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Case Study: Changes in Elementary Student Mindset After Mathematics Anxiety and Growth Mindset Teacher Training

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Concordia University–Portland
College of Education
Doctorate of Education Program

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Case Study: Changes in Elementary Student Mindset After Mathematics Anxiety
and Growth Mindset Teacher Training

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College of Education

Dissertation submitted to the Faculty of the College of Education in partial fulfillment of the
requirements for the degree of Doctor of Education in Teacher Leadership

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Abstract

The purpose of this qualitative case study was to explore how professional development on the topics of mathematics anxiety and incremental theories of intelligence affect the planning and instruction of mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers. This study was conducted at a suburban elementary school in the northeast region of the United States over a six-week period using a sample size of six teachers in grades three through five. Data was collected via interviews and observations, and then coded using the grounded theory of constant comparison, resulting in five major themes: embracing mistakes, shifting mindset, developing grit, developing a growth mindset, and preparing for mathematics mentally. The data was triangulated to ensure creditability in the results, which found that the study supports current research on growth mindset and mathematics anxiety. Participants noticed an increase in student motivation and confidence after growth mindset interventions were implemented. The results indicate that teachers should consider utilizing growth mindset interventions in their classrooms to help their students develop a positive mindset, thus reducing anxious feelings in the mathematics classroom. Future research should include a study of students and teachers in kindergarten through second grade to compare the number of students in kindergarten with mathematics anxiety to the number of students with mathematics anxiety in second grade. This may provide insight into when mathematics anxiety begins in elementary age students.

Keywords: implicit theories of intelligence, incremental theory of intelligence, entity theory of intelligence, growth mindset, fixed mindset, mathematics anxiety

Dedication

This dissertation is dedicated to my amazing children, as a reminder that you can achieve anything if you put your mind to it.

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First and foremost, I would like to thank my amazing husband Wayne, who knew what I could accomplish long before I did. Wayne – without you I would not be half the person I am today. You are my rock, my shoulder to cry on, my kick in the pants, and my biggest cheerleader. This could never have been accomplished without your unwavering support. We earned this together! Second, I would like to thank my four children: Billy, Jack, Amy, and Ben. You have sacrificed your time so that I could work, pitched in when needed, provided encouragement, and kept me laughing along the way. Jack—I’m done! I would also like to thank my mom, who dropped dinners off when I was under a time crunch and entertained the kids when I needed some quiet time. Dad – thank you for instilling a strong work ethic in me from an early age. You always told me if I was going to do something, do it right. To my siblings Debbie, Joe, and Mary – thank you for all of the support and encouraging words that got me through this process.

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Chapter 1: Introduction

An obstacle to student learning in mathematics is mathematics anxiety. While a great deal of research has been done on this topic in teens and adults, little research has been done on mathematics anxiety in the elementary grades (Ramirez, Gunderson, Levine, & Beilock, 2013). The goal of this research is to explore how professional development on the topics of incremental theories of intelligence and mathematics anxiety affect the planning and instruction in mathematics by classroom teachers, as well as changes in student mindset as perceived by teachers. The study was conducted at a suburban elementary school in the northeast region of the United States. As a result of this study, educators may change the way they approach math, considering student mindsets and levels of anxiety before delivering mathematics instruction.

Students may begin suffering from mathematics anxiety as early as elementary school (Jameson, 2014). The long-term effects of mathematics anxiety may include mathematics avoidance and a reluctance to attend college or pursue mathematics related careers (Jameson, 2014). In fact, upwards of 80% of students enrolled in community colleges suffer from mathematics anxiety (Adelson, 2014). While research has been done to address mathematics anxiety issues from middle school age and up, recent research is finding that mathematics anxiety can begin as early as first grade; therefore, it is necessary that educators begin to address this issue earlier to avoid the long-term effects of mathematics anxiety (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). If teachers are able to identify students with mathematics anxiety at a young age and provide them with proper intervention, they may be able to negate the effects of mathematics anxiety (Ramirez, Gunderson, Levine, & Beilock, 2013).

