibility in allowing students to explore mathematics, rotations during mathematics lessons, and allowing students to make mistakes while learning. In five years, Antonia would like to be a nine. She stated that she felt like there was always room for improvement, so she would never be a 10. Antonia wanted to understand the content and mathematics standards better as she moved forward in her teaching. She shared that most of her lessons are with students in rotations: one group with her, one playing mathematics games, and a third using technology to practice skills.

Antonia was candid in sharing that she never felt as if she was a good mathematics student. She stated that she was frequently nervous in class and worried about making mistakes but also never felt driven to succeed either. Her feelings about succeeding in mathematics changed a little in college because she wanted to do well, but she stated that mathematics was never her favorite subject; however, Antonia stated that her favorite class was statistics because the female teacher made it fun. She noted that she tried to do that with her students, to make it fun, as if students were not aware they were learning.

Antonia noted that there was a mathematics specialist on staff that provided professional learning for the teams. She stated that professional learning was useful and included assorted topics like how to enter data into the database being used by Kasey County and how to use Number Talks in class. She shared that students who had the traditional algorithm to solve problems were less likely to want to try other strategies in mathematics class. She noted that even though she prefers rotations and differentiation, she continued to worry about the students in her lowest mathematics group and if they were truly understanding the concepts when they

were working away from her. Antonia is the only participant who shared that someone else on staff puts in data and analyzes it for the team. She said that she uses that information to circle back to a concept if they are told that students are struggling with that. The data is obtained from their unit assessments, and the team meets for a data discussion to inform their instruction. Antonia felt the discussion, which included successful strategies to use, was helpful for her. She shared that hearing her teammates' discussion was beneficial because it gave her ideas but also reinforced her confidence that her students were not the only ones struggling with a concept. Antonia was not able to participate in the focus group in December, so the next time we met was her second interview.

Antonia's second interview was held in mid-January at her school. At the beginning of the interview, she shared that rotations and routines in the class were going very well. She felt that students who were "fence-sitters" were beginning to understand the mathematics, and her lower students were using manipulatives well and moving forward in their understanding. We spent some time talking about student work and how she could tell if students understood the concept. She noted that with her lower students, they struggled to read word problems, so they act out the problem and use manipulatives to find answers. She noted she was also working on students understanding the actual question and not just solving the equation and stopping. She also shared that an interventionist comes into work with some of her students. At the time, Antonia also shared that she was going to visit another classroom to see how that teacher set up rotations and monitored what her students were doing. That accountability continued to be a concern for her. I asked for more clarification on how the interventionist knew what to do when she came into the classroom, and Antonia shared that the interventionist attended weekly meetings with the team. Antonia also shared that there was an additional adult in her classroom,

supporting two students with special needs. That extra pair of hands was helpful to her during the day.

Antonia did not choose to respond to the quarterly journal prompt. On the quarterly benchmark assessments, 73% of her students were proficient for quarter one. Kasey County expects 80% of the students to be proficient each quarter. For quarters two and three, Antonia had 67% and 53% of her students at proficiency.

Caroline

My next participant was a new, first year teacher in Kasey County. "Caroline" was a traditional-aged novice teacher working in a brand-new school in first grade. This new building was a replacement building for an older elementary school that was then razed. There are five teachers per grade level with over 750 students. That number put the outdated school over capacity, so a new school was built on the grounds of the old building at the edge of a neighboring, more affluent county. There had been considerable growth in the area. The demographics for the school include an advanced academics program with a student body comprising 57% White, about 7% African American, 10% Hispanic, and 18% Asian. The FARMS (free and reduced meals) population is 8%, and students with special needs are 7.2%.

Caroline's responses to the initial survey yielded a few surprising answers. She stated that she agreed that her students had a limited ability to improve their basic math ability (question 10 in the teacher portion of the survey). She also noted that teaching math is boring or hard for her (question 3 in the teacher portion; rated as a four or agree) while the rest of the participants rated that a one or two (disagree or strongly disagree). The other statements in the survey were typical of the group overall.

We met for the first interview in her classroom the day after I had interviewed Laura in late November. Caroline and I chatted briefly to get to know each other before I began the formal interview. When asked how her year was going, her first comments were about the Student Services Team (SST) meetings she had completed or was in the process of requesting. She noted that she had students with challenging behaviors but felt that she was learning much about how to handle the behaviors. She noted she was receiving support from her team, which she appreciated. Caroline also shared that she had initially intended to become a school counselor or psychologist but changed her degree to one that allowed her to be a teacher.. She clearly stated, "Student teaching taught me nothing." She then amended her statement a few minutes later to say she had exaggerated and had learned quite a bit in student teaching but was not prepared for her classroom. The characteristics she shared of the best mathematics teacher included someone patient, who extended students' thinking, understood the curriculum, and helped students to understand they can do challenging work. Caroline mentioned that she was thinking about her teammate next door as she described this type of teacher. The characteristics of the worst mathematics teacher included someone with a closed mindset, someone who was negative, not excited about mathematics, and did not encourage students. As she shared, Caroline stated, "Even when you don't think math is exciting as a teacher you have to pretend that you think it's exciting." She reiterated that the teacher's attitude toward mathematics impacts student thinking about mathematics.

On the self-anchoring scale, Caroline placed her current skills at a six and a half. She noted that her rating could change from day to day, but her understanding of mathematics played into her ranking. She felt that the following year would be better for her because she would know the curriculum better but would also have time to organize and familiarize herself with the

mathematics manipulatives in her classroom. In five years, Caroline hoped to be a ten because she would know the curriculum, have organized materials, and an improved attitude. She felt that time would improve her skills.

Caroline shared her experiences as a mathematics student. She remembered using manipulatives but said, “I don’t really remember math ever being a positive experience.” She also shared that mathematics was hard for her and that the classes were typically lectures, even though she remembered using base ten blocks in class. She specifically noted a college professor that she enjoyed, and while the professor had limited English, Caroline noted that “she wanted us to succeed.” She mentioned that another college professor taught Elementary mathematics concepts in ways that allowed her to understand what students might be thinking. Caroline talked about a growth mindset in similar terms to the characteristics of the best mathematics teacher. She shared that the teacher must be patient and not show any frustration with the student and that students can learn, but not everyone learns at the same rate. When students struggle in mathematics, Caroline believed that the teacher needs to back up and re-teach the concept so that students understand. She did not talk about a change in the instruction, but the teacher had to make sure students could do each step.

Caroline participated in the December focus group. Commenting on the teacher in the videotape, Caroline positively noted that the teacher allowed students, while sitting on the carpet opportunities to participate, and the teacher talked with students during the lesson. She also commented that the teacher had all the students engaged in the lesson so that no students ran around the room. In determining a rating for the teacher in the videotape, Caroline noted the teacher needed to give more wait time when asking students questions. She praised the student who connected addition and subtraction in the lesson, but the teacher did not seize that moment

to make the connection clear for other students. Caroline rated this teacher as an eight on the self-anchoring scale, but while listening to others' ideas, she changed her rating to a six and said that the teacher needed to be more inspiring and happier while teaching. Caroline continued to comment on the teaching, suggesting the teacher may have asked a question that was too open-ended and that her students might need a sentence frame or visual.

Caroline's second interview occurred at the Staff Development Center in Kasey County. She was a member of the new teacher course being taught that evening, so our second interview was in between activities. When asked how mathematics instruction was, Caroline shared that she planned with her team leader and that she felt her team had become lazy in planning. She stated she was not excited about mathematics at that time (February). When I asked why, she felt the curriculum was scripted, and she was expected to take the multiple resources given to her and figure out how to teach the concepts so that students can pass the assessments. She told me that many of her students were proficient on the assessments, but her class had a lower average than teammates. She felt many of her students were understanding the concepts and enjoyed a challenge, but some students "are almost too closed-minded to develop a growth mindset."

Caroline talked about the assumptions made about her students and the assessments that showed something different. She gave the example of one female student in her on grade mathematics group that could not count when given the assessment. Caroline questioned her teaching. She said, "I had a few of those [students] which, I don't know, am I not teaching them to count? But I thought I was." She talked about the difference between having an additional adult in her classroom during mathematics instruction and not having one. The mathematics specialist was in her room daily earlier in the school year to help with behavior more than instruction, but that was changing to the specialist taking a small group for instruction in

February. Caroline wanted her mathematics rotations during lessons to be smoother. She felt it was better in February than in November but still wished that type of lesson functioned more smoothly in her classroom.

For each of the second interviews, I asked participants to review student work and talk to me about what the students appeared to understand. While Caroline articulated what she thought students understood, she became confused by some of the structures of student responses, and I found myself explaining the strategy the student used. I noted this later in my reflection on the interviews that Caroline seemed genuinely unfamiliar with the variety of ways students solved problems and how to understand their work. When asked how she might change her instruction to meet those students' needs, Caroline decided that harder numbers would be the change she would try.

Caroline did not respond to the quarterly journal entries about how mathematics was going for her. Her students' proficiency on quarterly benchmark assessments met the expectations for all three quarters. Caroline did not respond to the member checks for clarity on my findings.

Laura

"Laura" was a first-grade teacher at a large elementary school in Kasey County. She had been teaching for four years with some additional experience as an instructional assistant in another state. Her teaching experience included a Title I school in Kasey County. The school housed over 600 students, with over 30% percent of those students receiving free or reduced meals. About one-third of the students were White, 20% were African American, and 22% were Hispanic. Each grade level team had three to four teachers. I had met Laura previously, when she taught at the Title I school in Kasey County. I met with her at her school one afternoon in late

November 2018. We found space at her teacher table in her first-grade classroom. During the interview, we were interrupted once or twice by others not realizing there was an interview in progress. She was enthusiastic about teaching and was eager to share her thoughts. Laura was a slightly older novice teacher with a degree in sports management and a graduate degree in education. Her classroom was cheerful and full of large and small teaching spaces. Her teammates were next door and across the hall. Our comfort level with each other was more relaxed since we had met before, but I did wonder if she tried to answer questions the way she thought I wanted.

We began our interview discussing her reasons for becoming an elementary teacher. She talked about a fourth-grade teacher that had a significant impact on her and her enthusiasm for the ever-changing landscape of teaching. She stated that it "doesn't get boring." Her self-anchoring scale included the following characteristics for the best teacher:

> Conversations between teachers and students, conversations between students and students, questioning from the teacher to the students, trying to teach first graders how to come up with their own questions to ask teachers or other students. Solidifying skills with games, with independent work. Work at the small group table, being able to explain what they learned. Ending the lesson with either a quick formative assessment, thumbs up, thumbs down, thumbs to the side, how do you feel about what we learned today? Having the students be able to tell another adult or another student what they're learning that day, the learning objective. Fun. Kind of noisy, can get loud. Using tools, manipulatives, asking for help when they need it.

The worst teacher, according to Laura, was quiet, with disengaged students, no discussions, no number sense, and a negative tone. Laura then placed her current skills at a 5 on

the scale with the hope to become a 9 or 10 in five years. She felt that she needed to work on her questioning with students to become a better teacher. While Laura loved mathematics in elementary and high school, she dropped a mathematics course in college and did not take any more. When I pressed her about taking mathematics classes in graduate school, she stated that she must have but could not remember taking any, or the names of those classes. Her most active memory of mathematics was memorizing facts, getting the answer right, and being happy about that.

Laura shared that teaching elementary mathematics was hard and required much preplanning, including knowing the students and how to differentiate. She stated that the teacher had to be confident in her teaching, or students would not be confident in their abilities. She noted that teaching first grade was a change for her and that she needed to improve her skills by talking to others who had taught the same grade and reading about first-grade mathematics helped with her confidence in teaching. She also shared that when the school year started, her students were struggling with understanding mathematical concepts. She talked about encouraging students to practice and that they would learn the new concepts. However, she also mentioned that she had outliers, some of them in special education who were still not demonstrating concepts and some students who discovered mathematics a little easier than other students. Laura is one of the few participants who stated that she was unsure she demonstrated a growth mindset. She used words to encourage students but did not feel she used actions to demonstrate that growth mindset.

Laura talked about the amount of time allocated to teach mathematics and the pressure she felt to complete a standard and move on to the next. She shared that her team maps out the standards and must adjust their teaching and the team plan based on the academic calendar.

