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Relationships Between Teachers' Past Experiences Learning Mathematics and Their Pedagogical Practices and Beliefs

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RELATIONSHIPS BETWEEN TEACHERS' PAST EXPERIENCES LEARNING
MATHEMATICS AND THEIR PEDAGOGICAL PRACTICES AND BELIEFS

by

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A creative project submitted in partial fulfillment
of the requirements for the degree

of

MASTERS OF EDUCATION

in

Elementary Education

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Relationships Between Teachers' Past Experiences
in Learning Mathematics and their Pedagogical Practices and Beliefs

CHAPTER I: INTRODUCTION

When choosing a degree emphasis, mathematics is the only thing that truly appealed to me. Interestingly, I have not always felt comfortable doing mathematics. I felt quite unsure of myself from elementary school through high school, requiring consistent tutoring throughout my education. When I became a teacher, my perception of mathematics changed. I thoroughly enjoyed teaching mathematics at the elementary school level. With time, my anxiety subsided, and I felt able to competently teach my students. Year-to-year, my student's end-of-year test scores rose. Being a good mathematics teacher became part of my identity. These experiences contributed to my growing interest in teacher perception of mathematics. Considering my history, it would seem that I would struggle to teach mathematics effectively. I observed many of my colleagues struggle with teaching mathematics. My colleagues that were confident with teaching mathematics were consistently looking for creative manipulatives and ways for the students to learn. The students' perception of mathematics seemed to be tied to their teacher's underlying feelings around doing mathematics. My experiences combined with observations of fellow teachers sparked my interest in teachers' perception of mathematics and the overall effect that their perceptions had on pedagogy and instruction.

The purpose of this creative project is to examine what experiences elementary school teachers, employed at a local charter school, rely on when planning and teaching

mathematics. To examine these experiences, the teachers drew a journey map to use as a discussion piece and pictorial representation of their life-long journey through mathematics (Nyquist, Manning, Wulff, Austin, Sprague, Fraser, & Woodford, 1999; Meyer & Marx, 2014). The participants also participated in a semi-structured interview after a fifteen-minute scheduled observation. During the interview, the journey maps were used as conversation pieces for the participants to elaborate on. To consider how teachers' beliefs around teaching mathematics might relate to these experiences, I analyzed their levels of anxiety using the Mathematics Teaching Efficacy Beliefs Inventory (MTEBI) (Enochs, Smith, & Huinker, 2000). Using these methods of research, I particularly sought the following questions with this purpose in mind:

This project focused on how elementary classroom teachers' past experiences with mathematics and perceptions of mathematics relate to their current teaching practices. Levels of anxiety teachers discussed or evidenced in a survey explained additional dimensions to teacher's perceptions when planning and teaching mathematics. Specifically, I wanted to know the following:

- (1) How do elementary teachers' past experiences and perceptions about mathematics relate to their pedagogical practices?
- (2) What are elementary teachers' beliefs that influence their mathematics pedagogy?

CHAPTER II: LITERATURE REVIEW

Defining Mathematics Anxiety

Many studies have been done to research the effects of mathematics anxiety on pre-service and in-service teachers (Swetman, Munday & Windham, 1993; Bursal & Paznokas, 2006; Cooney, Sanchez, & Ice, 2000) Some of the definitions of *mathematics anxiety* include, “an illogical feeling of panic, embarrassment, flurry, avoidance, failing and fear, which are physically visible, and which prevent solution, learning and success about mathematics” (Bekdemir, 2010, p. 312). A key component of this definition is how anxiety with all of its levels and components, prevents success. Within a classroom setting, this definition of mathematics anxiety would imply that teachers with mathematics anxiety may inhibit success for some students within their care. A more simplistic characterization for mathematics anxiety is an anxious feeling that, “is aroused in situations involving mathematics” (Isiksal, Curran, Koc, & Askun, 2009, p.632) With daily requirements to teach mathematics, this constant arousal of anxiety could certainly take its toll on students and elementary school teachers. Teachers’ anxiety can vary in severity, but most research indicates that teachers’ anxiety toward mathematics will result in their students avoiding it in the future (Isiksal et. al., 2009; Vinson, 2001; Gresham, 2018).

Researchers agree that much of mathematics anxiety develops at a young age (Geist 2010, Bekdemir 2010). Often before children even enter elementary school, they construct perceptions of mathematics that can affect them throughout their lives. The literature suggests that anxiety in mathematics is not limited to particular situations involving mathematics, such as testing or performing a problem in front of the class.

Mathematics anxiety can arise in any situation related to the topic. It is different and personal for each individual. In fact, some of these anxiety-triggering situations are real or imagined and can happen at any point in a person's life (Stoehr, 2017).

With mathematics anxiety typically developing at a young age, it tends to play a significant role in the class choices made by students in middle school, high school, and college (Geist, 2010). Many students with mathematics anxiety will take the minimum required classes for mathematics at each level of schooling. These students typically choose to veer away from opportunities and careers involving mathematics before they are old enough to fully recognize the repercussions. Children will construct perceptions about mathematics that are not directly taught in the classroom. This development and relationship with mathematics can take a negative turn, often because of teacher anxiety (Geist, 2010, p. 24).

With the definition of mathematics anxiety in mind, we can understand more fully how to identify it in educators. Eden, Heine, and Jacobs (2013) indicate that around 20% of the population suffer from mathematics anxiety. Of that percentage, females make up more than half of that population (2013). With many of our elementary teachers being female, it is important to focus on the negative implications that may ensue for our teachers and students with mathematics anxiety.

Therefore, to better understand how mathematics anxiety relates to educators and students in elementary school, I will discuss the following themes from a review of the literature: (1) gender specific mathematics anxiety, (2) levels of anxiety, (3) affect on student attitude and perception of mathematics, (4) action plan for teachers with mathematics anxiety.

Gender Specific Mathematics Anxiety

The research suggests that there is a gender gap in mathematics achievement between male and female students. School age females often believe that they are not expected to succeed in mathematics (Stoehr, 2017). This directly relates to teacher achievement when those students, predominantly female, become elementary mathematics teachers. This negative social construct of mathematical achievement expectation is cyclical in nature, affecting female students in the same way that the teacher developed their own mathematics anxiety. Maloney and Beilock found that female students are negatively impacted by their female educators who suffer from mathematics anxiety (2012). Becoming cognizant of this research finding can help female educators pay attention to gender achievement gaps to ensure that their female students are not unintentionally slighted in their mathematics instruction.

Stoehr (2017) studied three female pre-service educators with mathematics anxiety. These teachers were interviewed to find how the three women related their anxiety to certain situations. Stoehr found, through a review of the literature, that much of the research focused on the psychomotor aspect of anxiety. However, she wanted to further examine female educators' affective and cognitive responses to anxiety. Stoehr studied women prospective educators with specific fears that tie to prior experiences in mathematics. These fears were analyzed to determine the affective aspects of these experiences. Stoehr found that these women were not only suffering from mathematics anxiety during mathematics tests or assignments, they were experiencing anxiety that branched into all aspects of their lives. They experienced fear of losing personal identity as well as a fear of losing social status. Her research on female pre-service educators may

help draw conclusions as to how female educators are coping with mathematics anxiety when teaching mathematics in the classroom. For instance, Stoehr found that the participants shared many coping strategies which had developed over time, enabling them to teach mathematics on a daily basis. Despite their inner feelings of distress when encountering math, these three teachers were able to use these coping mechanisms to further their education, become elementary teachers, and provide mathematics instruction within their classroom. Their coping mechanisms were helpful in many situations, but did not protect their students from realizing and feeding off of their mathematics anxiety. Stoehr found that the coping mechanisms helped them achieve their long-term goal of becoming a teacher, but they did not help them improve their anxiety levels in mathematics (2017).

With these findings in mind, it is critical to assist educators in coping with their mathematics anxiety. Each teacher's anxiety level will be different, but the overall goal of creating classrooms where teachers and students can feel comfortable with mathematics is ever present.

Levels of Anxiety

With mathematics anxiety being closely associated with low performance in mathematics and related subjects, it is important to draw attention to pre-service education (Suinn & Winston, 2003, p. 167). "Low math anxious preservice teachers are more confident to teach elementary mathematics and science than are their peers having higher levels of mathematics anxiety" (Bursal & Paznokas, 2006, p. 2). Before teachers enter the workforce, they can participate in classes that will help to minimize their anxiety. As they enter college, freshman have to make choices concerning mathematics

classes, but it is up to the university to provide well-planned classes with curriculum that can help perspective educators become less anxious about teaching mathematics.

Bekdemir (2010) suggests, "Teacher education programs should be designed and implemented so as to prevent student anxiety from beginning a barrier to mathematics achievement and a cycle of anxiety" (p. 326).

Kelly and Tomhave (1985) examined college freshman's anxiety levels to determine what areas of study the students were entering as it pertained to their mathematics anxiety level. These freshmen were given the Mathematics Anxiety Rating Scale (MARS) test. They found that pre-service elementary educators scored the highest on the MARS test than any other pre-professional group with the exception of students currently attending a workshop for mathematically anxious people. From their study, Kelly and Tomhave found mathematics anxiety prevalent among elementary educators, which they posit leads to concerns about teacher effectiveness in educating our future scientists, mathematicians, scholars, engineers, and any other mathematically driven profession.