Mathematics skills intervention is not the most productive approach for college age students with mathematics anxiety (Lyons & Beilock, 2012a). Teaching students to monitor and

regulate their emotions, otherwise known as cognitive reappraisal, when approaching mathematics problems has been shown to be more effective for students with mathematics anxiety. In fact, helping students learn to control their negative emotions in mathematics may result in success for students who otherwise would have continued to struggle mathematically (Lyons & Beilock, 2012a). This approach would require teachers to consider more than just the procedural aspects of math; they must be aware of the students' emotions towards the subject as well (Ramirez, Gunderson, Levine, & Beilock, 2013).

Neuroscientists support the idea of cognitive reappraisals in mathematics (Lyons & Beilock, 2012a). Neural activity in the brain has shown a negative relationship between mathematics anxiety and mathematics competence with anxiety appearing as the student approached the mathematics problem (Lyons & Beilock, 2012b). Portions of the brain that are linked to processing fear showed an increase in activity when students approached mathematics problems (Young, Wu, & Menon, 2012). Helping students formulate strategies to control their negative emotions towards mathematics may improve their mathematics skills particularly in students with high mathematics anxiety (Maloney & Beilock, 2012).

What a person believes about their intelligence, known as an implicit theory of intelligence, can have a significant effect on their learning (Rattan, Good, & Dweck, 2012). Implicit theories of intelligence are divided into two sub-theories: an entity theory of intelligence and an incremental theory of intelligence (Boaler, 2013). Students who hold an entity theory of intelligence, otherwise known as a fixed mindset, believe that their level of intelligence will not change regardless of the amount of effort they put forth (Boaler, 2013). Students who adopt an incremental theory of intelligence, also referred to as a growth mindset, believe that their intelligence is malleable and can change with increased practice and effort (Boaler, 2013).

Students are more likely to develop a fixed mindset in mathematics compared to other subjects because often people think they are either a mathematics person, or they are not a mathematics person (Boaler, 2013). By developing an incremental theory of intelligence, or growth mindset, teachers can help students change that perspective giving them more opportunities to grow mathematically.

When students suffer from mathematics anxiety in the early elementary years they can develop a negative attitude towards math, avoidance behaviors, and a decrease in motivation (Ramirez, Gunderson, Levine, & Beilock, 2013). Having an incremental theory of intelligence helps students to develop learning goals that can help motivate students to put more effort into their work and attribute success to their increased effort (Aditomo, 2015). Conversely, entity theorists struggle with academic emotions such as boredom and anxiety and engage in avoidance behaviors when approaching challenging subjects (Dweck & Leggett, 1988).

Incremental theorists view challenges as learning experiences and utilize constructive coping skills to work through challenges (Shih, 2011). Incremental theorists tend to have positive emotions towards academics and feel as though they have more control over their learning (King, McInerney, & Watkins, 2012). Students' mindsets can be changed and an incremental theory of intelligence can be explicitly taught to students helping them to foster a more positive approach to learning (Yeager & Dweck, 2012). Yeager and Dweck (2012) recommend looking for unproductive mindsets in students and providing age appropriate interventions to encourage a growth mindset.

It has not yet been determined what impact implicit theories of intelligence have on mathematics anxiety (Vukovic, Kieffer, Bailey, & Harari, 2013). More studies need to be conducted to determine the role instruction plays in reducing a child's mathematics anxiety

(Vukovic et al., 2013). Cognitive reappraisal, a strategy used to change negative thoughts into positive thoughts, may be an effective intervention to reduce mathematics anxiety, however further research needs to be done to prove this theory (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). By utilizing performance data to further investigate the relationship between mathematics performance and mathematics anxiety in elementary students, researchers can add to the existing research to show the relationship between mathematics anxiety and mathematics performance in adolescents and adults (Jameson, 2014).

Statement of the Problem

Mathematics anxiety and its impact on learning has been studied in adults and adolescents, however little research has been done to determine how mathematics anxiety affects elementary students, or the impact it has on their learning basic mathematics skills required to progress to more advanced strategies (Jameson, 2014). Mathematics anxiety has long-term negative effects on students, including an avoidance of mathematics classes and careers that involve math (Hembree, 1990; Beilock & Maloney, 2015). Strategies other than mathematical skills interventions need to be discovered to alleviate mathematics anxiety in the classroom, which will benefit students in the long run.

Purpose of the Study

The purpose of this research was to explore how professional development on the topics of mathematics anxiety and incremental theories of intelligence affect the planning and instruction of mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers. As part of the study, the participants attended a professional development session during which they received information and resources to identify

mathematics anxiety and mindset in their classrooms. Participants also learned strategies to transition students from a fixed mindset to a growth mindset.