Laura acknowledged that the standards come back later in the year but was feeling that she had a small percentage that would need extra support. In responding to further prompting, she noted that students could get further instruction using technology and small-group rotations. She also remarked that she was removing any students receiving special education from that group, with the implication that they would need further instruction to be proficient. She mentioned that her first group was the one that struggled, and she might adjust their time with her to be longer or make the problems easier for them (single digit vs. multi-digit). Laura shared that she used unit assessments as formatives partially because they are not required, and she did not have to record the results anywhere for others to see. She shared that the problem-solving mats on the benchmark assessments were a frustration for her. Students did well in the whole class setting with supports from the teacher but did not demonstrate that understanding independently on the assessment. She felt that her instruction was not where it needed to be for her students. The use of the mats was new for her and the amount of time she could dedicate to learning about the mats was limited. She wondered if the problem-solving mat was on the assessment because it was new in the curriculum.

Laura joined the focus group in early December. She enthusiastically joined in the conversation and seemed to engage with the other teachers comfortably. She was one of the first teachers to speak up and share an opinion of the videotaped mathematics lesson. During the focus group discussion, most participants began with positive statements about the lesson, then began to describe what was missing when pressed to determine a rating based on the rubric. Laura noted for the group that the teacher did not take the time to celebrate a student who had an alternative way of solving a problem posed by the teacher. She made a clear statement about children being able to manipulate numbers, not just share facts. Laura gave the teacher in the

video a five or six for her current teaching. That is also where Laura placed herself on the self-anchoring scale.

The second interview took place at Laura's school again. This time she closed the door to her classroom so that we were not interrupted. I was able to meet with her in the middle of January. When we talked about her current mathematics instruction, she noted that story problems were much better for her students. She felt they were doing well and that she was doing a better job of using the mats appropriately. She noted that she had slowed down her instruction and spent more time going through the expectations. She shared that spending fifteen minutes to solve one problem was better for her students. She also spent time critically reviewing the student work I provided for our discussion. The work showed students' thinking about a word problem but not using the problem-solving work mat she mentioned in both of her interviews. At one point, Laura counted the dots a student had drawn, and I asked her why. She stated that she was checking to see if the student's drawing matched the equation. She felt that students sometimes rushed through their work and drew pictures out of compliance rather than a desire to check their work or demonstrate their understanding. She also talked about answering the problem as written on student work. Many of the students had answered, yet it did not match the question asked. She wondered if students needed more instruction on how to go through the problem step-by-step to ensure they answered the question. As we talked through her expectations for lessons, Laura found herself generating innovative ideas for her lessons. She seemed excited about the ideas she developed as we talked about the next steps based on what students showed in written or oral work.

We spoke briefly about feedback on student work. Laura noted that she prefers to give it verbally because some of her students cannot read the written feedback if she chose to do that. At

the end of the week, she sent finished work home and typically used a smiley face for good work. She said she does not believe that any written feedback was read or used by students. Most work scheduled to be sent home is placed in a bin for students to take home on Fridays, so any written feedback is not visible to students until then. She also noted that some students do not have the concept yet, so she spends time going through ways to solve the problem rather than providing feedback about the work. Laura felt that verbal feedback was useful because she saw changes in student work the next day. She also praised students for taking and using the feedback.

Laura provided feedback at the end of quarters two, three, and four. Students completed the quarter two benchmark and did well. She was very proud of them. She felt that the graphing unit was fun and made it authentic for students by using their names in the data. Teaching students how to break apart "10" was difficult if students did not have good number sense. During a unit on measurement and time, students demonstrated excellent learning. They engaged in fun activities, and Laura used a math-focused escape room for students. In quarter four, students had success with several story problems each day that included explicit modeling. They worked hard on communicating their answers and Laura saw success. She noted that unit 10 was long, and the assessment was a "disaster." She felt students did not retain as much as she hoped. Students in Laura's class met the proficiency mark (70% of students had 80% or higher) with 78% for quarter one. In the other two quarters, the class was close to the 70% mark, with 68% and 67%.

Laura also participated in the member checks to the three questions I asked. When asked about assigning gender to student work, she wrote, "I think maybe that happened because it seems to be the default when talking about an unknown person/thing. I also remember learning a

long time ago that when you refer to a large object (boat, plane, etc.) it gets referred to as 'she'. Not sure why! Maybe some of the handwriting looked like boys handwriting?" When asked about reviewing student work that was not hers, Laura shared that she felt it was easier to observe others' work because, "if we see something they need to work on, we don't feel like we immediately have to go back to school the next day to fix it." She felt that looking at work objectively allowed teachers to talk about what they notice and not what they personally need to re-teach. Laura had experienced different grade levels in her five years of teaching. When she moved from second to first grade, she wrote that it:

> 100% impacts your thinking and planning for the next year because you need to know the curriculum and the developmental level of the students you are teaching. There's always that balance of trying to not expect too much or too little of the kiddos that are put in front of you starting Day 1 of the school year. You plan for that first week and use what you learn about them that week, to guide your upcoming weeks afterwards. It's never a one size fits all.

Laura taught first grade again for the 2019–2020 school year.

Louise

"Louise" was in her first year of teaching at a rural school in Kasey County. She was teaching first grade. Louise had also interned in my school the year before. The school she was teaching in was an older building housing around 450 students. Over 60% of the students were White, about 20% African American, and about 10% Hispanic. About 15% of the students received free or reduced meals, and about 8% are in special education. About 6% of the students are learning the English language. There are three teachers per grade level at grades one through five and four teachers at kindergarten.

Louise responded typically on the initial survey. Her responses were like the rest of the participants. She did respond with more threes than other participants. She indicated a "3" for liking to solve complex mathematical problems as a student and as a teacher (question 16 on both surveys). She also responded with a "3" to students getting answers quickly if they understand the mathematics, and students' understanding the reasonableness of their answers.

We met for the first interview in her classroom at her school. Her classroom was set up with desks in small groups of four to five. It was colorful and inviting. Louise was rather quiet in our one-on-one meetings but her excitement for teaching was evident in her responses. In sharing her beliefs about mathematics teaching through the self-anchoring scale, she noted that the worst teacher would lecture for most of the lesson and have students take notes with minimal interaction. There would be no hands-on lessons but lots of worksheets. Louise noted that she is a hands-on learner so having a mathematics teacher like that would mean she was not learning. A good mathematics teacher would be hands-on, create time for students to interact and allow for relevant learning where students are practicing the skill.

Louise rated herself as a seven at three months into her first year of teaching. She felt that her teaching more closely matched what the best mathematics teacher should be doing and that she used worksheets to gauge where her students were in their understanding. She felt her instruction the previous year, while an intern, was a five. She believed that she "played it safe" and spent too much time on what she called "hard teaching." She focused on direct instruction for students. Students might be asked to complete a worksheet or an activity or two with a partner, but she did not ask them to collaborate as much as she felt she should. She said, "It wasn't a full ninety minutes of lecture, but it was right in between." Louise wanted to be at a 9 or 10 in five years because she wanted students to enjoy mathematics class. She did not want to

"ruin their idea of math now" but noted that she still needed to work on finding mathematics activities that were fun for students. She also expressed concerns about her ability to be organized at this time in her career, getting used to the materials and the way her classroom rotations were set up. She wanted more time to collaborate with colleagues to get more ideas for teaching mathematics. She noted a feeling of not being as ready as her colleagues; "I feel like as I talk to other teachers, they're already so there and it's hard for me to ever feel like I'm going to be there, but they've been teaching for 25 years." Louise also noted that things could change in five years, and she would have to re-learn and re-do her mathematics instruction, but she was excited by that possibility.

Louise noted that the mathematics teachers she had were at the bottom of the self-anchoring scale. She called them "zeroes" with lectures, worksheets, and boring lessons. In middle school, she remembered having her first hands-on lesson with manipulatives in geometry. High school lessons were like her early years. College mathematics education classes ignited her spirit for exciting mathematics lessons again. She said, "We used every manipulative that I'd ever heard of in my life. We collaborated. We did projects at home and at school. We were hanging up our work. We were able to see other ideas. And that was an amazing experience."

Louise participated in the focus group. She knew some of the group members from her classes in college and the new teacher workshop that several were attending. The time at the beginning of the focus group and the warm-up activity gave her a chance to chat with others. She was one of the first to speak up in response to my questions related to the lesson we watched. She noted that explanations of student thinking were happening in the classroom. She also shared that she saw small group instruction and the availability of manipulatives at each table for students.

Louise was the first to offer a teacher evaluation rating for the observed lesson. She stated that she felt the teacher was proficient but noted that students did not automatically offer explanations unless asked by the teacher. Louise also noted that no closure to the lesson was observed, so it was hard to rate the teacher on that portion. She pushed her belief that the teacher was proficient based on the rubric, not distinguished, in response to others' ideas during the conversation. She stated support for her beliefs and noted that conversation in mathematics lessons is not one student speaking at a time, and students needed to be using the vocabulary, not just the teacher. She agreed with another participant who suggested that students using white boards to share their ideas and strategies would be closer to distinguished on the evaluation rubric because all students would be engaged. Louise rated this teacher as a seven on the self-anchoring scale and shared that she would like the teacher to show more excitement and enthusiasm for mathematics.

For the second interview, I met Louise at the Staff Development Center on class night. As with some of the other participants, she was part of a new teacher class that met at the Staff Development Center. As noted earlier, the room used for the interviews was bare and housed a table and two chairs for the interview. I began our interview with a general question about how mathematics was going for her and her students at this point in the year. She referenced the benchmark assessments students had completed at the end of quarter one and quarter two. She was disappointed that students did not demonstrate an understanding of subtraction in a story problem. She felt she needed to spend more time on that concept. She was excited to share that she had just done a rotation lesson with the mathematics specialist and the media specialist in her building. Each teacher took a small group of students and presented activities related to the mathematics concepts taught. The media specialist used technology and she felt the use of

technology was engaging for students and made the lesson more fun for them. She shared that she had asked to be the "guinea pig" for the use of technology in her mathematics lesson and was excited that the lesson had worked so well.

As the interview continued, I asked Louise some follow-up questions related to our first interview. She shared that she was worried about the wide range of abilities in her classroom and how to best meet their needs. She worried that some students were bored while others were struggling to grasp basic concepts. She connected that to the technology lesson she had experienced. The technology was engaging for all students, but Louise also noted that having two extra adults in the classroom was also helpful. Each of the adults took a small group for either re-teaching, introduction to the use of the technology, or an extension of the use of the technology. I asked Louise if she felt she had ventured out in her mathematics teaching, and she told me that she still felt like she was playing it safe. She stated that she wanted to feel like she had mastered the content in mathematics before she could play with it. She noted that she could be quite serious and forget to have fun with the instruction and her students, so she wanted to work on that.

When I asked Louise about doing gallery walks (allowing students to display their work and then walking around the room to look at that work) with her students, she noted that she had done it once or twice but not often. When I asked why, she told me that she plans with her team and because it was not part of the teams' plans, she decided not to do that. She stated, "I feel like I'm so afraid to stray from it even though nobody's told me I'm not allowed to but I just feel like it's my first year, let me just do what I'm supposed to do, and then leave it alone." However, she went on to say, "Then I just get these itches where I'm like, 'Well I've just got to do something new.' I'm still teaching the same thing my team is, just in a different way."

Louise responded to the quarterly journal entries. At the end of quarter one, Louise jotted that her students had understanding but were not retaining the information and that they were able to respond to questions verbally but were struggling to give written responses. She noted at the end of quarter two that the benchmark assessment was a surprise for her. Some of her students could not identify numbers over 100, and a few could not count them. Her quarter three reflection was also focused on the benchmark assessment:

> On Q3 assessments students struggled with drawing models of their thinking and jumped straight to attempting equations. This was okay for some students who were able to successfully record equations, but a lot struggled. Went back and re-taught making a simple model, which seemed to help! Students are able to use and apply unit vocabulary and demonstrate understanding. Have been working on steps of problem-solving process - using visuals that pair with each step has helped my students immensely! I do have students who want to jump to solving or jump to giving an 'answer' and I am struggling with how to stress the process and not just the outcome.

Louise did not respond to the member check inquiry over the summer. On the quarterly benchmarks, Louise's students were proficient in quarter one and quarter three.

Loree

"Loree" was a third-year teacher, currently teaching second grade, but had taught kindergarten the two previous years. She worked at a school with over 600 students, where 33% were African American, 21% were Hispanic, and 28% were White. Thirty-nine percent of the students received free or reduced meals, 13% received special education, and 12% of the students were English language learners. The school was a little over 20 years old and in a neighborhood easily accessible from several commuter routes. On the initial survey, most of

Loree's responses fit the expected responses. There were several statements on that survey where Loree's response differed from the norm. Statement four on both the student and teacher surveys was marked as a "3" response. Most of the other participants marked those as a "1" or a "2" (disagree or strongly disagree). On statement 2 in both surveys, Loree marked a "2." These statements are related to mathematics answers as being either right or wrong. Loree's mark indicates that she disagrees that in mathematics, the answer is either right or wrong (student), and she strongly disagrees that in mathematics, she expects her students to get the right answers. We met for her first interview at her school one afternoon in November.