In a study by Gresham (2018), in-service teachers, who were part of a study as pre-service teachers five years prior, were revisited to see whether their mathematics anxiety levels had improved, stayed the same, or worsened. The ten teachers from the first study had scored very high on the Math Anxiety Rating Scale (MARS), a 98-item Likert-style survey. After five years, Gresham found four of the ten teachers had furthered their education, receiving master's degrees. These four teachers explained that continual professional development in mathematics helped ease their mathematics anxiety. Gresham also found that teachers with the highest mathematics anxiety taught in

the lower grade levels because of their feelings of inadequacy when teaching mathematics. Those that received their master's degree of education scored lower on the Math Anxiety Rating Scale than those that had not yet furthered their education. In summary, the study found that the two main things that improved mathematics anxiety were continual education and teaching experience that can only come following years of teaching. Gresham posits, "The utilization of these principles in mathematics classrooms and in more mathematics courses presents an opportunity to potentially create stronger elementary teachers and students and, thus, break the cycle of mathematics anxiety" (p. 103). As her study found, having yearly continual education in the subject of mathematics for teachers can greatly decrease their mathematics anxiety.

Many of the teachers in Gresham's study tried to break the cycle of teacher perception becoming student perception. All of the teachers were cognizant of their inadequacies, and wanted to teach in grade levels where they felt comfortable. Many of these teachers created environments where they could feel success in mathematics and where they could still be positive influences in their student's lives. Educators have lasting affects on their students, and can often help shape their perceptions of any content area.

Affect on Student Attitude and Perception of Mathematics

Swetman, Munday, and Windham (1993) found that elementary teachers with higher anxiety purposely spend less time planning and carrying out mathematics activities in class than their peer teachers with low mathematics anxiety. Teachers with high levels of mathematics anxiety may also have a greater impact on negative student feelings and insufficiencies in learning mathematics than the students' curriculum or

external influences (Maloney & Beilock, 2012; Swetman et al., 1993). Vinson suggests that teachers need to portray to students an enjoyment for doing mathematics. They need to make mathematics activities enjoyable and relatable to everyday life. Teachers can do this by forming their instruction around things that interest their students (2001). Making mathematics enjoyable for students will also make the teaching of mathematics manageable for the teachers.

There are ways to counteract mathematics anxiety, and teachers can be made aware of these things even if they suffer from mathematics anxiety themselves. Becoming self-aware and driven to change is a positive step forward for elementary educators with mathematics anxiety.

Action Plan for Teachers with Mathematics Anxiety

With the high prevalence of elementary teachers suffering from mathematics anxiety, teacher education with the objective of combatting anxiety can be helpful. As previously mentioned, providing teachers with yearly mathematics training and continual mathematical support throughout the year, helps ease teachers' fears when planning and teaching mathematics lessons (Gresham, 2018; Vinson, 2001). Although Vinson (2001) found that mathematics courses were helpful in easing teachers' anxiety in mathematics, they were unfortunately not often found to change teacher attitudes toward the subject.

Negative attitudes toward mathematics relates to educators' avoidance in teaching mathematics. These attitudes can be subjected subconsciously through teaching practices (van Aalderen-Smeets & van der Molen, 2016). Negative thoughts and feelings can be diminished by thinking positively and talking positively about the subject (Vinson, 2001). When anxiety is regulated, a positive environment can replace the negative attitudes

associated with mathematics in order for it to be received well by all students (Maloney & Beilock, 2012).

Mathematics anxiety can be diminished with highly effective instruction including active learning opportunities such as, “games, simulations, problem solving activities, discoveries, and challenges” (Vinson, 2001, p. 91). As these tools are implemented, teachers feel more confident to make mathematics a priority within their classrooms. Elementary teachers can also try making their lessons connect to real-life experiences that the students may encounter daily. Using effective teaching tools can alleviate some anxiety from the teachers.

Bekdemir (2010) suggested several strategies for teachers to combat mathematics anxiety. His first suggestion is for teachers to be acutely aware of their own levels of mathematics anxiety and the anxiety of their own students. With that knowledge, Bekdemir suggests that teachers can seek help. Another key component of his research is that teachers should always be calm and understanding when teaching mathematics. Responding in a highly anxious manner could potentially affect the students. He also suggests that teachers should continually keep in mind that it is their responsibility to keep up with best teaching practices in mathematics. These strategies can provide teachers with the strength necessary to teach mathematics without continuing the cycle of mathematics anxiety.

In sum, the research indicates that mathematics anxiety is complex with individuals manifesting various levels of anxiety at different times when dealing with aspects of mathematics. With many teachers suffering from mathematics anxiety, their pedagogy of mathematics suffers. Teacher beliefs about their inabilities in mathematics

can form a cyclical pattern of unhealthy anxiety that effects their students whom eventually become educators themselves.

CHAPTER III: METHODOLOGY

The purpose of this creative project was to analyze how teachers' backgrounds and beliefs in mathematics affects their current teaching practices and pedagogy. With the literature in mind, I used an exploratory case study design to examine the relationship that a teachers' past experiences may have with their current pedagogical practices and beliefs. Therefore, in this chapter I will discuss the overview of my use of this exploratory case study design and its relation to the research questions, the participants and setting, the procedures and data collection tools, and an analysis.

Case Study Design and Research Question

In this project, I used an exploratory case study design because I used an inductive approach to my analysis to inform my project results. In this project, I define a case as all data collected in relation to each classroom teacher who participated in this project. Six classroom teachers participated in this project. As shown in Table 3.1, I used three qualitative instruments to measure relationships between teachers' past experiences/perceptions and their pedagogy. I also surveyed the teachers to determine how their beliefs around teaching mathematics might also relate to their pedagogy.

Table 3.1

Research Questions and Data Collection/Analysis		
Research Question	Data Collection Tool	Data Analysis
How do elementary teachers' past experiences and perceptions about mathematics relate to their pedagogical practices?	Qualitative Tools: Journey Map (Nyquist et al., 1999; Meyer & Marx, 2014) Interviews (Cooney et al., 2001) Observations	Open Coding to develop Categories within Cases Category Comparison Between Cases
What are elementary teachers' beliefs that influence their mathematics pedagogy?	Quantitative Tool: MTEBI survey (Enochs et al., 2000)	Descriptive Statistics

Participants and Setting

The project was held at a local charter school in rural, northern Utah. Six teachers from third grade-fifth grade participated in the study. The charter school receives funding from the state. Students come to this school through parent choice rather than geographic boundaries. Class sizes are typically around 30 students.

As delineated in table 3.2, participating teachers are from a variety of backgrounds. Half of the teachers in the study have graduated from a university with a degree in teaching while three received their Alternative Route to Licensure (ARL) or Alternative Pathway to Teaching (APT). Of the six teachers, five have only taught at the charter school. One of the teachers has taught at other schools including schools out of the state of Utah. There are two male teachers and four female. The teachers range in ages from 27 to 45 years old. The teachers' experience, or years of teaching, ranges from three years to fourteen years.

Table 3.2
Teachers' Professional Information

Teacher	Grade	Age	Gender	Total Years Teaching	Total Years at Charter School	College Degrees
Maddie	3 rd	27	Female	3	3	Elementary Education BS
Ashley	3 rd	42	Female	3	3	Anthropology BA ARL
Hannah	4 th	40	Female	5	5	Social Sciences BS and Counseling MA APT
Adam	4 th	41	Male	14	4	Environmental Studies/Geology BS Elementary Education MS Instructional Technology and Learning Sciences MS
Eden	5 th	45	Female	8	8	Cross-Cultural Communications BS Interdisciplinary Studies 1 st -8 th BS
Ivan	5 th	44	Male	6	6	Public Policy BA and MA ARL

Note: ARL- Alternative Route to Licensure; APT- Alternative Pathway to teaching; BS- Bachelor of Science; MS- Master of Science; BA- Bachelor of Arts; MA- Master of Arts

The state of Utah has two programs for individuals who desire to become teachers without following the traditional means of licensure attainment. These programs are the Alternative Route to Licensure (ARL), and the Academic Pathway to Teaching (APT). The ARL option is a program that individuals can complete if they do not have a background in education. They must meet specific requirements with the classes they took in college. If they do not meet the requirements, they then are able to take classes in certain areas where their pedagogy is not strong (Teaching and Learning, 2016).

The APT is a fairly new program in Utah. It received criticism from educators because the only requirement is that the educator holds a bachelor's degree and passes the Praxis exam. There are no other requirements to hold a teaching certificate through the APT. Due to the teacher shortage, the state implemented the APT with the hope that they could quickly fill teaching positions. It was the state's solution to the teacher shortage problem (Teaching and Learning, 2016).

As previously mentioned, three teachers (Ashley, Hannah, and Ivan) received their ARL or APT while first receiving bachelor's degrees in other areas of study before deciding to enter the teaching profession. One of the three teachers with elementary teaching degrees (Eden) received a bachelor's degree earlier in life in something unrelated, and then a second bachelor's degree twenty years later in education. One teacher (Adam) received a bachelor's in environmental studies and then two master's degrees; one in elementary education, and the other in instructional technology. The last teacher (Maddie) received a regular elementary education bachelor's degree. The participating teachers seemed to have more diverse educational backgrounds than typical elementary school teachers.

Procedures, Data Collection, and Instruments

The project was carried out in three phases. The first phase included teacher recruitment, consent, and baseline data from teachers' journey maps. The second phase involved the teachers taking a qualitative and quantitative online survey. In the third phase, I interviewed the participating teachers about their journey maps and observed them teaching a portion of a mathematics lesson.