The study results are expected to provide educators with insight into how shifting student mindsets can impact best teaching practices in mathematics and student achievement. By utilizing strategies, such as developing a growth mindset, educators could potentially adjust their approach to teaching mathematics by considering student mindsets and levels of anxiety before delivering mathematics instruction. Mathematics anxiety impedes student learning and if educators can help students change their mindset, they may notice a decrease in mathematics anxiety. By participating in this study, teachers may provide long-term benefits to students by helping them gain confidence in a subject they may otherwise avoid in the future.

Research Question

The research questions for this study are as follows:

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher's ability to address issues of mathematics anxiety in the classroom?

RQ2: How does adjusting teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student's grit as perceived by the teacher?

Significance of the Study

In 2016, the percentage of students who took the ACT and met the college and career readiness benchmark in math was only 41% (ACT, 2016). Mathematics performance and mathematics anxiety are issues that must be addressed in order for students to be prepared to

compete in a global society. Through this study, the researcher explored how professional development on the topics of mathematics anxiety and growth mindset affects the planning and instruction of mathematics, as well as student mindset and grit as perceived by the teacher. Through this study participants engaged in a discussion about of how altering ways of thinking about mathematics can improve mathematics ability.

By understanding the role mindset plays in reducing a child's mathematics anxiety, teachers can have a significant impact on student success in mathematics, unlocking a future that may otherwise have remained untapped due to a lack of ability in dealing with issues of anxiety in mathematics. Developing an understanding of whether or not mathematics anxiety and mathematics performance are related in the elementary school years could potentially change the way educators teach mathematics, putting students' emotions at the forefront, along with mathematics skills and procedures (Ramirez, Gunderson, Levine, & Beilock, 2013).

Definitions of Terms

Implicit theory of intelligence: what a person believes about their intelligence (Rattan, Good, & Dweck, 2012).

Incremental theory of intelligence: the belief that a person's level of intelligence is malleable and can be changed with an increase in practice and effort (Boaler, 2013).

Entity theory of intelligence: the belief that a person's level of intelligence is fixed, and will not change regardless of effort (Boaler, 2013).

Mathematics anxiety: having fear or feelings of apprehension about performing mathematics (Lyons & Beilock, 2012a).

Cognitive reappraisal: an emotion regulation strategy used to change the interpretation of a stimulus (Ramirez, Chang, Maloney, Levine, & Beilock, 2016).

Working memory: the part of the brain that is necessary to perform complex tasks such as reasoning, comprehension, and learning (Baddeley, 2010).

Self-concept: how a person perceives himself or herself in mathematics (Jameson, 2014).

Self-efficacy: a person's belief in their ability to succeed in a given situation (Bandura, 2012).

Research Design

This study was designed as a single exploratory case study. The purpose of this research was to explore how professional development on the topics of mathematics anxiety and incremental theories of intelligence affect the planning and instruction of mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers. A quantitative design was considered for the research, however, quantitative design methods require delving into measurable statistics and this study focuses on the thoughts and beliefs of the participants, which cannot be quantitatively measured. A mixed methods approach was considered but it was determined that the quantitative measures included in a mixed-method study would detract from the overall research questions, which require in-depth discussions with the participants to understand the thought processes behind their teaching methods.

The single exploratory case study was conducted in a newly established elementary school located in a suburban neighborhood in the northeast region of the United States. The elementary school had a population of 448 students, 18 classroom teachers, two administrators, and one lead teacher. Each classroom teacher had approximately 25 students in their class. Prior to the professional development session, the researcher met with each participant to conduct a semi-structured interview on the topics of mathematics anxiety and growth mindset. A semi-structured interview was used to determine how teachers plan their mathematics instruction and

whether or not they already considered mathematics anxiety a factor in inhibiting academic growth.

The professional development session on growth mindset consisted of a one-hour face-to-face dialogue during which participants received resources and strategies to identify mindset and mathematics anxiety in students, as well as strategies to develop a growth mindset in students. Additionally, the participants had the opportunity to participate in a growth mindset survey to determine their own mindsets.