Loree's classroom was set up for small and large group instruction and was welcoming for students. We sat at one of her tables and began our discussion. Loree was a Kasey County graduate and happy to have returned to teach there. She remarked that her administrators were supportive and welcoming, and she appreciated that. She felt that a teacher of mathematics should have an appreciation or love for mathematics and the ability to understand the reasoning and more profound thinking associated with mathematics. The worst teacher of mathematics hates math, Loree claimed, and it shows when he or she is teaching and gives a one-way strategy for solving problems. She rated herself as a six or seven because of the change in grade levels. She is a new teacher and still learning. A year ago, she would have placed herself at a five because she was teaching basic mathematics to kindergarten students. In five years, she hoped to be a 10 and a mathematics specialist working with other teachers.

Loree stated that she loved mathematics as a student because it was easy for her. She recalled a teacher in a geometry class she had who was the reason she enjoyed the course. The teacher was a woman who had the students truly organized and ensured they had notes and resources that Loree was able to apply to projects in the class. Loree also had a female college

professor who was a mentor for her. Loree loved the three classes she took with this professor and the way they were taught. She felt that her teaching was different from the way she was taught mathematics and that she tried to use a variety of strategies with her students. She noted that her biggest challenge so far was determining what her students knew about mathematics from kindergarten and first grade so that she could move them into the second-grade curriculum. Loree also has access to a mathematics intervention teacher in her classroom to work with her lower students.

Loree was unable to participate in the focus group. Our second interview was canceled because of bad weather. I invited her to meet me at a local coffee shop for the second interview, but she canceled, and we struggled to reschedule. On February 22, she requested to withdraw from the rest of the study due to health issues. On the benchmark assessments, 67% and 41% of Loree's students were proficient for quarters one and two, respectively. On the quarter three assessment, 78% of her students were proficient.

Cross-Participant Analysis

Analyzing each teacher's data individually and considering their individual experiences provided an in-depth understanding of them as new teachers of early childhood mathematics. To consider responses to the research questions, the data sources were analyzed collectively. This section includes description of the analysis process and presentations of the analysis and responses to the research questions.

Data Analysis

Data analysis involved a multiple step coding process to determine the salient themes and key findings. All data sources were analyzed through several re-readings, coding, and thematic insights. There were eight possible data sources for each participant—the initial survey, two

interviews, including the self-anchoring scale, the focus group, quarterly journal entries (four), quarterly assessments and member checks. In this section, the data analysis process first described in the methodology section is revisited with illustrative quotes and data.

Initial interview transcriptions were read multiple times. Codes linked to the research questions were used to understand the data. Initial codes and emergent themes were posited in response to the research questions. I looked for statements of beliefs which indicated *mindset* in the transcripts. For example, Laura, when asked about the number of mathematics courses she had taken, replied, "If I could [have] pass[ed] statistics, I probably would have taken another class beyond that" (first interview). Louise talked about what she believed early childhood teachers felt about teaching:

> I think most early childhood or elementary believe that math instruction is hard. It requires a lot of pre-planning, knowing your kids, what they know how to do, what they don't know how to do. What tools each of the groups has to use, how you're going to present it to everybody at first and then differentiate it down into the three or four different styles of learning (first interview).

Nicole shared mindset as it related to her students. She said, "my students performed a lot better on it (a recent assessment), than they, I mean it was, not that I wasn't expecting, but better than first quarter. I know that in first quarter we had struggled with the way that some of the questions were worded. They were not how we were presenting them in class." The amount of data under that code were further categorized into subareas I labeled *general statements about mindset, statements about mathematics related to mindset, statements related to students, and to the self about mindset*. Additionally, self-ranking, related to the self-anchoring question in interview one, became a code as did teachers' experiences related to mathematics. I also found another

subtheme related to what teachers believe about mathematics separated from the overall mindset theme. During the interviews, teachers shared their beliefs about mathematics related to what they had experienced as students, and these statements were coded. *Teaching practices* was coded for instances when participants shared how they organized and taught mathematics in their classrooms. Out of that, a sub code related to *assessments* became apparent. The teachers frequently mentioned assessments in relation to their students' achievement. Assessments were also related to instruction. As the teachers approached the end of each quarter, they had to give benchmark or unit assessments to students.

As I organized the codes and sorted interview data under each, I then looked across the other data sources to see where there was congruence. The focus group transcription was analyzed for the same codes. In the group setting, the participants' responses played off each other. When one teacher suggested or posited a thought, others would join in and either confirm and agree or share a different idea. The organization of the focus group allowed for other ideas to flow and for me to ask questions and get clarification. Responses from the first interview and the focus group transcription allowed me to develop additional questions for interview two. Several questions were specific to each teacher and allowed me to probe further in a one-on-one setting to confirm ideas or statements.

It was in the focus group where I heard discussion around student work related specifically and solely to male students. This gender focus was one that was not seen in other data sources. I probed further for this in member checks. I asked the participants to talk more about why they had referred to a student as "he" when we looked at student work with no identifiers on it. Shirley responded by writing, "Maybe we judged gender based on handwriting? Sometimes we think of bubbly writing as girls and the not as neat writing as boys?

I am not sure!" Louise wrote, "I believe for others, it may have happened because many times boys are the dominant gender when discussing math for many people. I remember growing up, always hearing about how boys were dominant in science and math and girls shouldn't worry if they didn't succeed because we were better for arts."

The quarterly journal writing data were coded. Participants shared about mathematics instruction in their classrooms. Several wrote comments about assessments. For example, Lea wrote, "My math data improved tremendously this quarter. As a whole kindergarten we met our school goal for the amount of passing students. My personal goal was to have all my students meeting the expectation and I had all of my returning students do that and one incoming student is approaching. Caroline wrote, "I do not like scoring on the math benchmark assessments, I think there should be more questions and allow students room for error, they are not able to make any mistakes to be listed as meeting expectations." I noted the possibility of the coinciding timing of the survey, with the end-of-quarter assessments as a contributing factor to the teachers' focus on assessment. In the survey statements, teachers talked about their students' achievement either related to the assessment or to an individual's growth over the quarter. For example, Nicole shared, "My students all performed really well on the end of unit benchmark assessments for quarter 2. I encouraged students to use more mathematical vocabulary this quarter which I think benefited students on the assessment." Laura shared, "With the benchmark, I realized that some kids can't identify numbers over 100 and a couple can't even count them!" Laura did not realize her students were struggling until the quarterly benchmark assessment was given.

Student achievement data were gathered and analyzed differently from other sources. At the end of each quarter, I pulled each teacher's assessment data for either their unit assessments (kindergarten) or their benchmark assessments (grades 1 and 2). These data were matched

against Kasey County's expectations for each quarter (Table 3). I noted where teachers' data met the district standard of proficiency and where they did not. The data were compared to teachers' statements about assessments and became part of that code. Kasey County set the expectation as 75% of students will score 80% or higher on benchmark assessments.

Table 3

Student Achievement Data

Name	Grade	Q1 % proficient	Q2 % proficient	Q3 % proficient
Lea	K	100%*,100%*, 73.7%	88%*, 88%*, 93% *	71%, 81%*, 62%
Michelle	K	does not use same assessments		
Nicole	K	90%*, 85%*, 70 %	90%* 95% *	95%*, 95%*, 95% *
Shirley	K	95%*, 94%*, 100% *	95%*, 86%*, 86% *	100%, 81%, 86% *
Antonia	1	73%	67%	53%
Caroline	1	89% *	76% *	68%
Laura	1	78% *	68%	67%
Louise	1	80% *	57%	76% *
Loree	2	67%	41%	78% *

Note: * indicates Kasey County expectations were met

Summative Findings

When considering the individual participant data and the collective analysis through the lenses of the theoretical framework and the research questions, I sought evidence of each teacher's self-efficacy related to her experiences as a novice teacher as well as her experiences as a student of mathematics. Those experiences influenced personal definitions of a growth or fixed mindset. In some instances, the teachers made statements or responded to survey questions in an expected way; they knew the study was about growth mindset and used words and phrases that

connected to their understanding of a growth mindset. The four salient findings from the collective analysis were:

1. Novice teachers wanted to give their students a different mathematics experience than the one they had.
2. A variety of factors impacted novice teachers' instructional experiences and influenced their mindset.
3. Novice teachers held an unconscious bias related to gender and mathematics.
4. Although novice teachers stated they have a growth mindset, their actual mindset is not indicative of being fully growth oriented.

The following discussion sections expand on each of these findings in more detail.

Experiences as Mathematics Students vs. Teachers of Mathematics

The first salient finding centered on novice teachers wanting to give their students a different mathematics experience than the one they had. The novice teacher participants pulled experiences from their mathematics instruction in high school and college to explain how they wanted to teach. Some wanted their teaching to emulate that of a particular college professor or high school teacher. They enjoyed themselves in these mathematics learning experiences as I could see from the excitement in their facial expressions. They wanted to replicate these positive feelings for their students. They also talked about the opposite desire of not teaching like a particular teacher who lectured or made them feel inadequate in their understanding. Lea shared, "I felt like there was so much more that I could have been learning and then that hindered me in high school because I got into high school and I was so upset because I had no idea what algebra was so I took some of the lower courses to get built back up so I could then take the Calc and the

Trig my senior year." She was frustrated because her middle school experience left her lacking in mathematics skills. For example, Antonia stated:

> I know from experience, my worst math teacher wasn't the stricter, wasn't the hard one, it wasn't the cookie-cutter one who gave me worksheets. Granted, did I learn during that? No, because I'm not a worksheet type of student. I think the worst math teacher I've had, she was a sweetheart, but she just gave us the answers. I don't know if she was afraid for us to make those mistakes and make herself look bad, but she would give us a worksheet and then if we asked her for help she wouldn't help us and let us explore and discover on our own, she just gave us the answers.

The teachers wanted to give their students a different mathematics experience and help them enjoy mathematics. Antonia shared that her least favorite trait from a teacher was one who just gave the answer (first interview). Nicole started to share a generalization about the worst possible mathematics teacher, but she soon shifted to describing a particular one from her previous experience, "They always explain it the same exact way. They're not flexible There's one way to do it. He didn't connect at all to his students. He was there to do the job, and it wasn't about the students, it was just about the job." When I asked if she had a specific teacher in mind, she confirmed that she was speaking about a high school teacher. She sought out other mathematics teachers to answer her questions.

Participants talked about differentiating for their students and trying to stay away from worksheets as practices they wanted to emulate. Having mathematics discussions was important to most of the participants. During the second round of interviews, problem-solving with students was prominent. Caroline stated, "I don't really remember math ever being a positive experience." However, she took that experience and told me that she tells students that math is

fun and works to understand why they do not like mathematics. Antonia shared a different perspective from her own life. She said she never felt confident in mathematics, that she never had access to manipulatives, hated the worksheets, and was nervous in mathematics. She asserted she did not want to make mistakes, but neither was she driven to succeed.

The novice teachers described their experiences as a mathematics student and how this impacted their continued growth as a student. As they became teachers, they aspired to be better than their teachers. They indicated their own desire to grow over the next five years, but their responses also indicated other factors that slowed their growth as a teacher and impacted their self-efficacy about mathematics instruction.

Factors That Impact Mathematics Instruction and Influence Mindset

Not only did the experiences as students of mathematics influence how these novices saw themselves as mathematics teachers, but there were also other factors that significantly impacted their mathematics instruction and evolution of their mindset. Grade level changes and assessments were two such factors. The teachers with only three months experience felt less successful than those who had a few years of experience. The access to resources, competing expectations, and teammates all contributed to their feelings of success or angst about teaching. Each of these five factors impacted their initial teaching experiences, how they viewed and experienced mathematics instruction, their self-efficacy, and their mindset.

Grade Level Changes

During the initial interviews, I asked each teacher how long she had been teaching. Several had noted they switched grade levels within the few years they have been teaching. Of the five teachers not in their first year of teaching, all five had taught more than one grade. Shirley had taught a new grade every year in her four and a half years of teaching. She stated,

"My first year teaching, I didn't learn through Common Core strategies, and I had to reteach myself. And every year when I was in a different grade, I'd have to reteach myself those strategies."