Phase 1. To introduce the project to the participating teachers, I went to their faculty meeting early in the school year. At this meeting, I introduced the project, and had them complete a journey map (Nyquist et al., 1999; Meyer, Marx, 2014). The purpose of the map was to provide a pictorial representation of their journey through mathematics. This qualitative piece of data also served as a discussion piece as I talked with them in an interview during phase three of this project.

Phase 2. The six participating teachers also completed a survey online, the Mathematics Teaching Efficacy Beliefs Inventory (MTEBI) (Enochs et al., 2000). I gathered qualitative and quantitative data from the survey. Having the survey completed before the observation and interview allowed me to ask questions to further understand some of their responses on the survey.

The survey contained two subscales: the mathematics teaching outcome expectancy (MTOE), and the personal mathematics teaching efficacy (PMTE). These two constructs were integrated in the 21-item, five likert-scale MTEBI survey (see Appendix A). The MTOE contained eight positively worded questions. The PMTE contained five positively worded and eight negatively worded questions.

The mathematics teaching outcome expectancy (MTOE) explores the participants' expected teaching outcomes. For example, question 10 states, "When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher." The personal mathematics teaching efficacy (PMTE) looks at the teacher's belief in their own effect on students. For example, question 11 states, "I understand mathematics concepts well enough to be effective in teaching elementary mathematics." MTOE is generalized to all teachers, and PMTE is personalized using the pronoun I in

every sentence. These two subcategories allow us to further explore teacher beliefs about teaching efficacy in mathematics education. Given teachers' differing beliefs in what should happen when teaching mathematics (MTOE) compared to what they feel they are able to teach in mathematics (PMTE) was helpful in identifying particular conflicts in constructs around teachers' perceived mathematics anxiety.

Phase 3: The qualitative pieces of the project involved a journey map, observation, and interview. The observation was scheduled for each individual, and the interview followed the observation. Each teacher was separately observed for a 15-30 minutes during their mathematics teaching. The observations were at the beginning of each mathematics lesson. After their observation, we met for a 20-30 minute semi-structured interview. During the interview, I followed a list of interview questions (see Appendix B) while integrating my own questions along the way (Cooney et al., 2001).

The journey map, survey, observation, and interview combined to look at beliefs and pedagogy of mathematics for teachers within the charter school.

Analysis

Quantitative analysis. When analyzing the quantitative data from the survey, I first began by examining the descriptive statistics from each of the constructs. These statistics included mean, median, standard deviation, and range. By using descriptive statistics, I was able to gain insight as to how participant teacher outcome expectancy (MTOE) compared with their efficacy when teaching mathematics (PMTE). Next, I compared means between the participants and the aforementioned constructs. This informed the study's findings regarding how teachers' efficacy related to their expected teaching experiences.

Qualitative analysis. I began analyzing the qualitative data on an individual case-by-case basis. Looking at them individually allowed me to become more familiar with their particular levels of mathematics anxiety. Thus analysis included open coding of transcripts and field notes. From these open codes, I developed categories explaining particular broad themes from each participant. Each participant had varying backgrounds, and it was interesting to analyze how their backgrounds manifested in their teaching observation, interview, and journey map. These three components of study helped build a trifecta of information, all bringing different aspects of their background forward to create a more complete picture of their lives.

Next, I conducted a cross-case-analysis where I considered the aforementioned categories of codes between the six participants. Each participant manifested the coded categories in slightly different ways, but with many similar categories. These similar categories informed this study of the broad, overarching means in which participating teachers teach mathematics in respect to their belief around learning and teaching mathematics.

Mixed analysis. When looking at the qualitative and quantitative results, I found common themes that related between the two types of results. I used the categories from the cross case analysis and applied them to three different levels of anxiety: high anxiety with learning and teaching mathematics, high anxiety while learning and low anxiety while teaching mathematics, and low anxiety while learning and teaching mathematics. These levels of anxiety were then compared to the results from the five-likert scale MTEBI survey. The coding categories helped explain which teachers belonged in each

anxiety group and how this related to their expected teaching and outcomes from teaching mathematics.

CHAPTER IV: RESULTS

Quantitative Results

For the quantitative results portion of my project, I used the results from the MTEBI survey taken by the six participants to find descriptive statistics about their mathematical beliefs. The survey was broken into two constructs, mathematics teaching outcome expectancy (MTOE), and the personal mathematics teaching efficacy (PMTE). I used these two constructs to find descriptive statistics for the group as a whole. I then found mean scores for MTOE and PMTE for each individual participant.

Table 4.1

Descriptive statistics from the MTEBI survey, organized by construct

Construct	Mean	Median	Standard Deviation	Range	Minimum	Maximum
MTOE	3.65	3.63	.14	.38	3.50	3.88
PMTE	4.01	4.00	.35	1.08	3.54	4.62

Note. MTEBI – Mathematics Teaching Efficacy Belief Instrument (validated by Enochs, Smith, & Huinker, 2000); MTOE – Mathematics Teaching Outcome Expectancy; PMTE – Personal Mathematics Teaching Efficacy.

The descriptive statistics above depict a gap between mean scores for the MTOE (3.65) and PMTE (4.01) constructs. It is notable that the mean for MTOE is lower than the PMTE. This gap depicts a gap in the participants' perception of what is expected in their teaching outcomes (MTOE) compared to their personal belief around their efficacy in teaching mathematics (PMTE). The participants felt that their efficacy in teaching mathematics was overall very good, but when a student was not succeeding, some teachers believed the outcomes from that student were not directly tied to their teaching. This is important to note because these statistics represent a gap in teachers' perceived ability and their perceived accountability. In other words, these findings suggest that the

teachers believed they were capable in teaching mathematics, but not accountable for the outcomes associated with their teaching of mathematics.

When looking comparatively within these two measures, it is notable that the PMTE has a higher standard deviation (.35) than the MTOE (.14). This may be due to the fact that some instructors lack confidence in their abilities to effectively teach the subject. In other words, the participating teachers' mathematics anxiety may be a factor in the higher variance of scores. The lower MTOE standard deviation indicated that teachers are mostly in agreement with what outcomes should prevail given effective teaching of mathematics. The PMTE standard deviation suggests that teachers have more variance in their beliefs about their abilities to teach mathematics.

In table 4.2, I found the mean scores for MTOE and PMTE for each participant. I then compared the scores on an individual basis. I also compared the scores as a whole group. I was able to use this information to inform my results.

Table 4.2

Mean Comparisons from the MTEBI survey, organized by participant and construct

Participant	MTOE Mean	PMTE Mean
Ashley	3.88	3.54
Maddie	3.63	4.00
Hannah	3.75	3.85
Adam	3.50	4.08
Ivan	3.63	4.62
Eden	3.50	4.00

Note. MTEBI – Mathematics Teaching Efficacy Belief Instrument (validated by Enochs, Smith, & Huinker, 2000); MTOE – Mathematics Teacher Outcome Expectancy; PMTE – Personal Mathematics Teaching Efficacy.

When the two constructs of the MTEBI are analyzed on an individual participant level, other similarities and differences come to light. For instance, Ashley and Hannah have similar mean scores for both constructs (3.88/3.54 and 3.75/3.85, respectively). This

indicates that what they expect their teaching outcomes to be aligns with their beliefs in their personal ability to teach mathematics.

Most of the participants had a large variance between their MTOE and PMTE mean scores. Ivan particularly had almost a one-point difference between his MTOE and PMTE means (3.63 and 4.62, respectively). His large gap in his mean scores may indicate that he believes in his teaching abilities and efficacy, but he believes instruction is not necessarily the main driver of student success. This trend is seen to a lesser extent with Maddie, Adam, and Eden as well.

Qualitative Results

Categories from coding within the case studies. Several components of the data were similar in nature. After open coding, I was able to group the information into four categories: growth mindset, mathematical background, coping mechanisms, and influential people or experiences. All four categories were discussed or manifested by each participant in the study. The six participants engaged in these coding categories at different times of their lives and in different ways.

The first category is the idea that “we need a growth mindset.” Every participant mentioned that they want to teach their students to have a growth mindset as opposed to a fixed mindset. I suspect the reason behind all six participants mentioning this idea in their interview is that the school has been providing training on growth mindset from various books during their teacher professional learning communities. This mind shift is a healthy teaching tool to assist students with mathematics anxiety. Many interviewees mentioned aspects of their past where they had a fixed mindset. For example, Adam mentioned, “I just wasn’t a math student.” Ashley compared mathematics to the foreign language of

German. Hannah acknowledged her fixed mindset when she discussed that she does not feel comfortable with manipulatives, so she plans her lessons without them. She recognized that some students would do better if she changed her ways. Most of the participants mentioned aspects of their mathematical past where they were functioning with a fixed mindset, but all participants showed that they are shifting their mentality to a growth mindset.

The second category was “mathematical background.” It was interesting to hear how every individual had a unique history of mathematics. One poignant take-away is that everyone has an aspect of their “mathematical background” which promoted struggle. The differences between participants was the ways in which they dealt with the struggle. Some participants engaged in a productive struggle with mathematics. They found concepts that were difficult for them, and they worked hard and found ways of being successful with those classes. Other participants were unproductive in their struggle with mathematics. They would take the same classes repeatedly with high levels of anxiety. Ivan seemed to be the most comfortable with mathematics overall. His first career was centered in statistical analysis of political data. Even Ivan struggled with certain mathematics classes throughout his education. It does not matter if an individual is struggling in Pre-Algebra or Geometry, Calculus or graduate level Statistics, mathematics can be difficult. The key is to have a growth mindset with a productive struggle as previously mentioned. All six teachers struggled with something, but they are all successfully teaching at their current levels. They all successfully found ways of coping with their mathematics issues or anxiety.