Four weeks after the professional development session the researcher requested the opportunity to informally observe participants during their mathematics instructional sessions. This observation was solely designed to explore how growth mindset strategies were being utilized in the classroom. Upon completion of the observation, participants were invited to participate in a semi-structured interview designed to determine the effectiveness of the professional development on their planning and instruction, as well as understand the teachers' perceptions of its impact on students with mathematics anxiety.

The intent of the study was to provide a clear picture of how professional development on the topics of mathematics anxiety and growth mindset affects the planning and instruction of mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers at one elementary school. This was done by combining multiple data points to allow for triangulation of the data, validating the data through a variety of observations and interviews (Esteves & Pastor, 2004). The classroom observations included a checklist of targeted behaviors for developing an incremental theory of intelligence and allowed for anecdotal notes to provide deeper analysis of the study.

Assumptions, Limitations, and Delimitations of the Study

Within this study there were assumptions, limitations, and delimitations that needed to be considered. An assumption is something that cannot be proven, and in this study it was assumed that teachers would be truthful in their interviews (Seal, 1999). It was also assumed that the responses given were relevant to the research questions. A limitation of the study included the fact that only 10 teachers within the school meet the criteria for the study, resulting in a small sample size (Yin, 2012). Delimitations, or the boundaries of the study, included the selected school in a specified location and the sample size, which was limited to only teachers of mathematics in grades two through five (Ellis & Levy, 2009).

Summary

Mathematics anxiety in elementary students is an area that requires further research so that teachers may prevent students from exhibiting behaviors such as fear, anxiety, or avoidance when faced with mathematics challenges. It is no wonder that students with mathematics anxiety attempt to avoid situations involving mathematics given that simply anticipating a mathematics event activates a part of the brain that is linked to processing pain (Lyons & Beilock, 2012b). The goal of this research is to help teachers cultivate cognitive reappraisals in their students by developing an incremental theory of intelligence and transitioning their negative thoughts about mathematics to positive thoughts. By implementing an incremental theory of intelligence, or growth mindset, in students with mathematics anxiety, students may potentially have overcome their anxiety viewing mistakes in mathematics as learning experiences and not as failures (Lyons & Beilock, 2012a).

The theories supporting this research, including attentional control theory and implicit theories of intelligence, are outlined in the following chapter. Both the entity theory of

intelligence and the incremental theory of intelligence are explained in detail as part of the conceptual framework in Chapter 2 to provide background information that supports this study. In order to fully understand the basis of mathematics anxiety, the environmental factors associated with mathematics anxiety, as well as the impact mathematics anxiety has on student emotions are explained. A student's negative emotions towards mathematics can be improved by developing a growth mindset, and this topic is reviewed as well. Covered in Chapter 1 was an introduction to the study, the statement of the problem, and purpose of the study. Also covered were the significance of the study, definitions of key terms, and the assumptions, limitation, and delimitations considered in the study. A thorough review of the literature on implicit theories of intelligence, mathematics anxiety, professional development, and case studies are also included in Chapter 2.

Chapter 2: Literature Review

One of the goals students are expected to achieve upon graduation from high school in the United States is to be college and career ready (Conley, 2012). A student is considered college and career ready if they are prepared to take credit-bearing courses that lead to either a baccalaureate, certificate, or a career-training program without remediation or additional preparatory coursework (Conley, 2012). In order for students to be college and career ready, instructional leaders need to focus on four key areas: cognitive strategies, content knowledge, learning skills and techniques, and transition knowledge and skills (Conley, 2012). Although teachers are aware of the expectations of students, in 2016, only 41% of students who took the ACT met the benchmark for college and career readiness in mathematics (ACT, 2016). The question is what is happening in classrooms and how can educators help students achieve high standards to be college and career ready upon graduation? For some students, there are obstacles that get in the way of being able to master these key math learning skills and techniques, including mathematics anxiety (Adelson, 2014).

Statistics show that of students who pursue higher education, 25% who attend four-year colleges and 80% who attend community colleges suffer from mathematics anxiety (Adelson, 2014). Mathematics anxiety can have long-term effects on students, including mathematics avoidance, which can result in students avoiding college majors and career paths that involve mathematics (Hembree, 1990, as cited in Vukovic, Kieffer, Bailey, & Harari, 2013).