Antonia, with two years of experience, had taught two grades. Loree, Nicole, and Laura had each taught a different grade within their years of experience. In her written response to me, Shirley noted that she will be teaching kindergarten for the second year in a row and was looking forward to working with her team to focus on pacing and common formative assessments (personal communication, August 1, 2019). Laura noted that she also was not switching for the coming school year but noted that when she moved from second to first grade previously, "It 100% impacts your thinking and planning for the next year because you need to know the curriculum and the developmental level of the students you are teaching. There's always the balance of trying to not expect too much or too little of the kiddos that are put in front of you" (personal communication, July 22, 2019). Lea and Louise shared that they are staying in the same grade level for next year, but Lea noted that there was, "talk about me moving to second and then to first" (personal communication, July 22, 2019). Louise stated that "I know that if I were switching, I would start all over with my confidence level in teaching math" (personal communication, July 31, 2019).

In her first interview, Loree stated, "Just because I'm still learning the new, like second grade part of it. I'm still learning as I'm teaching, too, so I don't have all the answers." Loree was in her third year of teaching when this interview was conducted but had switched grade levels from kindergarten to second grade.

The teachers felt less self-efficacy about teaching mathematics when they had to learn new curriculum, how to work with new teammates and, in some cases, the expectations of a

different administration. The teachers stated their confidence levels would decline. Their growth mindset would be more fixed as they negotiated the new setting.

Resources

Many of the novice teachers talked about the resources available to them. Technology played a role in several of the classrooms when used to differentiate concepts for students. Some of the teachers noted that the sheer volume of resources was overwhelming and trying to figure out the best use of those resources was time-consuming. Caroline shared:

> I came into my classroom and it was full of stuff, which is awesome because a lot of people come into empty classrooms their first year. But it's all since been shoved in these beautiful cabinets. I've gone through some of it, but a lot of it just isn't organized enough for me to be using it well yet.

She also noted in response to the self-anchoring scale for next year:

> They'd [resources] be really organized, because I have a lot of them, but they're not organized. I can just really be more prepared. I'll also have more materials available next year. I didn't have as many things organized. I got hired two days before the preservice week started.

The novice teachers also talked about human resources in their classrooms. Lea had support from a mathematics specialist, as did Louise, who had planned a lesson with her and the media specialist that she was excited about. The use of technology was part of the lesson. Louise shared that her students were excited about using Flipgrid (a program that allows teachers to pose questions in video form and students to answer or show their work in the same format) in the lesson. Her own excitement was evident when sharing something new to incorporate into her

lessons. She felt it had made an enormous difference in her lesson but also noted that having two additional adults in her room was helpful.

Caroline noted that at her previous school she had extra adult support in the classroom. She stated, “Having 22 little tiny people needing me all day long” was very difficult and she missed the extra pair of hands. Shirley appreciated the support of her mathematics specialist, particularly her accessibility and feedback during informal walkthroughs. Antonia talked about visiting another teacher so she could see how to differentiate her groups.

While extra human resources supported the teachers and made them feel more successful, navigating the number of resources and when to use each one was difficult for the novice teachers. They wanted to include technology in their lessons but first had to learn how to use it. Their mindset about the resources, in some cases, was resigned. As Caroline stated, she knew she had plenty of resources to use in instruction but had not yet had time to sort through and figure out what was available. Teammates are another human resource for the novices but the role they play with the novice teachers’ self-efficacy is different from other human resources.

Teammates

Teammates can play an essential role in the first few years for novice teachers. They have experience and resources to offer. All participants mentioned teammates in some way. Most felt their teammates were very supportive, but there seemed some wistfulness in thinking about that support. Lea noted in team meetings that her teammates would talk about things that they did last year, and Lea would have to ask for clarification and access to the materials. She shared that she has to say, “I don’t know what you are talking about” so that her teammates would stop and give her the background to the lessons. Lea also noted that she enjoyed hearing and seeing how her teammates carried out the lessons. She applied what she learned to her classroom, including

working on differentiation and the flow of her groups during a lesson. Louise mentioned restraints she felt when meeting with her teammates:

> We team plan, and we have almost identical plans. And I feel like I'm so afraid to stray from it even though nobody's ever told me I'm not allowed to, but I just feel like it's my first year, let me just do what I'm supposed to do, and then leave it alone. But then I get these itches, where I'm like, "Well, I've just got to do something new."

Antonia shared that she appreciated the time with her teammates because she realized she was not alone with her plans and her struggles with students. Meeting with them gave her more confidence. Caroline received support from her team, which was helpful.

Several mentioned an opportunity to visit another classroom to watch instruction. That experience either solidified some of the practices of the novice teachers or had them questioning their abilities. Others talked about sitting with teammates and discussing upcoming mathematical concepts to be presented to students. Experienced teachers pulled out activities and worksheets to support mathematics instruction which the novice teachers took as representative of expectations. Few novice teachers were ready to branch out and do their own instruction. Others felt the need for support but as the year progressed, the team planning was not as frequent. Nicole shared, "today my team leader came in after school and she said, 'Oh, I was just upstairs meeting with the school-based mentor for a really long time because she wants us to plan math together.' And I'm like, I kind of knew she was going to talk to you about that because we're supposed to be planning as a team and we're not" (second interview).

The novices appreciated their teammates' support but wanted to feel like they had enough understanding and effectiveness in teaching to expand the lessons beyond what teammates were doing. Their self-efficacy and mindset about teaching mathematics was ready to take them

forward but they felt they needed permission to stray from team plans or activities from previous years.

Competing Expectations

Several novice teachers noted that they felt competing expectations in the classroom from their administrators, teammates, and themselves. Laura talked about her own expectations for students and how she felt she had rushed through quarter one mathematics content because she was also working on getting to know her class, building a community, getting into routines, and looking at content. She said her academics took a little bit of a backseat while she was working toward her students getting ready to learn. Lea was worried about the expectations from her administrators:

> Our principals want us to differentiate each math rotation group for a different SMP [Standards for Mathematical Practices]. It's my first time ever even seeing them, so I'm finally getting the hang of them, and I'm seeing all their benefits because it's creating mathematicians who have tools to solve the problems. We might be covering 3D shapes, but they want to try to see me hitting a different SMP for each group. So, like my high group might have already attended to precision on really being able to just identify and count how many vertices are on a cube.

Lea talked about her expectations for her own teaching:

> Sometimes I see it with what other teachers are doing, and a lot of times I'll see it with I just did something like oh my goodness, I'm never doing that again. So, there are definitely times where I do have to use other resources to try to help because it's my first year with the content, and I don't really know ways to help meet my students the best way possible.

Lea also appreciated her principal's reaction to her request to visit a teammate's classroom. The experience gave her immediate feedback for her lessons and expanded her bank of ideas and strategies for future classrooms. However, the visit gave her a chance to ensure she was teaching like her teammates so, "then you don't have those huge gaps in data where one classroom who's performing really well in math and one classroom's not." Her desire to learn was tempered with making sure she was doing things right.

Michelle discussed changing a lesson one day for her administrator to see her students engaged and able to show their full potential. "I came up with an activity that was kind of off-target of what we were doing at the time" because she knew the principal wanted to see something specific. Michelle shared that the observation was set the day before. The school improvement plan (SIP) can also impact mathematics instruction. Laura noted that as a school, the SIP was to create differentiated "I can…" statements for each unit. She had spent the past few months with her team creating statements for each mathematical standard to use in lessons.

These competing expectations put the novice teacher in a difficult position. They wanted to do what was best for their students even when expectations were not supportive of their students. They understood their role as a novice teacher and wanted to follow through with expectations, but their self-efficacy was in jeopardy. They also felt they needed to be compliant and follow the rules. If that impacted their instruction, they felt it was necessary. Michelle changed a plan for the next day's lesson when she learned her principal was coming to observe. The new lesson didn't match the flow of the current lessons but was based on what the teacher believed the administrator wanted to see. Expectations can change a teacher's mindset for instruction.

Assessment Results Drive Mathematics Instruction

Assessments came up repeatedly. Data from the assessments were shared in team meetings. Teachers compared their results to teammates' results and expressed concern that their students' scores were poor or that students were not demonstrating what had been taught . When I checked in quarterly, most of the responses dealt with quarterly assessment results. This could be attributed to the timing of the check-in, but the teachers seemed focused on assessment results. Administrator and Kasey County expectations influenced this perception. Results are available to administrators from all schools across Kasey County. Comparisons are part of the data and contribute to the expectations from the administration that students must do well. In team meetings or professional learning sessions with mathematics specialists and administrators, teachers felt pressure to show student growth and high proficiency numbers. Teachers expressed concerns about students taking assessments. They felt they had taught the curriculum, but often students did not demonstrate their knowledge. Laura captured these feelings in the following statement: "I just remember sitting there being so sad because they did so well when we taught that standard and then the benchmark came, and it was …just a disaster" (personal communication, January 15, 2019). Louise revealed the pressure she felt for her students to do well:

> At my very first benchmark, they, for the most part, did a really good job. They had some struggles with showing their work because I have a pretty high group of kids and they all just knew the answer. But part of the benchmark is showing your work so even though I said, "We have to show our work" they lost a lot of points with that. So, this week so far, we have just been pushing and pushing on showing our work and I've been doing a game where if they don't show their work, I say, 'Well, I don't believe you.' And then they

> show me and then they're able to. So, I'm hoping that the benchmarks this quarter will be a little bit better. The first quarter was, it was the showing your work part that really got them.

Louise was enthusiastic about her students doing a better job the next time but noted the amount of time she spent working on skills to pass the assessment. Loree talked about her students' ability to respond to discussions and expectations in the classroom. She focused on modeling the correct response for students and then having them model it back for her as a measure of their ability. Lea put some of the responsibility on the students, teaching them how to let her know when they were stuck. She shared that she used a "red light-green light" signal with students. They would put up a red signal if they had a question or were stuck, and she would know to check in with them during small group instruction.

Laura related her assessment to the number of days of instruction. With multiple days off, she found that one mathematics standard was only allotted three days in the pacing calendar provided by Kasey County. She noted that her unit assessments were used to gauge where students were in their understanding. She said, "So my unit assessments are really just for looking and seeing where they're at, because some of the questions on those assessments I don't particularly agree with." The benchmark assessments in mathematics required students to show their thinking, and teachers were feeling the stress of teaching young children how to complete the work mat on the assessment. Laura shared:

> But I will say they (work mats) were hard to teach, like trying to tell first graders the correct box to write something in, when all they want to do is just draw a picture of nine ducks and cross two of them out, and then write the equation.

Antonia shared that her school also had a data person who would input mathematics data for them. She indicated that she used the data, by standard, to determine if she would re-teach a concept either in a whole group lesson or with individual students, depending on need. She talked about being able to see how well students in percentages, matched to the benchmark assessment. Teachers were then able to determine which misconceptions and strategies to work on with students. She felt this was beneficial to her instruction.

The many factors influencing these novice teachers pulled them in different directions. While they wanted to feel successful in teaching mathematics, the teachers who experienced grade level changes, felt they started over again each time a change occurred. Teachers had numerous resources both in the people available to support them and the concrete resources available to teach mathematics. The number of and variety of resources did not increase their self-efficacy or mindset about teaching mathematics. In most cases, the resources were something else that had to be learned. Watching a teammate or someone else teach, had both a positive and negative effect. The novice might feel encouraged by new strategies or the organization of their small group rotations if what was observed confirmed what she was doing. The opposite effect might be generated if she felt the observed lesson was beyond her current teaching capabilities.

Teammates played another role with novice teachers. There was a subtle but distinct pressure to conform to the lessons planned by the team. Activities and lesson plans from previous years were freely shared and while the novices appreciated the support, they also chafed at feeling restrained in their mindset or self-efficacy about teaching the concepts. Assessments play a role in mathematics instruction. From Kasey County's common assessments to classroom exit cards, teachers use assessment to gauge how students are learning. These novice teachers

frequently remarked on assessments. They talked about their surprise or dismay when students performed differently from their expectations. They noted that the assessment results were shared and compared within their teams, across their school and across Kasey County. Their feelings of self-efficacy and mindset about their ability to teach were impacted by assessment results. Their instruction changed over the year to better meet the expectations on the assessments, rather than change to meet students' needs. The factors influencing their mindset and self-efficacy had greater impact than I had expected.