The third category, which each teacher mentioned was “coping mechanisms.” Coping mechanisms seemed to aid participating teachers in their mathematics anxiety development. Adam mentioned that in college, he avoided all mathematics classes because he found out that he could take technology classes instead. Hannah wanted to complete her mathematics classes quickly in college, so she took them the first semester to get them out of the way. Maddie uses creative ways of teaching mathematics in order to reach students that would otherwise be bored or uncomfortable with a black board and note taking lesson. Three of the teachers type notes for every mathematics lesson so that the students will have something to return to after the lesson. Several of the teachers mentioned that they will look online for ideas of how to teach certain concepts if they are uncomfortable.

The fourth category, which participating teachers explained pressed them to enter the teaching profession was an “influential person or a positive experience.” With five of the six teachers having initial degrees outside that of education, many of them had experiences later in life that led them to the profession. Adam became a teacher with the good influence of a coworker during his time with AmeriCorps. Ivan had great experiences during his service mission and later teaching missionaries at the training center. Eden had many positive experiences teaching various subjects that helped foster her desire to become a teacher full time. Even though several of the participants struggled with mathematics anxiety, their desire to teach became the overpowering factor in choosing their career.

Case Studies

Case 1: Hannah. Hannah was the first participant in the study. She engaged in all four coding categories. In her interview, Hannah mentioned growth mindset, her mathematical background, some coping mechanisms that aid her with mathematics instruction, and a positive experience in her graduate school mathematics class that helped her feel confident enough to become a teacher.

Hannah's observation. The class was finishing their Language Arts lesson as I entered, and quickly transitioned to their mathematics timing to practice multiplication and subtraction. Before their lesson started, they practiced mental mathematics problems to get their brain tuned into mathematics. At the beginning of the lesson, they only had nine minutes left before recess. Hannah seemed rushed to quickly fit in the lesson. She did not clearly state an objective at the beginning, but she reviewed the commutative property of multiplication that the students were taught a few days before. She added to that original lesson by introducing missing factors into a number sentence. The students had to solve number sentences with three and four factors with one missing number. With a short amount of time for the lesson, they had to finish the concept later in the day.

Hannah's interview. Hannah's educational background in mathematics aligns with the literature about mathematics anxiety. In elementary school, she felt comfortable with mathematics because it was easy and natural to her. In middle school, the concepts became harder for her and her grades started to fail. Hannah contributed this failure to her lack of study skills. This was a continual problem for her through high school and college and resulted in an avoidance of mathematics classes. In high school, Hannah was homeschooled for the last two years, and ended up taking her GED to graduate. In

college, she took two mathematics classes her first year in order to get them out-of-the-way. At that point, she had no plans to take any more mathematics courses in the future. In her graduate program, she was required to take a Statistical Analysis class. Hannah expressed in the interview:

I understood Statistical Analysis. That didn't mean I enjoyed it, but I understood it. I felt enough confidence to where I thought, 'Hey I wanna be a teacher.' Then I could do it. I don't think I would have felt confident enough to do it if I hadn't had my grad school experience where I felt like I understood it.

Her positive experience in the class was a driving force in her choosing to enter the teaching profession. Hannah had many negative experiences in mathematics, but because of her most recent mathematics class being a successful one, she was confident enough in her abilities to switch careers from psychology to education.

When asked what causes anxiety in mathematics, Hannah stated that she believed that the core cause of anxiety is the examples that students have before them. She expressed that the relationship between girls and mathematics is ever present in her mind. She stated:

Women especially, if they don't feel confident in math, their daughters a lot of times don't feel confident in math. Or if they use 'I'm just not good at that,' instead of, 'I'm not good at that yet,' or, 'I haven't learned that yet,' or, 'let's figure that out together.' Then I think it's easy for kids to see that and just say, 'I'm just not good at that,' or 'my brain's not made for that.' We want kids to know that they can grow.

This comment from Hannah shows that despite her struggle with mathematics, she believes that all students have the ability to grow and succeed if they have the right mindset and good examples around them. She discussed in depth what a growth mindset sounds like. She desires to teach growth mindset to her students.

Hannah expressed that she still feels uncomfortable with using manipulatives while teaching. When planning lessons, she plans to teach concepts in ways that are comfortable and familiar to her. This is a coping mechanism that Hannah executes to feel confident while teaching math. She expressed that this is a weakness of hers that she would like to work on. Hannah mentioned that one strength of hers is showing excitement for the subject. Hannah is trying to break the cycle of teacher anxiety impacting students.

Hannah's educational background. Hannah graduated with her BS in Social Sciences and an MA in Counseling. She started at the elementary school as an aide, and then eventually got her APT from the state of Utah in order to teach. The school utilized her in middle school for Drama and a computer class before giving her a position as a fourth grade teacher. She is the only teacher at the school with the APT certification.

Hannah's Journey

Map. Hannah's journey map depicts four specific phases of her life in relation to mathematics. In 1987, or

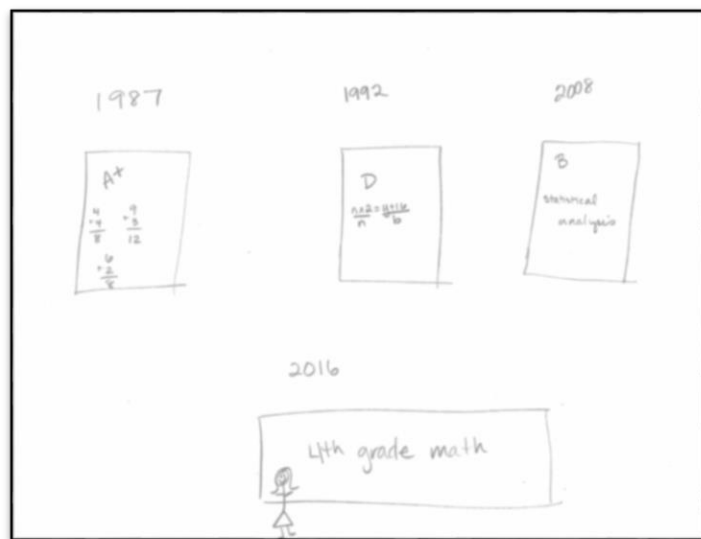


Figure 4.1

elementary school, Hannah felt great confidence with mathematics as depicted by her A+ grade and basic problems such as $4+4=8$. In 1992 she depicted a much lower grade of a D, which represents her struggle in middle school with Algebra. In 2008 she took Statistical Analysis in her graduate program and felt some success as depicted with the grade of a B. In 2016, the fourth phase represents her getting her current job as a fourth-grade teacher. The stick-figure teacher in front of the board has a smile on her face showing that she is feeling successful at teaching mathematics at this level.

Case 2: Eden. Eden teaches fifth grade, and is a very passionate teacher. She loves her job, and wants to continue learning and growing in her position. All four coding categories emerged in Eden's interview data as well. In her interview, she mentioned having a growth mindset. She also shared some personal aspects of her mathematical background with some coping mechanisms that have helped her be successful in mathematics teaching. Eden has also had several good experiences in her past and one negative teacher whom impacted her greatly.

Eden's observation. Eden started her lesson right after recess break. She clearly stated the objective of the lesson, factors and prime numbers, and passed out notes to her fifth graders that she had typed ahead of time. The students were to follow along and write their own notes as the lesson progressed. She worked quickly to give the students ample opportunity to work on the concept in their short ten-minute lesson window.

Eden's interview. After the lesson, Eden expressed to me that she was frustrated by the lack of time allotted them for mathematics lessons. She also expressed concern for the direct instruction format in the school. Her concern centered on how difficult it is to add components like manipulatives to the lessons. An interesting take-away from her

interview was that Eden seemed to feel like her hands were tied when it came to curriculum and the school's instructional format. She did mention in the interview that my questions gave her some things to consider regarding her current teaching structure around mathematics. She mentioned that restructuring math-time by occasionally giving time for a longer lesson with manipulatives and less homework problems could be beneficial. I found it interesting that she typed up very specific notes for the students to the point that they would not need to write anything down. This seemed to be a coping mechanism for the lack of time spent on the mathematics lesson.

Eden's mathematical history was overall positive. She expressed that she did not remember very much about elementary school (which she claims must be a good thing). During the middle years of her education, Eden specifically stated her love for Algebra and distaste for Geometry. She stated, "Algebra is...like a puzzle. I love puzzles, so to me, Algebra kind of fit." She did not care for Geometry because it was abstract. She also mentioned that her tenth grade Geometry teacher had a significant impact on her in a negative way. Eden said about her teacher, "I never wanted to ask questions because I was afraid she would be mean or belittling about it." This negative influence caused some mathematics anxiety for Eden in that particular class. Eden talked about how she never wants her students to feel the way she felt in her Geometry class. Even though the experience with this teacher was negative, Eden was positively impacted from this encounter in her teaching style.

To Eden, low confidence in mathematics is caused by missing concepts in school. She likened mathematics to building Legos. She mentioned in the interview that mathematics is a subject where you need the foundational pieces in order to build on top

of it. Her desire is to help students fill those gaps in order to fully grasp the concepts being taught in her class.

Eden's educational background. Eden's educational background is very unique. She received a BS in Cross-Cultural Communications with the purpose in mind that she would travel the world and study other cultures. After getting married, she realized that she needed to choose a career that would be more home friendly. She taught in several different scenarios over a short amount of time. She taught a summer school camp, an adult ESL class, second grade, PE, seventh grade math, and kindergarten. All of this, she did before she received her teaching degree. They were very positive experiences for her as well. She received her BS in Interdisciplinary Studies 1st-8th grade 15 years after receiving her initial Bachelor's Degree. Her desire to teach was very strong. She recounts:

I would bring my kids to school at the beginning of the year. And I would literally be tearing up... I would be like "Lord, I wanna be a teacher!" I remember bringing my third son to class and literally I was crying in class... People were probably thinking that I was so emotional because my baby boy was going to school full time. NO! My desire to teach was so strong!

Eden's journey map. With such a strong desire to teach, it was not surprising to find that Eden's journey map depicted a party in the section where she depicts her teaching years. Her map is sectioned into three categories: early years, middle years, and teacher years. Her early years of mathematics were happy. She remembers very little, but takes that as a good sign that there was nothing scaring in her early years. Her middle years depict a split. It shows her love for Algebra with a heart, and her negative feelings toward

Geometry with a circle that is crossed out. Specifically, she mentioned that tenth grade teacher who was consistently mean. Her third section depicts her teacher years full of hearts and confetti! Eden specifically mentioned

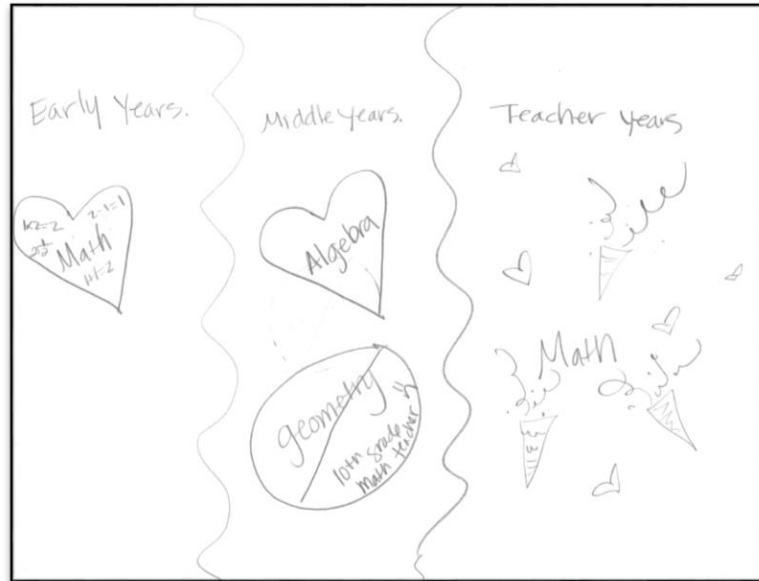


Figure 4.2

that her enjoyment currently is because of her comfort with the content being taught. She said, “If we switched things out, I don’t know that my hearts and confetti would be there.” This indicates that some anxiety about mathematical content could arise in the future, but with her healthy attitude about teaching, it would likely be only a momentary issue.

Case 3: Ivan. Ivan teaches fifth grade at the charter school. His interview responses demonstrated three of the four coding categories: growth mindset, discussion of mathematical background, and discussion of experiences and people that influenced him. His background in mathematics is very positive with few negative encounters.

Ivan’s Observation. In only two minutes, Ivan’s fifth grade class came in from recess, settled into their seats, and started their mathematics timing practice for multiplication and subtraction. He greeted each student at the door before the timing, and gave words of encouragement to many. The environment was rewarding and positive. In

preparation for the lesson, Ivan stated, “The math part of your brain is turning on.” After the mathematics timing, the students had ten seconds to put away their timing and get out their white boards. All students were engaged and eager to share their answers to the mental mathematics activities that Ivan was orally giving. On many occasions, Ivan asked the students to orally express their thought process in getting to an answer. All of this happened within a few short minutes, and before the actual lesson began.

The lesson objective was clearly stated as divisibility. Ivan divided the different end-digit divisibility rules into what he called the easy rules, and the fun rules. The easy rules were numbers that divide by 2, 5, and 0. The fun rules were those where you had to get a sum of the digits. They were looking to see if the sum of the digits of a number were divisible by 3 or 9. Instead of saying the hard rules, Ivan said the fun rules. This slight change in delivery seemed to be helpful to student perception of the tasks. They did three problems together as a class and then Ivan asked the students to do the practice set in the mathematics book. To get their homework started, they had to have Ivan check their work from the practice problems. It seemed that Ivan’s upbeat lesson was effective for his students. In the end, he helped all students feel success with the subject content.

Ivan’s interview. Ivan’s upbeat vibe carried over to his interview. When asked what specific positive experiences he had with mathematics, Ivan mentioned that he loved his high school mathematics teacher, Mr. Mow. This teacher had a very positive influence on Ivan. He expressed that he was never a really high-level student, but always an, “almost high-level student.” Mr. Mow had such an influence on Ivan to help him succeed and be placed in accelerated mathematics classes. This love of mathematics continued into his college years as he chose to receive his BA and MA in public policy.

When asked what causes low confidence or anxiety in mathematics, Ivan said that low self-esteem or belief in one's self is the root cause. He believes that the desire to please or achieve is at the core of anxiety. He has found that if he takes the personal relationship of success or failure out of the mathematics problems, students are more able to work through what they don't understand.

Ivan's educational background. Ivan received his BA and MA in public policy from Brigham Young University. He was very interested in the economics and statistics behind human experience. Ivan's first career was working for the state of California and then later at a consulting firm in California. He expressed that these jobs were not what he desired from his profession. They were more like accounting jobs, which he disliked. His desire was to learn about, "society and then analyz(e) what, or how the different issues were related." He expressed in the interview that choosing to become a teacher was a journey in finding out who he truly was as a person. Ivan said about teaching, "It's my profession language. And so I'm a teacher! It's perfect! It's not work! I come, I inspire and teach kids to do well, and I love that." Ivan received his ARL and began his teaching career six years ago.

Ivan's journey map. Ivan's journey map depicts a rocket ship on a graph-like timeline. On the X-Axis, Ivan put his education levels and time. On the Y-Axis, his level of confidence growing with mathematics education. In big, bubble letters, Ivan writes, "The Journey Continues." This picture seems very aligned with his interview because of his love for mathematics. He seems to have always had a fairly healthy relationship with math. This positive outlook on mathematics manifested in his teaching of the subject. Ivan said:

Teaching mathematics is really important to me. I feel like it's a skill that teaches kids logic without them knowing it. It's strengthening their brains in a secret way. Their brains are getting built... in ways that language instruction doesn't build them. I think it's actually especially important for the lower kids because they're the ones that need some of these mental logic skills that they just haven't developed yet, so the more and more that they get good at the basic skills, and then the medium skills, intermediate, and then the challenging skills. They are going to know how to think. I really like that.

Ivan shows that he believes in a growth mindset because of his comments about how students' skills, “

haven't developed yet.”

He expresses that all students have the capacity to learn and grow. Although Ivan has not suffered from mathematics anxiety in his educational past, he

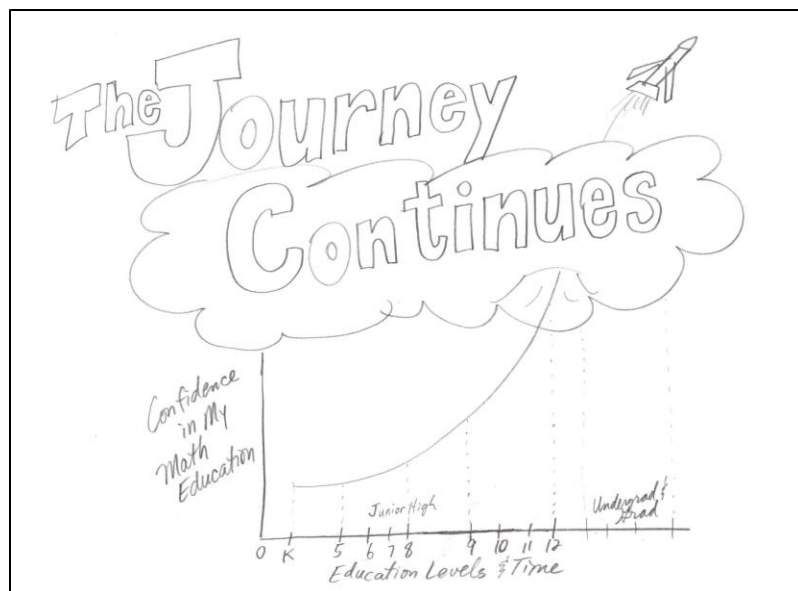


Figure 4.3

is cognizant of how

others may perceive the subject. He is mindful to craft lessons in ways that will lend themselves to being easily received by all students. He thinks ahead to how he should present the topics. Ivan's mindful teaching is a model that teacher's with anxiety could follow in order to help ease their anxiety with the subject.

Case 4: Adam. Adam teaches fourth grade at THE CHARTER SCHOOL. He is the only teacher in the sample set that has taught professionally at other schools. Adam's responses demonstrated all four coding categories. He discussed growth mindset, educational background, and an influential person in his background. He particularly spent time discussing coping mechanisms that he engaged during his own educational experience.