Unconscious Gender Bias

The focus group, with seven of the nine participants, created an atmosphere of collegiality that is not possible in individual interviews. Participant comments were connected to each other's ideas and became a way for them to share ideas. Findings were generated via this conversation. As I listened to their discussions, I heard a theme of referring to student work using the pronoun "he." There is not enough data to determine if this is a complete finding, but it was something that I noticed in listening to the participants. There were natural side conversations as the participants agreed or disagreed with their ideas and shared their thoughts. Gender was an issue in several discussions when looking at student work. In the focus group, participants referred to the student as "he" even though there was no evidence of biographical information on the student work. Only once in the discussion did a participant say, "he or she" when referring to student work. I was intrigued by the idea that mathematics work was completed by boys. The teachers did not seem to recognize they were making judgments about who had completed the work. "Oh God poor thing, he just ignored the whole thing… He picked that gumball." And then later, "This one does a really good job, you could really make sense of it, I like when this kid put down 17 cents, find all possible coins in pocket, like-That's awesome. He nailed it."

I wondered if there was a connection to beliefs about who can and cannot do mathematics well, but there was not enough data to support a connection. Through member checks, I was able to explore this finding further. Laura and Shirley noted that maybe the handwriting looked like a boy's writing, so that prompted the "he" in the conversations. Shirley went further and said, "Sometimes we think of bubbly writing as girls and the not as neat writing as boys?" (personal communication, August 1, 2019). Louise at first notes that it may have been an accident in the conversation but then states, "it may have happened because many times boys are the dominant gender when discussing math for many people. I remember growing up, always hearing about how boys were dominant in science and math, and girls shouldn't worry if they didn't succeed because we were better for arts" (personal communication, July 31, 2019). From the member checks, teachers seemed to be sharing that it's a habit or an expectation to use "he" when discussing mathematics. Novice teachers are unaware they were perhaps perpetuating a bias about mathematics success. While they state a growth mindset and believe they will grow as teachers in the next five years, they may not be expecting a growth mindset or success in mathematics from their students. These female novice teachers may unconsciously expect boys to do a better job in mathematics. Caroline was surprised when one of her struggling female students made growth. She attributed this growth to the parents working with the student at home, not her own teaching or the expected growth of the student.

Stated vs. Actual Mindset

In the initial survey and through some of the interview questions, teachers repeatedly used words or phrases that might indicate a growth mindset. Seven of the nine teachers (78%) in the study expressed either implicitly or explicitly that they believe they have a growth mindset in mathematics or that they have a mathematical mindset. Several teachers used the term "yet" to

show that they were encouraging their students to try even when the work seemed hard. They talked about posters on the walls of the classroom or professional learning with teammates that focused on a growth mindset. As stated earlier, Kasey County had growth mindset as a focus, so administrators used the phrase and had expectations for the use of growth mindset practices in the classroom.

However, there were multiple responses in interviews from the teachers where growth mindset was notably absent. Teachers talked about certain groups of students in their classrooms that struggled to do things when the teacher was directly instructing. Students with special needs were excluded when talking about student growth or instruction. Multiple teachers noted the wish or need for an additional person in the room to help with struggling students, even the ones who typically would easily understand the mathematics, but then cried when presented with a new type of problem or a unique way to solve a problem. For example, Caroline shared part of a lesson and one student's reaction:

> One of my most capable, highest-achieving students, we did this thing today where you were coloring in numbers on a 120 chart. They were coloring in the number as it was transitioning to the next slide, but it was going too fast, and he was almost in tears because he had convinced himself that he was not going to be successful at this activity.

The teachers related this to the student not having a growth mindset but struggled to explain a way to help the students. Laura talked about making the assignment easier and removing students with special needs from her response:

> I'm going to take out that small percent of special education kids, but let's just say there's three students that are still struggling with that. We have TenMarks [software program;

no longer available] on the chrome book, so I can reassign them something like a lower level question TenMarks assignment.

Participants shared that many times students cannot do mathematics without teacher direction or support. Antonia spoke about her students having a growth mindset; they were learning that it was okay to make mistakes but she also stated, "that's something I'm struggling with this year is, when my lower kids are at my math games, I'm worried that they're not playing them correctly." She also shared that "I do find myself afraid if my students are getting horrible grades and benchmarks that reflect on me." Caroline and Laura shared their thoughts:

> If I have my high-achieving students at the table, then the remainder of the class needs more assistance out there, so like they need less support here, and for example, in reading I can get up from the table and be, like, 'Finish your book. I'm gonna circulate and I'll be back.' But you can't really do that in math" (Caroline)
>
> They need to have somebody say to them, they need more self-talk or positive reinforcement from an adult, but I think others, they might just pick up on math a little bit easier . . . my first group is the group that struggles and if they don't get it the first day I usually adjust their time, their group time so they'll stay with me longer and then we'll just scale it back (Laura)

The contrast of the stated versus actual mindset was seen in the self-anchoring scale data as well. On the self-anchoring scale completed in the first interview, 8/9 (89%) of the teachers expected to be a 10 as a mathematics teacher in five years. All rated themselves from a five to an eight for their current beliefs. The four teachers in their first year stated they wanted to go from a 5 or 6 to a 9 or 10 (Table 4).

Table 4

Results of Self-Anchoring Scale Comparing Present to Future Rankings

Name	Years Teaching	Current Rating	In Five Years
Lea	First year	6	9-10
Michelle	First year	7-8	10
Nicole	4	8	10
Shirley	4.5	5-6	8-9
Antonia	2	7-8	9
Caroline	First year	6.5	10
Laura	5	5	9-10
Louise	First year	5	9-10
Loree	3	6-7	10

Although most teachers ranked themselves in the middle of the scale or higher, their words indicated hesitation in their ability. Caroline said, "I feel like it varies day by day. I just feel like I don't know enough yet. I can't wait until next year. Like I wish I could just speed through the rest of this year and get to the next year because I know that I'll always know what's coming" (first interview). Lea talks about being a first-year teacher and what she still needs to learn. She wants to make her classroom a positive place but talked about the age of her students and having to go back to reteach when lessons go "terribly wrong sometimes" (first interview).

For these novice teachers, they expressed that they held a growth mindset. With Kasey County promoting a growth mindset, teachers may have felt it necessary to project a growth mindset but their responses in interviews and when reviewing student work indicated otherwise. Yet, when prompted to talk about specific instructional instances or ranking at their current level of experience, they showed that their mindsets were a bit more fixed or had more work to do. Being prompted to talk about their own mindset, each thought of herself as holding a growth mindset. The self-perception of the mindset differed from the expressed description.

Conclusions

The use of a survey, teacher interviews, a focus group discussion, journal responses and student achievement data contributed to the findings. The novice teachers, from Michelle, a first-year teacher in a charter school, to the other first year teachers, Louise, Lea, and Caroline, to the slightly more experienced teachers, Antonia, Loree, Laura, Nicole and Shirley shared their experiences via the data sources. After reviewing and coding the data, findings emerged that began to answer my research questions. Findings one, three, and four informed the response to the first research question: How does a growth mindset and self-efficacy of early childhood teachers connect to mathematics instruction and a mathematical mindset? Novice teachers state they have a growth mindset, but their responses to interview questions suggest otherwise. Gender as unconscious bias was unexpected but helped to answer the same question. Novice teachers want to give their students a different mathematics experience than the one they had, which points to the fact that their early experiences as students are greatly influential to their current experiences as teachers.

Finding three informed the response to the second research question: What factors do novice teachers perceive impact their ability to teach mathematics to young children? Novice teachers want to have a growth mindset, but a variety of factors impact their ability to teach. Grade level changes for the five teachers not in their first year, human and capital resources, competing expectations, and teammates all contribute to the mindset and self-efficacy for teaching mathematics. Assessment results were a driving force for instruction and for the teachers' feelings of self-efficacy around that instruction.

In Chapter 5, the results are discussed further in relation to the relevant literature. An additional discussion surrounds the conceptual framework which stemmed from the findings of this study. Implications for future practice are then outlined and further research suggested.

CHAPTER 5: DISCUSSION AND IMPLICATIONS

Dweck (2006) and Boaler's (2016) research states that having a growth mindset in general and one in mathematics contributes to feelings of self-efficacy. These positive feelings can impact instruction in the mathematics classroom and students' achievement in mathematics. At the beginning of this journey, I sought to understand how these ideas applied to novice, early childhood teachers. I embarked on a case study with nine novice female teachers. My four findings were that: teachers stated a growth mindset, but their words belied their statements; unconscious gender bias played a role in this finding; teachers wanted to provide a mathematics experience for their students that was different from what they experienced; and that there are multiple factors, such as a grade level change for the teacher, teammates, available resources, competing expectations, and assessments that impact a novice teacher's mindset and self-efficacy.

In this chapter, I first provide a discussion of the findings in relation to my research questions and the relevant literature. Next, I offer recommendations for further practice. I then provide a summary of the research limitations and implications for future research. Finally, I conclude the dissertation with summative comments.

Discussion

This study allowed me to look at novice teachers and determine how their mindset and self-efficacy about mathematics connected and what other factors might impact that mindset. Through face-to-face interviews, a growth mindset survey asking about their experiences as a student of mathematics and as a teacher of mathematics, student achievement data and my interpretations of interactions with those teachers, I discovered notable findings through my case study analysis:

1. Novice teachers wanted to give their students a different mathematics experience than the one they had.
2. A variety of factors impacted novice teachers' instructional experiences and influenced their mindset.
3. Novice teachers held an unconscious bias related to gender and mathematics.
4. Although novice teachers stated they have a growth mindset, their actual mindset is not indicative of being fully growth oriented.

Below is a discussion of the findings in relation to these research questions.

1. How does a growth mindset and self-efficacy of early childhood teachers connect to mathematics instruction and a mathematical mindset?
2. What factors do novice teachers perceive impact their ability to teach mathematics to young children?

Self-Efficacy and Mindset of Novice Teachers

Dweck (2012), Boaler (2016), and Anderson et al. (2018) discussed a growth vs. a fixed mindset for teachers. Boaler (2016) and Anderson et al. (2018) focused on mathematics, suggesting that a teacher must have a growth mindset about mathematics in order to teach mathematics well. The teacher will be open to ideas and concepts about mathematics and translate that into her instruction. In this study, findings suggest that a teacher may state she has a growth mindset, especially if there is a focus on mindset in the school system where she works. She may feel excited by mathematics instruction and can communicate that to her students. The reality from the teachers' words was a growth mindset in mathematics may not be present on a regular basis. The teacher may believe that her students are struggling, and she is not sure how to

help them. She may believe that most of her students can do well in mathematics but not the students with special needs.

The teacher voices in this study told the story of their growth mindset. When the teachers answered the initial mindset survey to join the study, they appeared to answer in ways that might be expected. Their responses in the interviews and focus group indicated they want to have a growth mindset, and they want to instill a growth mindset in their students. Sometimes their words betrayed their true feelings. They stated that only certain groups of students did well in mathematics. Several "took out" the lower performing groups, or they gave those students less to do, lower numbers, lowered expectations, but wondered why those students did poorly on assessments. Some high-performing students struggled when confronted with explaining the concept behind the numerals; they cried or got angry. The novice teachers excused their behavior and shared that once they spent time working with the students, everything was fine. One wondered if the students who struggled just needed a little more attention or the mathematics explained differently to be successful. Caroline stated in her first interview that she was surprised by a student's growth. She shared that

> I do have one student who at the beginning of the year I was like, 'Oh goodness. This is going to be bad.' I had the other one who I'm going to SST (student services team) as well, and so I've got two without any number sense, and something must have just clicked in her brain. I said to her parents at conferences, 'Are you working with her at home because she's doing really well and showed them her 4/10 on the first unit, and then like an 8/10 on the second unit.

Caroline gave herself no credit for the student's growth and genuinely seemed surprised that the student had done well when she had no number sense. Parent- teacher conference time in Kasey County was in late October.

The novice teachers wanted additional support in their classrooms. They felt their students would be better mathematicians if someone else worked with them. They welcomed the mathematics specialist, the media specialist, the data specialist, and the instructional assistant into the classroom. They talked about how that allowed them to teach most of the students while the low group or those students who needed help could ask someone else.

Novices also talked about the management of their mathematics lessons. They felt students were mostly under control and easy to see if they were in a small group with the teacher. They worried that students in partner games or independent work were doing something other than mathematics. Their teammates had a similar structure to their lessons, but the novices did not feel comfortable unless a student was in the "hot seat" (a term one teacher used to describe the seat next to hers in a small group for that student who needed to demonstrate understanding or was struggling with concepts) or under their direct supervision. The question is whether a teacher with a growth mindset would have similar concerns, or whether novices do not yet have time to think about a growth mindset. Dweck (2012) and Boaler (2016) suggested that teachers must have a growth mindset and one about mathematics. I would suggest that the novice teacher has too much on her plate initially to develop that growth mindset and strong self-efficacy about teaching mathematics. I was not surprised that teachers used vocabulary words associated with a growth mindset. If a staff or administration is supporting a county initiative, it makes sense that a novice teacher would use those words. The probing questions from the interviews revealed teachers' feelings about mathematics and instruction.

Unconscious Bias About Gender

In reviewing current literature, I noted that female teachers might be passing along their mindset about mathematics to their female students (Beilock et al., 2010; Dowker et al., 2016; Geist, 2015). Beilock et al. (2010) examined female teachers and anxiety related to mathematics instruction. When the teachers in my study talked about student work, they frequently referred to the student as "he" although no identifying information was on the work. When asked for clarification, teachers said they had been taught to use that identifier if the gender was unknown, but some also referenced the writing as being typical of a girl's handwriting or a boy's depending on the sloppiness. As I probed some of the respondents for this work, the unconscious bias associated with boys doing better in mathematics was unstated, but evident.

Gender-specific responses were only noted when teachers reviewed student work with no demographic information. Teachers automatically referred to the student as "he." When participants were asked to expand on that idea in member checks, all responses indicated that is what they were taught to do, and in one case, that they had the belief or understanding from what they were told: boys were better in mathematics and science while girls were better in reading and the arts. While gender was not explicitly studied, the unconscious bias revealed when the teachers were discussing the unidentified student work, showed how ingrained this stereotype is for these new teachers. It is an indication of a more fixed mindset, particularly in relation to mathematics.

Factors Impacting Mathematics Teaching

As the novice teachers responded to the data sources, many factors were indicated as impacting their instruction. These factors included the novice teachers adjusting to a grade level change as they moved forward from their first year, a plethora of resources, competing

expectations from the administration, the team, and Kasey County, the support or pressure from teammates, assessments, both required and employed by the teachers to monitor student growth.

Novice teachers were clear about the impact of demands on their time and instruction. Administrators demanded a specific structure for lesson plans. Kasey County also required a structure to lesson plans, even providing sample lesson plans in the expected structure for teachers. When observations are completed for novice teachers, the lesson should look like the expected structure provided. Michelle changed the plan and the structure for a mathematics lesson to ensure that her principal saw the strengths of the students for an observation.

Teachers talked about assessments in interviews, the focus group, and quarterly journal entries. The results and follow-up discussions with other staff affected teachers' instruction. Some of the interview questions were designed to ask about the way teachers knew students understood the content and several responded with exit cards or informal assessments. Quarterly journal responses indicated that assessments were heavily on everyone's mind. The question asked what was happening in mathematics at that point and was there anything the teacher wanted to share? Most entries were about assessments. Students did poorly on the assessment even though they had done well in class. The class average was lower than the teammates' averages. The teacher was feeling good about the assessment, but students did poorly on a question. The whole team discussed assessments and determined that vocabulary needed to be taught or the structure of the problem-solving work mat needed to be reinforced.

Darling-Hammond (2010) and Ingersoll (2012) suggested that teachers need an induction program and professional learning to be successful. Administrators need to be aware that new teachers may leave within their first few years of teaching, the period I focused on for this study. My findings indicate that teachers appreciate the human resources available in the building. Not

all schools have access to the staff mentioned in their responses, but those who had a mathematics specialist expressed appreciation for that support. Teachers wanted time to visit their peers to expand their skill set and to have their beliefs supported.

Resources, both human and classroom, came up frequently in the data. Teachers walked into classrooms to begin teaching and had no idea which manipulatives they had available for teaching. Kaitlyn had things in her cupboards that she had not even looked at yet. She was ready for year two when she would have time to pull those out and organize them. The novice teachers talked about sitting with teammates and not even understanding what the discussion was about. Louise had to speak up and tell them she did not know what they were talking about so that her teammates would stop and share the information so that she could use it. As multiple teachers talked about the additional support from another teacher, a specialist, or a visit to another classroom, they seemed relieved by the human resources available to them. They were happy that someone else could take a small group of students. They were happy that a data person would compile the data into percentages that told the team which standards to focus on for the next few weeks. They were happy to visit another classroom and have their beliefs supported or see that another teacher taught in a way that did not support their beliefs. Lea "liked to be able to see how they're running it because I can get ideas on how I can use technology a little bit better or have those math centers."

Several novice teachers were taught in college to use a language arts strategy to organize their math lessons. They were used to modeling the strategy for students, doing it as a group, then asking students to do it independently. There are administrators who also support this strategy. NCTM's (2014) Principles for School Mathematics stated that teachers must understand

and be learners of mathematics while encouraging students to understand mathematics. Students must be learners of mathematics, not followers of someone else's procedures.

Conceptual Framework

My conceptual framework (Figure 1) centers on the experiences of female novice teachers and their self-efficacy as it relates to teaching of mathematics and pulls together the components of the study. The framework is a visual display of the study's findings and relationships between the different components researched. In the center is a large circle indicating the experiences female, novice teachers encounter. Many factors compete for a new teacher's attention, such as the building administrator's expectations, time of year, teaching curriculum—not just mathematics, but all content areas, available resources, and teammates.

In considering self-efficacy around mathematics specifically, the novice teacher must balance those multiple factors with her own understanding of mathematics and her feelings about teaching mathematics. Beginning a teaching career with a growth mindset about mathematics can support the novice teacher to navigate those competing interests; a fixed mindset can lead to heavily reliance on the use of lecture, limited expectations for students, reduced time in mathematics instruction and students who believe there is a gender difference in ability in mathematics. The instruction from a teacher with a growth mindset is indicated in the upper right cloud while the characteristics of a lesson from a teacher with a fixed mindset is in the lower right cloud. Large arrows lead back from student experiences to positive or negative experiences with mathematics and those influencing the novice teacher.

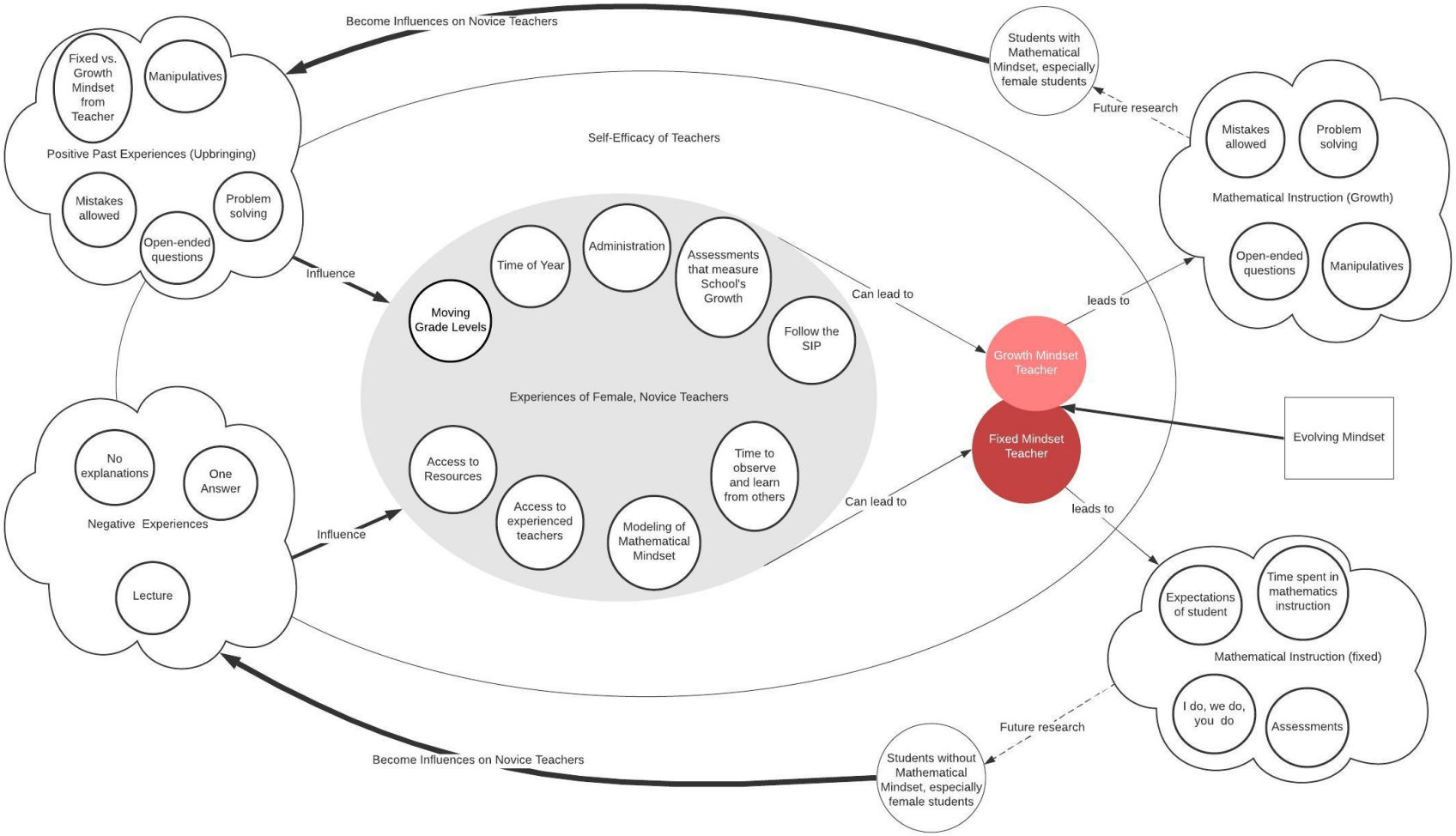

Figure 1. *Conceptual Framework*

In thinking about competing interests for novice teachers, I used my own experiences as a teacher specialist with novice teachers and the ongoing conversations I have had with teachers about mathematics. I spent ten years supporting novice teachers in mathematics instruction. I modeled mathematics lessons, planned lessons with them and pulled materials together to help support their understanding of mathematical concepts. The experiences teachers have had affected their overall mindset. In the center circle, self-efficacy is influenced by experiences the teacher has from her past and in her current teaching position. Teachers can bring positive or negative past experiences to the classroom. When teachers allow student mistakes in the classroom and manipulatives (typically small objects used to explore mathematical concepts) are available to strengthen understanding, open-ended questions are asked, and problem-solving is encouraged, a novice teacher will impart those same characteristics to her students. The same is true for negative experiences. If a teacher feels her ability to teach mathematics is weak and her instruction is merely about students getting the right answer and listening to the lecture, then she may impart the same detrimental attitude to her students.

As the novice teacher moves into the classroom, her mindset is impacted by her experiences. Her past and current life affect her mindset toward mathematics, such as whether she has switched grade levels of instruction once, twice, or more times within the first five years. Her access to manipulatives, a mathematics specialist, curriculum, and assessments is essential. An important question is whether she has stood her ground with proper mathematics instruction or acquiesced to what her teammates have always done. In brief, she can continue to move to a growth mindset or continue with a fixed mindset.

However, my experience would indicate that not everything for the novice teacher is either a growth or fixed mindset. Throughout this study and anecdotally with my experiences as

a math specialist, I discovered there is a continuum of mindset, especially for novice teachers. While they might articulate a growth mindset, they may not fully understand what it is or embrace it completely in their instruction. I also believe that novice teachers understand and may have a fixed mindset about mathematics but could be reticent to state fixed-mindset ideas. As novice teachers learn and grow, I believe they move along a continuum between fixed and growth. I consider this ***evolving mindset*** as the process of becoming between the growth and fixed. Even teachers who verbally state a growth mindset may need time to move from some fixed ideas toward a growth mindset. I also believe that their ability to do so is highly impacted by earlier school and classroom experiences.

As a novice teacher moves toward either a growth or fixed mindset about mathematics, this could change her method of instruction. For instance, she may set up her classroom with problem-solving questions, manipulatives, open-ended questions, discussion, and allowing student mistakes, or she could trend toward more fixed mindset mathematical instruction. In a fixed instruction scenario, a prescribed lesson format is used, the time spent on mathematics reduces, and student expectations are to get the right answers rather than understand the concepts behind the mathematics. I believe the teacher impacts her students, particularly female students', understanding and beliefs about their ability to do mathematics. The teacher's impact translates into students who have either a fixed or a growth mindset about mathematics. Those female students can grow up to be teachers and their experiences impact their self-efficacy about teaching mathematics, and the cycle repeats itself.

The cyclical nature of my conceptual framework suggests that students, when interacting with a teacher of mathematics, may develop a growth or fixed mindset. These experiences can impact or influence the beliefs of the next generation of novice teachers. A growth mindset about

mathematics should be nourished and supported. As educators and researchers, we must continue to reflect on how to break the fixed mindset cycle by questioning how mathematics is taught.