Adam's observation. Adam's mathematics lesson began shortly after recess ended. His students already had their materials on their desks, so the transition went smoothly. Adam began the lesson by stating the objective: dividing with and without remainders. He began by calling several children to stand before the class. The remaining students in the class were all paying attention to this activity because their peers were in front of the room. He said, "I like to model division with using manipulatives." Then he proceeded to divide the children up into two even groups. They did several models to represent the same thing, and the students were asked to indicate understanding with a thumbs up or thumbs down action. Before doing their homework the students were able to check their understanding by modeling competency on the practice set of problems from the book.

Adam's interview. With fourteen years of teaching under his belt, it was apparent that Adam knew how to get the attention of his fourth grade students when teaching mathematics. Adam did not always feel comfortable with mathematics though. He expressed in his interview that his first feeling of success was in middle school when a teacher finally pointed out that he had done something well. He stated that during elementary school, he had a bad attitude of, "This is dumb. I don't wanna do this." He

remembers just writing random numbers down on his assignments to get him out of staying in for recess. He stated, "I just wasn't a math student. I didn't really care for it." From this comment, it is apparent that Adam has had some negative experiences in mathematics that caused some level of anxiety and low confidence. He created coping mechanisms as a child to get out of doing his work and to detach himself from being a mathematics student.

Despite Adam's mathematics anxiety, he received a Bachelor's and two master's degrees. Adam found ways of coping with his mathematics anxiety. In his interview, Adam noted that he took technology classes in college to fulfill the mathematics requirements. This was after he failed a statistics class his freshman year of college. He did not want anything to do with the mathematics classes if he could manage without. He also mentioned that in preparation for Utah State's entrance exam for the master's program, he found someone highly qualified to help him study for the test. These coping mechanisms helped Adam succeed through the majority of his schooling.

When asked what the causes of mathematics anxiety are, he said that the root cause is poor experience during school. He said it could be caused by, "bad teaching or just not getting the support that is needed." Like many other teachers in the study, Adam mentioned that it's important to have a good mindset of, "I don't have this yet, but I will get there."

Adam's educational background. Adam received his first degree in environmental studies from St. Lawrence in New York. When that career option did not work out, he started working with AmeriCorps and the Student Conservation Association working in the Adirondacks in northern New York. Part of that experience was teaching

an environmental class to the fifth grade group in the area. His career path veered toward teaching when he discovered that he had a knack for it. The teacher he was working with was the driving force behind him going back to school to receive his master's in elementary education. After working there for ten years, he decided to return to school to receive a master's of education in instructional technology and learning sciences from Utah State University.

Adam's journey map. Adam's journey map is separated into six sections of schooling. In elementary school, Adam had a little stick figure boy saying, "No, it is evil!" In middle school Adam wrote that a teacher said something complementary, and he was surprised! This was a happy time for him in mathematics. In high school, he wrote that, "Math was not fun again." He expressed confusion by seeing letters in math. In college, he wrote about statistics, "I am going to deviate in a standard way outa here!" In grad school, he received help from a Jeopardy winner to prepare for the entrance exam. Presently, he loves teaching mathematics at the fourth grade level.

Adam's journey map is quite personal. He shares openly his feelings of dislike for mathematics. With his history, it is great that he has found ways of coping in order to teach mathematics.

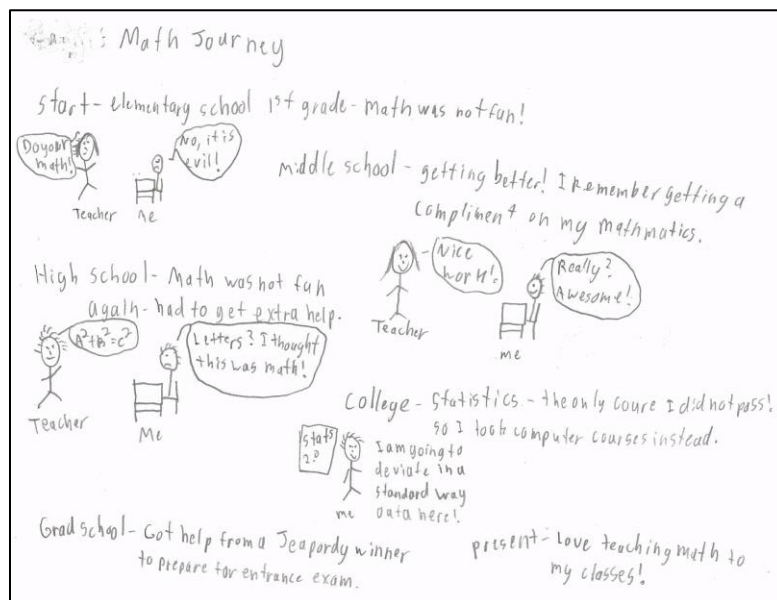


Figure 4.4

Throughout the years, it seems that he has formed better ways of coping with his mathematics anxiety. In elementary school, he just wrote things down to appease the teacher. In high school, he was tutored through classes. In college, he just avoided the subject altogether by fulfilling the requirements with technology classes, and now, he teaches successfully at the fourth grade level. By staying at a level of mathematics that is comfortable, he can be creative in teaching.

Case 5: Ashley. Ashley teaches third grade, and her interview also demonstrated all four coding categories. Ashley discussed needing a growth mindset, her rocky mathematical background, coping mechanisms to deal with mathematics anxiety, and a positive experience that helped shape her into the teacher she is today.

Ashley's observation. Her students were excited as they came in from recess. They had not finished spelling due to the interruption of picture day. Before the mathematics lesson began, the students corrected their math homework. Ashley then started the lesson directly stating the objective of studying temperature. She typed up notes for the students to paste in their mathematics journals. There were several pictures in the notes depicting different thermometers with varying readings. The children were engaged in the lesson, and did well with the concept. Ashley provided several extra pictures of scales to read in preparation for reading the thermometer. The students were only given one or two examples of how to read the thermometer before beginning their practice set of problems.

Ashley's interview. Ashley noted that mathematics was not her strongest subject. When asked what good experiences she had in mathematics, she could not think of even one. She mentioned that in middle school, there was a placement test, which really

scarred her. It was the first time that she was completely confused with mathematics. In her Pre-Algebra class, she remembers feeling very overwhelmed. She mentioned that she would be in tears every night while doing mathematics homework. Ashley said that those experiences were the start of feeling like she did not like mathematics anymore. The mathematics anxiety stayed with her for the remainder of her education. In her future class choices she avoided mathematics at all costs.

Ashley is now feeling successful in mathematics. She says, "I feel a lot better about it now than I did at the beginning when I first started teaching." Her comment aligns with the literature that mentions years of teaching being a factor in easing mathematics anxiety. She said, "I've gotten really good at third-grade math. So I'm like wow! I can do fractions!" When asked what important quality a mathematics teacher should possess, Ashley mentioned that teachers need to anticipate the concepts that are going to be hard for the children. She seemed to do this well in her mathematics lesson.

Her journey through mathematics was rocky. She mentioned in the interview that she put a lot of pressure on herself with her perfectionistic tendencies. A very interesting part of her interview was her confession, "I just knew I didn't want to be a teacher." Her dad was a mathematics teacher, and from that she knew that she did not want to go into teaching. Ashley avoided all things relating to mathematics during her education. This was a coping mechanism she enacted.

It is worth noting that Ashley does one particular thing differently than the other teachers at the school. She corrects mathematics homework during class time. Other teachers typically have their aide correct the mathematics as they all have full-time aides helping them individually all day. This is notable because she also has them call out their

mathematics scores aloud in front of the other students. I found this interesting because during the interview, Ashley said that comparing one's self to other people in class causes mathematics anxiety. The practice of vocalizing scores in front of other students could easily cause mathematics anxiety for some students.

Ashley's educational background. Her first degree was a bachelor's in Anthropology. She received her ARL after being a teacher's aide for a few years. She said, "It's like I have been avoiding this my entire life, and it keeps catching up to me." Despite her avoidance of teaching, Ashley enjoys teaching third grade mathematics now.

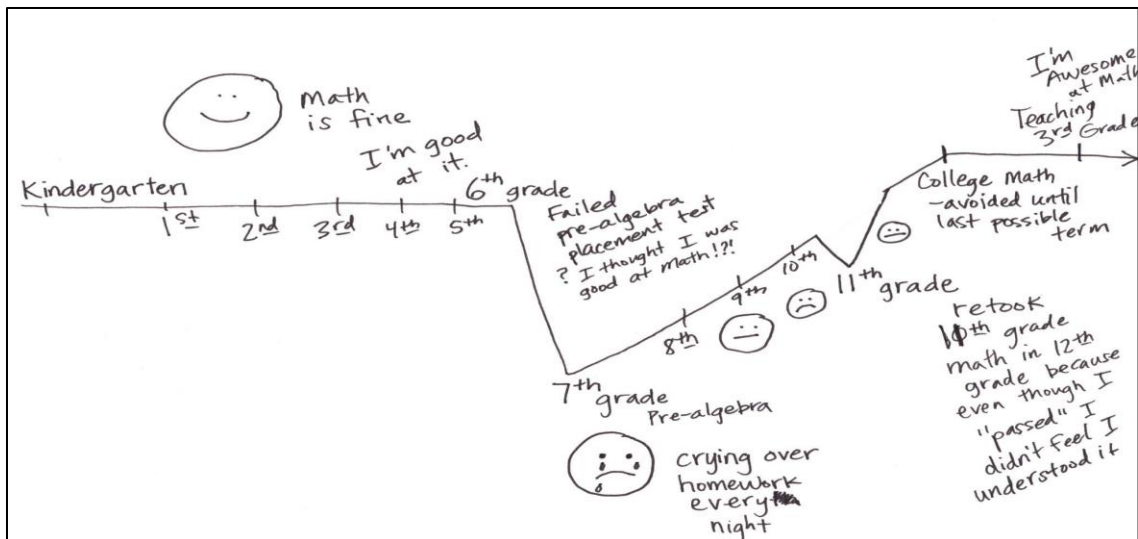


Figure 4.5

Ashley's journey map. Ashley's journey map depicts a timeline starting in kindergarten through sixth grade. She has a smiley face saying, "Math is fine. I am good at it." After sixth grade there is a huge drop-off depicting the mathematics placement test that she failed. This was catastrophic for her because it took her a very long time to recover from the experience. Seventh grade depicts her lowest level of confidence with a frown and tears on the little face she drew. The timeline seems to go up to show that her confidence was also going up slowly. In eleventh grade, she retook a mathematics class

because she did not understand the concepts. The end of her timeline shows her teaching third grade math. She says, "I'm awesome at math!" With time, Ashley has developed a sense of security in her teaching abilities with mathematics. It is great to see that she is feeling success at this level.