Evolving Mindset

This study suggests that novice, female teachers' mindset can vary. Growth mindset can be informed by previous experiences but is also impacted regularly by varying demands that can push the novice towards a fixed mindset. The novice can hope or want to have a growth mindset towards mathematics but can also feel pressure to conform to the team's decisions about instruction. With assessment scores used for comparison across a class or among teammates, novice teachers can feel the pressure to instruct so that students do a better job on the assessment. Novices can talk about student work and make assumptions about the gender based on implicit biases and stereotypes.

For example, Louise mentioned wanting to be a teacher before college and had a passion for teaching mathematics. She wants mathematics learning to be fun for her students and yet, she said she was playing it safe. She stated, "I feel like sometimes I get a little stumped on thinking of something fun for them and I play it safe with the activities I know instead of adventuring out and trying something new" (first interview). When asked how she would move from the safe area, she talked about getting used to the materials and having her rotations working for her. These are areas the novice teacher is working on during the first few years but are not evidence of a fixed mindset about teaching mathematics. Antonia has similar thoughts. She mentioned her previous teaching in another school and grade and how uncomfortable she was there. She was afraid to try rotations in mathematics. She even said she was not good in mathematics but then rephrased it to say her grades were poor. She talked about what she is doing differently with her current students and how much she likes doing rotations. Antonia wanted to do well as a

mathematics teacher but there are other factors in her way. Laura referenced the way professional learning has helped her with her mathematics. She talked about how hard it is to be an elementary teacher but referenced how much she needed to know her students, and what they needed as well as understanding the curriculum and expectations. Caroline said she was really overwhelmed at the beginning of the year, "like I feel all new teachers are." She recognized her feelings were part of being a new teacher but shared that she was much more relaxed in our first interview in October, "I feel like I kind of know what I'm doing, even though I don't really a hundred percent."

My conceptual framework conveys this idea of mindset being on an evolving continuum, situated between growth and fixed. Teachers want to or feel they must say they have a growth mindset. However, their stated beliefs and their actions are impacted by other factors. As teachers learn, grow, and find their voice, their mindset can shift. Teachers felt compelled to follow the lessons that teammates had planned or follow the course set by a mathematics specialist. As a novice teacher, they were not yet comfortable enough or did they feel they had the self-efficacy to teach mathematics in the way they envisioned.

I began the study thinking I would definitively find a growth or a fixed mindset about mathematics. Most teachers expressed feelings about mathematics within the definition of a growth or fixed mindset, but I also sensed that there was something else at play. There were hesitations in some responses. They wanted to have a growth mindset, but the reality of being a novice teacher affected them. They expressed concerns about doing mathematics like their teammates or finding the time to learn about and use technology or manipulatives. Those who had access to another person in the room during mathematics looked relieved as we talked. Assessments surfaced so frequently I worried teachers were so focused on students being

proficient that they lost sight of the students or the mathematics. I did not hear that in their responses. I heard that they realized they were working with young children and wanted to temper their expectations to match the student. They seemed surprised sometimes by student responses; those students who seemed to do well in class sometimes seemed overwhelmed, and students who struggled suddenly accelerated their learning and were successful.

I also found that novices saw themselves in a growth frame of reference because of how they rated themselves on the self-anchoring scale in relation to the ideal mathematics teacher. They all saw themselves as about average. And they indicated that they would improve over time and become almost perfect mathematics teachers after a period of years of experience. While this indicated a growth mindset, it showed how it was on an evolutionary continuum. Yet, there were also times when I would hear from these teachers more fixed ideas about mathematics. With no identifying information, the novices still referred to student work as being completed by "he." They referenced poor handwriting as indicative of belonging to a boy. One novice teacher stated in the member check that the referent "he" was due to the accepted belief that boys were better in science and mathematics and girls were better in the arts and reading. Several of the novices wrote they weren't sure why "he" was used. I believe most were not aware of the use of the male pronoun during the focus group discussions.

Also noteworthy is that the novice teachers with more than one year of teaching had all moved grade levels at least once. A first-year teacher expressed in a member check that the possibility of switching grade levels for her second year would impact her feelings about mathematics instruction. She would spend the second year feeling like a first-year teacher again. She would have to learn a new curriculum, new assessments, new teammates, and more. I found myself wondering, how often this is happening in our schools. I have moved novice teachers to

new grade levels before, and as I examine my past practice, I realize that I assumed was easier for a novice to move to a new grade level because she was not yet entrenched in her current grade level and attached to a particular curriculum. The administration should be looking for the best teacher at each grade level, not what is easiest. I am not suggesting administrators move teachers around for the sake of moving them, but they need to be systematic and thoughtful when moving teachers within their first few years. The evolving mindset is hampered by the thought or reality of switching grade levels often in the first few years of teaching.

I found that teachers moved back and forth on the continuum. If their mindset about mathematics was strong, their responses were skewed either towards a growth or fixed mindset. However, they frequently mentioned so many other factors that impacted their instruction and feelings towards mathematics that this idea of an evolving mindset began to form.

The contradictions and complexities in my findings led me to consider that mindset evolves and runs along a continuum rather than being strictly either fixed or growth. There are instances when it reveals fixed beliefs and actions, and sometimes these occur outside the awareness of the novice teacher. There are other instances when it showcases the ability to be growth oriented. This evolving nature of mindset expands what is in the current literature.

Implications and Recommendations

More than a growth versus fixed mindset is at play when it comes to teaching mathematics at the early childhood level with female novice teachers. Administrators, college professors, experienced teachers and specialists in the schools need to know that novice teachers bring a variety of experiences to the classroom, especially in mathematics. Novice teachers' education and experience in the mathematics classroom may cloud their perceptions about mathematics instruction. They need encouraged permission to express those beliefs and work

through them. A school system can focus on a growth mindset, but that cannot be forced on staff. A growth mindset must be modeled and discussed in practical terms beyond an esoteric or superficial level. Teachers also need tacit permission to occasionally dwell in a fixed mindset, but administrators should not allow them to stay there. An enthusiastic mathematics specialist or a teammate who has taught the same way for years may intimidate the novice into feeling incompetent.

Administrators should recognize that they may be putting pressure on novice instructors to teach in a certain way, ensuring all students are proficient on mathematics concepts and that the strategies in the school improvement plan are implemented. The question remains whether administrators differentiate for staff the way they expect teachers to differentiate for their students. Consideration should also be made of novice teachers' needs. For instance, if a teacher is hired two weeks before school starts, support should be provided in setting up the classroom, including organizing the availability of mathematics manipulatives for students. Professional learning plans need to give equal time to math with the intent to improve understanding of mathematical concepts, not simply a data review, if teachers are to move their mindset toward growth. A growth mindset in mathematics means learning from mistakes and moving past them. Teachers should be allowed to make mistakes, and supervisors should be cautious about the behavior they are modeling. For example, if a teacher is told it is all right to make a mistake, yet that mistake is transcribed in an evaluation, this creates the wrong atmosphere to improve instruction. Teaching staff must move beyond what they learned, understood, and felt as math students so that they can be the best teacher of mathematics for all students. If conversations in team meetings ignore students who are struggling, then those students will not progress, causing the next generation to develop a fixed mindset about mathematics. Having too many resources to

sort through and learn to use, discussing mathematics only when reviewing assessments, and allowing mathematics to be taught like language arts (for example, “I do, we do, you do”) is doing a disservice to our teachers and students. Many resources do not equal good instruction. Novice teachers need to feel they are supported, not supplanted, by access to specialists and visits to teammates’ classrooms.

Experienced teachers may not, after all, be the best role models for novice teachers. For instance, if team meetings focus on the past year’s accomplishments and those resources are then given to the novice, the message sent is that the novice’s ideas are not good enough. The discouraging message is that the experienced teachers know what they are doing, and novices do not. As a result, novice teachers may maintain a fixed mindset just to survive the first year.

The novices I spoke to expressed trepidation that they were not doing well. Their students’ scores in mathematics might have been lower than their teammates’ students’ scores or even the scores of students in other schools. The challenge is to support them, so they want to stay in teaching. Watching another teacher teach is a standard practice in Kasey County. Novice teachers can visit another school with their mentor teacher. This practice may confirm or refute what they are doing in the classroom. Administrators must set the mentor teacher up to support the novice in her mathematics understanding. If a teacher sees practices that support her instruction that should be encouraged. On the contrary, if the observed lesson makes her feel less successful, then the novice should be asked what help she might need.

Assessments played a significant role in responses teachers shared with me. They talked about assessments each quarter, including how their students performed and what they changed in their teaching to ensure better understanding of expectations for the next assessment. Some teachers expressed concern about occurrences when the material was taught but students did not

do well. When the school system expectation is for a certain level of proficiency, all the pressure is placed on the teachers. Novice teachers, however, may not yet understand how to withstand such pressure. They do not yet have all the content and best practices in their repertoire, and it is the administrators' job to help support them. Kasey County should consider their expectations and how they translate into the classroom for each student. If assessments are driving some or all mathematics instruction, then the message students receive is flawed. Students need to see mathematics as a learned skill. If mathematics is learned merely to pass an assessment, students will not see the need to enjoy and appreciate its beauty.

Limitations and Further Research

There are limitations to my research. I chose to focus on novice, early childhood female teachers. This is a case study which represents a small portion of novice teachers. My findings are not intended to be generalizable however, triangulation of data allowed my findings to resonate in other contexts with similar novice, female teachers. Studying a similar set of male teachers may lead to additional conclusions. Doing classroom observations of teachers during mathematics lessons was not part of my case study. Adding this piece to a study may allow discussion about teacher stated beliefs and teacher's mathematics instruction.

I did not explore students' perceptions of mathematics and what their mindsets might be. Boaler (2016) has researched this area and connecting it full circle to the perceptions of mathematics from female students who later become teachers would add to the literature. As shown in the conceptual framework (Figure 1), I believe that experiences as a student influence a female, novice teacher's beliefs about her ability to teach mathematics well. Research to connect a student's experiences to her beliefs about teaching mathematics as a novice are worth exploring.

While student data around benchmark assessments in Kasey County were included, they play more of a role in the growth mindset of the teacher. The data were included as part of the interviews and discussion around each participant.

Considering novice teachers at the upper elementary, middle, and high school levels would add another perspective about mathematics instruction. Teachers in Kasey County who work at the secondary level must hold degrees in the content they teach. Novice female teachers could be further researched in a study regarding teachers who enter the mathematics classroom with a degree in mathematics. Research on the growth mindset at the secondary level would be an interesting extension of this study. Using survey data, Banilower et al. (2018) suggested that teachers with a degree in mathematics self-report a higher comfort level with instruction in mathematics. The teachers' own words gathered through face-to-face interviews about instructional practices and analyzed through the growth mindset lens, would add to the research base.

The idea of an evolving mindset needs further research. This study allowed me to gather data over the course of a school year. To follow novice teachers as they continue in their careers is worth considering. I sent an additional member check recently to the participants and asked how mathematics instruction was going. I also asked what advice they would give to a first-year teacher, since all are now beyond that initial phase. Laura shared her advice as being open to making the curriculum work for students. She also noted that the materials are there as guides but are not a requirement and suggested that a novice teacher should try new things because "it's fun to take a risk and step out of the box." Lea noted that she was struggling in her second year. She had a larger class and shared that her students were behind where she expected them to be. She said she would tell herself, "just because they aren't above grade level or soaring through

everything doesn't mean they aren't making progress. I'd make sure a new teacher knew to watch where they start and where they go so they can celebrate all victories and not just the big ones!" Novice teachers continue to need support and encouragement beyond the first year. Further research could reveal the necessary supports.

Conclusions

A growth mindset in mathematics, or mathematical mindset, is ever-evolving and impacted by the novice female teacher's past experiences and current situation. The teacher who has switched grade levels but only taught for two years is at a disadvantage compared to the teacher who has taught the same grade for several years. The new teacher feels as if she is starting over with each move. The feelings of trying to survive, teaching like others on the team, and having proficient students on assessments are exacerbated by having to learn a different grade level curriculum. Those teachers who come to education with an enthusiasm for teaching mathematics have their excitement tempered by administrators, the amount of resources available, and the education they received prior to teaching. Young children greet the teacher every morning, showing an eagerness to learn and looking up to the teacher for guidance in mathematics. The teacher must therefore be ready to provide that instruction to the best of her ability. Administrators must ensure that novice teachers feel equipped to teach mathematical concepts while maneuvering the expectations of the first few years of teaching.