Case 6: Maddie. Maddie teaches third grade at the charter school. She is the only teacher that entered the profession as her first choice. Maddie has a rocky history with mathematics. She mentioned all four aspects of the coding categories during her interview: growth mindset, mathematical background, coping mechanisms, and positive experiences that shaped who she is today as a teacher.

Maddie's observation. Maddie's students came in from recess to see that she had set up a Kahoot activity, an online game to help the students prepare for the mathematics lesson. The students were asked to set up their computers and prepare for the game. The excitement level was very high. Before the children came in, Maddie mentioned that the students never complained about taking mathematics tests because they love practicing with Kahoot. During the practice, I noticed that the students could see that they got the answer wrong, but they never saw it solved correctly. There were a few problems that Maddie retaught during the game, but only when more than half the class got the concept wrong. My observation was more of a classroom management observation as opposed to watching her teach a mathematical concept. It was fun to see the new activity and the engagement of each student. I could see that Maddie enjoys teaching mathematics to her students.

Maddie's interview. Maddie struggled with mathematics in middle school and high school. She did well in elementary, and remembers being a fairly advanced child. In

middle school, she lost interest, and by high school her mindset shifted to thinking, "I'm bad at math." She claims that her bad experiences center around feeling like she could not understand what was being taught. She said:

Since I was really bad at math, like high school, I'm pretty sure I didn't learn anything after Geometry. I had to retake Algebra 2 like three times. Even then, I didn't finish the fourth quarter, and I had to just take some class I took in middle school just so I could graduate because I couldn't repeat. So I just had super ultimate low confidence in math because I couldn't even pass Algebra 2.

Maddie's "ultimate low confidence" in mathematics was almost the cause of her not graduating high school. Her mathematics anxiety was debilitating to the point that it was difficult to move forward successfully with her education. She would receive help from her father, but would just let him work the problems out. This coping mechanism wasn't working well for her. In college, Maddie expressed feeling like she was given a fresh start. She did fairly well with mathematics from that point forward.

Despite Maddie's mathematics anxiety, she has become a very successful teacher. She mentioned in her interview that she loves to try new ways of teaching concepts. She uses manipulatives and visual aides as often as possible. She is invested in teaching, and spends time making lessons that are enjoyable to the children. Her love for teaching helps her cope with her mathematics anxiety. She uses good teaching strategies to help her plan lessons that are engaging for her third grade students.

Maddie's educational background. Maddie is the only teacher in the study that went into teaching as her first choice career. She received her bachelor's of Elementary Education from Utah State University. She said, "When I was in elementary school, I

literally played school every day at my house.... I loved it!” With her difficult mathematical history, Maddie had to find coping mechanisms to help her succeed in college. She mentioned feeling like college was a fresh start for her. She said, “I did realize how important it is to fill holes before you try to move on.” After filling in the gaps in her learning, she was able to move forward with her mathematics classes.

Maddie’s journey map.

Maddie’s journey map depicts two versions of herself. The much younger version, her elementary self, seems happy and successful. The older version seems very uneasy about mathematics. She claimed being very insecure about her work because of her



Figure 4.6

lack of understanding. She said it was a very drastic change from, “being excited and showing off my work, and then being bashful and covering it up.” I found it interesting that she did not draw anything involving her current state of mind with mathematics as a fourth grade teacher.

Cross case analysis. There are several ways in which the participants are very similar and different. One similarity is that each individual in participation claimed that they are comfortable with their current teaching position in mathematics. While some of

the teachers claimed that they would have a hard time if their curriculum were switched, others seemed comfortable with any elementary level of mathematics.

From the data collection, it seems that four of the six teachers have struggled with anxiety in mathematics. All six have struggled with mathematics at some point in their history. The four teachers with histories of mathematics anxiety all avoided mathematics classes in their educational careers. Three of the four chose a profession that required little mathematics before they decided to switch to teaching. Maddie is the only teacher that chose teaching as her first degree, and she did that despite her struggle with mathematics. Two of the four teachers with mathematics anxiety received alternative licenses through the state of Utah. Because half of the teachers have alternative licenses and half have traditional licenses, there is no conclusive proof that individuals with either type of license have a higher likelihood of having mathematics anxiety. It is notable that the two individuals that did not suffer from mathematics anxiety both teach in the highest grade participating in the project, fifth grade. This aligns with the literature because teachers with higher levels of anxiety tend to teach in the lower grades because they feel more comfortable with the content.

Convergent results: Degree of anxiety when teaching and learning mathematics. With the qualitative and quantitative data in mind, I was able to identify three main categories of anxiety: high anxiety when teaching and learning mathematics, high anxiety when learning mathematics and low when teaching, and low anxiety when teaching and learning mathematics. These categories of anxiety are related to the four coding categories in varying aspects. Most often, teachers mentioned growth mindset when they were speaking of a time when mathematics was difficult for either themselves

or their students. Coping mechanisms were mentioned during the participants interview about past experiences where their anxiety was typically higher. Mathematical backgrounds varied greatly, and all related to times of low or high mathematics anxiety for all six participants. The participants talked about influential people and experiences in context of both high and low anxiety. Thus, in the subsequent section, participating teachers' degree of mathematics anxiety related to the categories found in the qualitative analysis will inform the mixed results.

Higher anxiety when teaching and learning mathematics. Maddie, Ashley, and Hannah indicated higher levels of anxiety while teaching and learning mathematics. Each participant portrayed their anxiety about teaching in different ways. Maddie claimed that she feels her content knowledge isn't as rich as she would like. She feels like continued learning is necessary to be the best mathematics teacher that she can be. Ashley and Hannah both indicated that mathematics is not their strongest subject, but that they are continually working to improve. Hannah has anxiety related to using manipulatives and would benefit greatly from continuing education. Ashley is engaging her students in practices that are linked to mathematics anxiety, and would benefit from continuing education as well.

Higher anxiety when learning mathematics and lower anxiety when teaching mathematics. Adam had an interesting dynamic between history with mathematics and his current teaching of mathematics. In the interview, Adam expressed high levels of anxiety to the point that he avoided mathematics classes as much as possible. When talking about his current teaching level, he seemed at ease with mathematics. This aligns with the literature because he has taught for 14 years. The literature review states that

years teaching can help to lower mathematics anxiety (Gresham, 2018). Adam's PMTE mean score on the MTEBI was high indicating that he feels confidence in his abilities to teach mathematics effectively.

Lower anxiety when teaching and learning mathematics. Two teachers particularly had lower anxiety when teaching and learning mathematics. Interestingly, the two teachers in fifth grade had the lowest level of anxiety. This aligns with the literature because often teachers with higher anxiety will choose to teach at lower grade levels because of their comfort level in that subject (Gresham, 2018). Eden and Ivan both expressed low levels of anxiety within their interviews, but Ivan clearly is the teacher with the lowest levels of anxiety based on the MTEBI. This is not surprising when finding out that Ivan's first career was mathematically driven. Eden had an overall positive mentality about mathematics, but seemed to use the curriculum and the school's direct instruction format as crutches for mathematics issues within her class. She also uses fully typed notes as a way of helping students get the big picture. These notes seem to be a handicap for some students as many of them were not paying attention during the lesson. Both teachers scored a high mean on the efficacy scale in the MTEBI.

As noted previously, the four coding categories are growth mindset, mathematical background and its effect on their perception of mathematics, coping mechanisms used to combat anxiety, and influential people or experiences that led them to teaching mathematics at the elementary level. These categories were helpful in determining the levels of anxiety that the participants held. The six participants engaged each coding category differently, which helped construct the groups for levels of anxiety. I found that participants who talked about having a fixed mindset with a difficult mathematical past

had higher anxiety when learning mathematics. They were also the participants that had some anxiety about teaching mathematics. Many of the participants that expressed coping mechanisms in their past also suffered from mathematics anxiety while they were learning and teaching. Adam was the teacher who did not express anxiety about teaching currently, even though he suffered from mathematics anxiety in the past. All participants talked about positive experiences or people that led them to the profession of teaching. It was interesting to note that every teacher had something positive triggering his or her choice of teaching elementary education.

Chapter 5: Discussion and Conclusion

With my focus on how elementary teachers' past experiences with mathematics relates to their current teaching practices and beliefs, it was clear through my study that mathematics anxiety can affect many teachers and their students. As I developed my project, I specifically focused on the following questions:

- (1) How do elementary teachers' past experiences and perceptions about mathematics relate to their pedagogical practices?
- (2) What are elementary teachers' beliefs that influence their mathematics pedagogy?

These questions helped me focus particularly on pedagogical practices and beliefs surrounding mathematics.

Teachers' past experiences and perceptions about mathematics relating to their pedagogical practices

All six participants in the project were from vastly different backgrounds in regards to their education and experience in mathematics. Ivan came from a background where he initially chose a career that was mathematically driven, while Maddie, Ashley, Hannah, and Adam avoided mathematics in high school and college. It appears that each participant's background still influences his or her practices today. The teachers who currently still have mathematics anxiety manifest their anxiety in their pedagogical practices. Hannah avoids manipulatives due to her uncomfortable background with them. Ashley sat at the front of the room by her notes for the entire lesson and provided detailed notes for all students. She also demonstrated only two examples to help the students during the mathematics lesson. Maddie seemed to be ultra aware of her weaknesses in mathematics. She discussed spending many hours planning engaging lessons in order to

help her teach the content. All three teachers with current mathematics anxiety seemed to have personal coping mechanisms that helped them feel comfortable when teaching mathematics.

As I started this project, I anticipated finding a correlation between teachers with an ARL or APT and high levels of mathematics anxiety. I found that having an alternative license to teach elementary education did not correlate with mathematics anxiety. In fact, both of the teachers that do not currently manifest mathematics anxiety, initially chose alternate career paths. The only teacher who initially chose a degree in elementary education, suffered from mathematics anxiety to the point that she almost did not graduate high school.

Participants noted that despite their backgrounds with mathematics anxiety, there were positive experiences and good teachers from their past that effected their choice to enter the teaching profession. These positive experiences with mathematics and past educators seemed to drive each participant to the profession. Hannah mentioned that she would not have felt comfortable teaching elementary school if she had not experienced some success with mathematics in her graduate program. Many of the participants expressed similar experiences. It appears that positive experiences and good teachers in the past influence educators' feelings of confidence and competence when teaching mathematics in elementary schools.

Teachers' beliefs around their mathematics pedagogy

With varying backgrounds in mathematics, it seems natural that each teacher holds different beliefs about their mathematics pedagogy. At the charter school, the teachers use an adopted curriculum, but the ways in which each teacher implements the

curriculum is unique and directly correlates to his or her beliefs about mathematics. For example, Maddie expressed several times in her interview that she is a concrete learner. She demonstrated this in my observation of her when she had the students use unique forms of technology to study for the test. She believes that mathematics should be more concrete, tangible, and fun. Often, she used this belief when planning and implementing lessons that used manipulatives or hands on learning. Eden expressed concern with the time restraints and curriculum guides when planning mathematics lessons. Her beliefs were apparent when she gave fully typed notes to each student, seemingly to compensate for the short amount of time to cover so much material during her mathematics class.

Interestingly, each teacher held various beliefs about the causes of mathematics anxiety. Hannah believes that the examples students have before them in their teachers and parents contribute the most to a students' mathematics anxiety. Eden believes that mathematics anxiety is caused by students feeling like they missed or misunderstood information. Ivan believed that anxiety could be caused by low self-esteem. Adam believes that low confidence or anxiety about mathematics is caused by, "poor experiences in school." Ashley believes that comparing one's self to others is the root cause of mathematics anxiety. Maddie believes that mathematics anxiety is caused by students feeling like they can not make mistakes. Each teacher believes that there are different causes of mathematics anxiety. Many of their responses directly reflect experiences they had as students of mathematics. Consequently, their responses indicate that their past experiences with mathematics influence their current beliefs in what causes mathematics anxiety.

Implications

From this project, it seems that many of the participants noted that anxiety surrounding mathematics needs to be supported. This implies that teacher education programs at the collegiate level need to be cognizant that all teachers come from varying backgrounds. There are varying levels of mathematics anxiety for each individual teacher as modeled with my sample of educators. Teacher education programs should provide education in mathematics with these backgrounds and pedagogical beliefs in mind. With thoughtful pre-service teacher curriculum, mathematics anxiety could be minimized before teachers enter the workforce.

As modeled by my unique sample of teachers, educators come from various educational backgrounds. Some of the teachers received an ARL or APT from the state of Utah. This indicates that they have not had specialized instruction on how to teach elementary mathematics. One teacher received her degree online, which also poses unique challenges in educating teachers. Only two of the six educators, Maddie and Adam, received their elementary education teaching license in the traditional way with teachers present in the classroom for their pre-service educational experience. With only 33% of the teachers in my project receiving traditional, pre-service instruction on how to teach mathematics, it seems that the focus of teacher education needs to be on in-service teachers. Districts and principals could combat teacher mathematics anxiety by providing quality teacher training to their elementary educators. With yearly in-service training in mathematics, teachers could potentially minimize mathematics anxiety manifesting in their instruction.

Every case study helped to provide an overall view of how mathematics anxiety can effect the lives of teachers, but Adam's results provide hope to educators with

mathematics anxiety. Throughout his entire educational career, he avoided mathematics as much as possible. Now, with fourteen years of teaching and two masters degrees under his belt, he feels confident and competent to teach mathematics effectively. His results provide an actual example of someone successfully overcoming mathematics anxiety. I believe that his experience can be helpful for universities and schools seeking answers as to what needs to be done to help teachers overcome mathematics anxiety. Providing teachers with educational opportunities in mathematics is the first step to overcoming this prevalent problem within our schools. I don't believe that every teacher needs to receive a masters degree, but that simple classes before or during the school year can help provide teachers with the necessary knowledge to teach mathematics effectively.

All of the participants hold beliefs about mathematics that influence their pedagogical practices. One positive belief that all participants mentioned was the idea of growth mindset. It was apparent through observations and interviews that the participants manifest growth mindset about mathematics at varying times. The charter school is focusing on implementing positive mindset throughout the school, and it is translating into how the teachers think and speak about mathematics. It is interesting the school's focus on growth mindset was discussed in all six interviews. The school should provide training in mathematics, and perhaps the educators would implement those ideas in a like manner to the growth mindset training.

Limitations

This creative project took place at a local charter school in rural Utah. There were only six teachers participating in the study in grades three through five, two from each grade level. Of the teachers in participation, only three have traditional teaching degrees.

The other three teachers have bachelor's and master's degrees in other areas and received their ARL (Alternative Route to Licensure) or APT (Academic Pathway to Teaching). Only one of the six teachers has taught at a school other than the charter school. At this school, parents choose to bring their children which results in more parental involvement within the school. I believe the sample of teachers, and possibly the students, are atypical of most schools because of their diverse backgrounds. Even though the sample size is limited, much can be gleaned from this case study.

Conclusion

All participants struggled with mathematics at some point in their lives. I was able to see that some participants dealt with their struggle in mathematics constructively while others developed mathematical anxiety. From the study it seems that a high percentage of the participants are currently functioning constructively with mathematics despite their history of struggling in the subject. Many attributed their current success to aspects of their past that were positive, often a great teacher or positive encounter with mathematics.

I was able to see that half of the teachers in the project still hold visible levels of mathematics anxiety, but the anxiety is typically tied to a particular branch of mathematics instead of all aspects of the subject. Four of the teachers delineated experiences in their past that caused great anxiety for them in mathematics. Only one of the teachers seemed to have a past with little to no mathematical anxiety. This denotes that most teachers have low to high levels of anxiety tied to mathematics. Pre-service and in-service teacher education may benefit by being cognizant of these statistics, and planning classes and trainings for educators to become more comfortable with mathematics.

As evidenced by the lived experiences of the educators I interviewed, years of teaching experience and time can dim the ill-effects of mathematics anxiety. However, pre-service education, in-service education, and teacher attitude can be helpful in breaking the mathematics cycle of anxiety. The ultimate goal in breaking the mathematics anxiety cycle should focus on changing teacher's core beliefs and thereby improving pedagogical practices. Achieving this goal will build confidence in the next generation of mathematics students and break the deleterious cycle of mathematics anxiety.

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APPENDICES

APPENDIX A

Mathematics Teaching Efficacy Beliefs Inventory (MTEBI)

SA=Strongly Agree A=Agree UN= Uncertain D=Disagree SD= Strongly Disagree

1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2. I will continually find better ways to teach mathematics.
3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
5. I know how to teach mathematics concepts effectively.
6. I will not be very effective in monitoring mathematics activities.
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
8. I will generally teach mathematics ineffectively.
9. The inadequacy of a student's mathematics background can be overcome by good teaching.
10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
11. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.

12. The teacher is generally responsible for the achievement of students in mathematics.
13. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.
14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
15. I will find it difficult to use manipulatives to explain to students why mathematics works.
16. I will typically be able to answer students' questions.
17. I wonder if I will have the necessary skills to teach mathematics.
18. Given a choice, I will not invite the principal to evaluate my mathematics teaching.
19. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.
20. When teaching mathematics, I will usually welcome student questions.
21. I do not know what to do to turn students on to mathematics.

APPENDIX B

Interview Questions

1. One of my best mathematics experiences as a student was.....
2. One of my most challenging experiences as a mathematics students was...
3. For me, teaching mathematics is....
4. One of the most important qualities that a mathematics teacher should possess is...
5. When I am planning my weekly mathematics lessons and I come to a content area that I love I...
6. When I am planning my weekly mathematics lessons and I come to a content area that I am unsure about I....
7. If my students do not understand a mathematical concept that I am teaching....
8. A time when I feel unsure about teaching mathematics is when...
9. I think anxiety and or low confidence in mathematics is caused by....