Researcher Reflections

As I finish the work I began over four years ago, I am excited to add two passions of mine to the information about mathematical mindsets and novice teachers. Boaler (2016) states, "*Teachers are the most important resource* for students. They are the ones who can create exciting mathematics environments, give students the positive messages they need, and take any

math task and make it one that piques students' curiosity and interest" (p. 57). That is my hope for the thousands of teachers working with young children. If mathematics is not a perceived strength, make it one. Take the journey with a colleague. Learn to appreciate mistakes and celebrate them on the path to learning. Figure out how to maximize self-efficacy about mathematics and instruction. Break the cycle of female teachers perpetuating the message to young girls that mathematics is hard or not for them. Don't let a kindergarten student or a parent say, "I'm not good in mathematics" without challenging that thinking. Look for the joy in mathematics and celebrate it with students.

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Appendices

Appendix A

Mathematical Mindset Survey

Thank you for taking the time to complete this survey. The results will become part of my dissertation work for a local college. All responses are confidential and anonymous. By clicking on a response to the question below you are agreeing to the terms of data use as outlined above and to being part of my research study. Your participation is voluntary. The survey takes about twenty minutes to complete.

* Required

I agree to participate in the Mathematical Mindset Survey. *
Yes
No
Maybe: I have questions before I proceed and will contact you.

Student Mathematical Mindset

Please respond thinking about your experiences as a student. Please answer the extent to which you agree or disagree with each statement, with 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = somewhat agree and 5 = strongly agree.

1. I enjoy being challenged in math. *

2. In math, answers are either right or wrong. *

3. Math is boring. *

4. People who really understand math will get an answer quickly.*

5. I can tell if my answers in math make sense. *

6. When I get a bad grade in math, I think I am not very smart in math. *

7. I believe that I can do well in math. *

8. When I make a mistake in math, I feel bad. *

9. It is important in math to be fast. *

10. There are limits to how much people can improve their basic math ability. *

11. If I put in enough effort I can succeed in math. *

12. You have a certain amount of math intelligence, and you can't really do much to change it. *

13. Math is a subject with lots of connections between ideas. *

14. It is really helpful to talk about math with others. *

15. There is usually only one way to solve a math problem. *

16. I like to solve complex math problems. *

Teacher Mathematical Mindset

Please respond thinking about your experiences as a teacher. Please answer the extent to which you agree or disagree with each statement, with 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = somewhat agree and 5 = strongly agree.

1. I enjoy teaching math. *

2. I expect students to get the right answers in math. *

3. Teaching math is boring/hard. *

4. If students understand math, they will get the answers quickly. *

5. My students understand the reasonableness of their answers. *

6. When I give a poor grade in math, that indicates the student is not very smart in math. *

7. I believe all of my students can do well in math. *

8. When my students make a mistake in math, I feel frustrated. *

9. It is important in math for my students to be fast. *

10. There are limits to how much my students can improve their basic math ability. *

11. I want my students to succeed in mathematics. *

12. Some students have a certain amount of math intelligence, and I can't really do much to change it. *

13. I can help students see connections between ideas in math.*

14. It is really helpful to talk about math with other teachers. *

15. Students need to know there is more than one way to solve a math problem. *

16. My students like to solve complex math problems. *

Appendix B

Mathematical Mindset Semi-Structured Interview (1)

1. (intro questions- getting to know you) a. How long have you been teaching? b. which grade do you teach? c. have you taught other grades?
2. Why did you choose to become an elementary teacher?
3. Self-Anchoring question:
    - At the top of the paper, tell me the characteristics and actions of the best math teacher.
    - At the bottom of the paper, tell me the characteristics and actions of the worst math teacher
    - Number the paper from 0-10 with 0 at the bottom and 10 at the top (me).
    - Where do you see your own teaching currently on this scale and why?
    - Where do you see your own teaching a year ago and why? (put a 1 next to that ranking)
    - Where do you see your own teaching five years from now and why? (put a 5 next to that ranking)
    - What would need to occur to move you to the top of the scale?

4. Describe your experiences as a math student.
    - What do you remember most about mathematics as a student?
    - Did you take mathematics classes beyond high school? Why or why not?

5. Do you see yourself teaching math similar to the way you learned or were taught? Or do you teach significantly differently from those experiences?

6. What do you think most early childhood teachers believe about mathematics instruction?

7. Describe a growth mindset in mathematics.

    - What does it look and sound like in the classroom?
    - What is the teacher doing?
    - What are students doing?

8. If you could ensure the most positive student achievement in mathematics, what would your mathematics lessons look and/or sound like?

9. What do you do when students struggle in mathematics?

    - What have you tried?
    - How do you know the student is successful?

10. Is there anything else you'd like to share?

Appendix C

Focus Group Mathematical Mindset

Will ask participants to sign off on form for use of their data (discussion)

Video

1. Bring participants together at a local college (library- study room with technology).
2. Review the Framework for Teaching rubric used in observations/evaluation for Kasey County. Briefly discuss the standards in Domain 3 (Instruction).
3. Ask participants to rate the teacher in the video (k/1st grade math lesson, 7 min, is under 3c in instruction and is considered a 3 on a 4-point scale) using the rubric/ Domain 3
4. Discussion- What did you notice or want to share about the lesson? Where did you score the teacher and why? Where does this teacher fall on the best math lesson/ worst math lesson scale? Why?

Student Work:

1. Show a piece of student work in mathematics (no names- from my school)
2. Discuss the work: tell me about this piece of student work considering a mathematical mindset. What do you see in the student response? What do you think the teacher planned and did to elicit this response from the student? Do you think this teacher has (might have) a mathematical mindset? Why or why not?

Closure:

1. My study is focused on early elementary teachers and their growth mindset in mathematics. I'm interested to know your thoughts and if you see connections between this video of a mathematics lesson, the student work, and a mathematical mindset (may need to define).

Appendix D

Mathematical Mindset Semi-Structured Interview (2)

1. How has math instruction been going for you?
2. How do you feel your students are doing? Do they understand the math? How do you determine whether or not they are "getting it"? I'd love to hear an example of a time when one or more of your students "got it" and/ or didn't understand.
3. I would like to ask you some follow-up questions from our first interview and the focus group discussion: *the questions to follow would be based on individual responses from the first interview and/or discussion points from the focus group discussion. They will be added once this data is gathered.*
    a. In the focus group you talked about a time when…
    b. I am interested to hear more about the specifics around…

Appendix E

Quarterly Math Journal Entry

Please share your thoughts below. Thank you for your time. By responding, you are giving me permission to use your response in my data.

* Required

Has anything interesting happened in math class recently? Something that you feel good about or a disaster that is still bothering you or even some ideas or questions, now that I've asked you, that you'd like to share. Feel free to jot ideas below (bulleted list, phrases, ideas- full sentences/ paragraph not necessary). Thank you! *

Your answer

Appendix F

Participants' Responses to Initial Survey

Note: 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = somewhat agree and 5 = strongly agree.

Questions	Loree	Lea	Michelle	Louise	Caroline	Shirley	Antonia	Laura	Nicole
1. I enjoy being challenged in math.	5	5	4	4	4	4	4	4	4
2. In math, answers are either right or wrong.	2	4	2	4	4	3	4	3	3
3. Math is boring.	1	1	1	1	2	1	1	1	1
4. People who really understand math will get an answer quickly.	3	3	2	3	2	2	1	2	2
5. I can tell if my answers in math make sense.	5	3	4	4	5	4	4	3	4
6. When I get a bad grade in math, I think I am not very smart in math.	1	2	2	4	5	3	1	2	2
7. I believe that I can do well in math.	5	5	5	5	4	4	5	3	4
8. When I make a mistake in math, I feel bad.	1	1	4	4	2	4	1	3	4
9. It is important in math to be fast.	3	1	1	1	3	1	1	2	1
10. There are limits to how much people can improve their basic math ability.	1	1	3	2	2	1	2	2	2
11. If I put in enough effort I can succeed in math.	5	5	5	4	4	5	5	5	3
12. You have a certain amount of math intelligence, and you can't really do much to change it.	1	1	2	2	2	1	3	2	4

Questions	Loree	Lea	Michelle	Louise	Caroline	Shirley	Antonia	Laura	Nicole
13. Math is a subject with lots of connections between ideas.	5	5	5	4	4	5	4	4	NR
14. It is really helpful to talk about math with others.	5	4	4	5	5	5	5	5	NR
15. There is usually only one way to solve a math problem.	1	1	2	1	1	1	1	1	2
16. I like to solve complex math problems.	4	5	3	3	5	3	3	3	4
1. I enjoy teaching math.	5	5	5	4	4	5	4	4	4
2. I expect students to get the right answers in math.	1	3	2	4	4	4	2	2	2
3. Teaching math is boring/hard.	1	1	1	2	4	1	2	1	2
4. If students understand math, they will get the answers quickly.	3	3	1	3	1	2	2	2	2
5. My students understand the reasonableness of their answers.	4	2	4	3	1	3	4	2	4
6. When I give a poor grade in math, that indicates the student is not very smart in math.	1	1	1	1	4	1	1	1	2
7. I believe all of my students can do well in math.	5	5	5	5	5	5	5	5	4
8. When my students make a mistake in math, I feel frustrated.	2	1	2	3	4	1	2	3	2
9. It is important in math for my students to be fast.	1	1	1	1	1	2	2	1	1
10. There are limits to how much my students can improve their basic math ability.	2	1	3	2	4	1	2	2	1

Questions	Loree	Lea	Michelle	Louise	Caroline	Shirley	Antonia	Laura	Nicole
11. I want my students to succeed in mathematics.	5	5	5	5	5	5	5	5	5
12. Some students have a certain amount of math intelligence, and I can't really do much to change it.	1	1	2	1	2	1	4	3	2
13. I can help students see connections between ideas in math.	5	5	4	4	5	4	4	3	5
14. It is really helpful to talk about math with other teachers.	5	5	5	5	5	4	5	5	5
15. Students need to know there is more than one way to solve a math problem.	5	5	1	5	5	5	5	5	5
16. My students like to solve complex math problems.	3	3	4	3	4	5	3	2	3

Appendix G

Informed Consent

Participant's Informed Consent

Introduction

You are invited to be a participant in a case study for my doctoral program at a local college. If you agree to participate, you will be asked to complete an initial thirty-two question survey, two individual face-to-face semi-structured interviews, and a focus group with other participants and a quarterly single question survey.

Purpose

The purpose of my study is to determine what impact the mathematical mindset and self-efficacy of elementary teachers has on mathematics instruction and student achievement.

Duration and Location

The initial survey is anticipated to take 20-30 minutes. The initial interview is anticipated to be 30-45 minutes. The focus group will be approximately 30-45 minutes. The second interview will be about 30 minutes and the quarterly survey will take 5-10 minutes depending on the comments added to the question. Interviews will be conducted in a mutually agreed upon setting and time either at one of the schools or a setting outside of school. The focus group will be conducted at a local college's library in one of the study rooms. Surveys will be completed on the computer at a time that works for the participant.

Procedures for the initial survey: you will be asked to agree to complete the survey at the beginning. Using a computer, you will be asked to respond to questions about mathematics instruction when you were a student, your own mathematics instruction today and how mathematics instruction is going during the school year. Procedures for the initial semi-

structured interview: You will be asked a series of ten questions such as: “What do you think most early childhood teachers believe about mathematics instruction?” The second semi-structured interview will be an opportunity to follow up on any responses from the initial interview and the focus group discussion. Procedures for the focus group include sitting together with the other participants (up to 2 other teachers) and watching a videotaped math lesson together (from Teachscape) and discussing the elements of the lesson. You will also be asked to review and discuss student work as it relates to possible teacher skills or behaviors in the classroom that would have produced the student work. Quarterly surveys will be a single question asking for input about your current mathematics instruction.

You do not need to answer any question you do not wish to answer. You will need to agree to audio-recording of the interviews and focus group discussion, so I can listen to you more easily rather than trying to write down your full responses.

Risks and Benefits

There are no foreseeable risks involved in the study. The beneficial outcomes I anticipate are you may gain an increased understanding of your own views on the topic being explored. To thank you for your participation, I will have a gift card to give you at the end of the study.

Confidentiality

Your identity will be protected through the use of a pseudonym and the removal of any identifying information (like your position and school) in my final report.

Voluntary Nature of the Study

Your participation in this study is completely voluntary. If you decide to participate in this study, you are free to withdraw at any time. However, the data I collect prior to your

decision to leave may be used in this study. If you have any question about this study, please contact me at ---------- or my committee chair, Dr. Jennifer Cuddapah at----.

I understand the terms described above and agree to participate in this research study.

Participant _____ Date _____

I have explained the terms described above and believe the participant understands them fully.

Researcher _____ Date _____