Mathematics anxiety in adolescents and adults and its impact on their learning has been studied but little research has been done to determine how mathematics anxiety affects elementary students or the impact on their learning basic mathematics skills required to progress to more advanced strategies (Jameson, 2014).

Mathematics anxiety is defined as having a fear or feelings of apprehension about performing mathematics (Lyons & Beilock, 2012a). These feelings of apprehension are linked to a delay in acquiring core mathematics and number concepts, which results in lower mathematics competence in students (Lyons & Beilock, 2012a). High levels of mathematics anxiety in second grade students predicted lower gains in their applications of mathematics strategies (Vukovic, Kieffer, Bailey, & Harari, 2013).

Included in the literature review is an overview of research related to implicit theories of intelligence, mathematics anxiety, professional development, and case studies. The major search engines utilized in this research included the Concordia University online library, ERIC, and Google Scholar. The majority of the articles referenced in this study are from peer-reviewed journals published within the past eight years; however, some seminal research prior to 2009 was utilized to establish a stronger foundation of research. In the initial phases of research, broad search terms were utilized such as *growth mindset* and *mathematics anxiety*. As the research progressed, more specific terms were required to establish a more solid basis of literature. Search terms included, but were not limited to: *mathematics achievement, cognitive development, academic emotions, elementary students, demotivation in mathematics, entity theory of intelligence, incremental theory of intelligence, implicit theories of intelligence, heterogeneous grouping, homogeneous grouping, professional development, case study methodology, mathematics avoidance, cognitive neuroscience, and mathematical ability*. In the search, over 60 items were related to the research topic, however, during the process of reviewing the literature, approximately 30 articles were discarded due to irrelevance in regards to the topic. Throughout the research process, more articles were included in the research in order to develop the topic further.

Conceptual Framework

The conceptual framework for this study is based on attention control theory and implicit theories of intelligence. Attention control theory refers to the impact negative emotions have on motivation and learning, linking mathematics anxiety to learning. Implicit theories of intelligence refer to what a person believes about their intelligence. How individuals feel about their intelligence can impact their learning, however these beliefs can be changed with strategic interventions.

Attention Control Theory

Anxiety causes negative emotions and impacts motivation in a threatening situation (Eysenck, Derakshan, Santos, & Calvo, 2007). The act of worrying interferes with the use of space in a person's working memory and therefore affects the learning process (Eysenck et al., 2007). Instead of utilizing working memory to process learning, space is being taken up by anxious thoughts, which prevents learning from occurring (Eysenck et al., 2007). This can be overcome by providing auxiliary processing resources (Eysenck et al., 2007). If students have access to resources to help them cope with anxiety, their performance may not be hindered, whereas a lack of auxiliary resources will result in reduced performance (Eysenck et al., 2007). Having anxiety impairs efficiency, decreases the amount of available central executive capacity, and reduces performance on tasks (Eysenck et al., 2007). This is particularly true when the mathematics task is perceived by the student to be threatening (Eysenck et al., 2007).

Implicit Theories of Intelligence

The conceptual framework of this study is centered on implicit theories of intelligence, which refers to the belief an individual has about their intelligence and whether or not they perceive their intelligence as fixed or malleable (Rattan, Good, & Dweck, 2012). How one

thinks about their intelligence can significantly impact their ability to learn in the classroom. There is a positive relationship between perseverance and the belief that intelligence is malleable when working on tasks that involve active thinking skills (Burke & Williams, 2012). The opposite is true, however, for those who believe intelligence is fixed. Students who believe their intelligence is fixed tend to lack the motivation that is required to persevere through difficult tasks and give up easily (Burke & Williams, 2012). How a student feels about their abilities can affect many aspects of their learning.

There are two implicit theories of intelligence: the entity theory of intelligence and the incremental theory of intelligence. People who hold an entity theory of intelligence believe that their intelligence is fixed and demonstrate their ability through performance goals such as academic grades (Dweck, Chiu, & Hong, 1995). These individuals adopt learning goals and believe that their intelligence improves with practice and effort, resulting in the confidence necessary to establish goals and work towards them (Dweck, Chiu, & Hong, 1995; Aditomo, 2015). When a person feels limited in their ability (fixed mindset), they are less likely to try and succeed (Aditomo, 2015). These students are afraid of making mistakes and fear failure; therefore, they attempt to avoid situations that could result in failure (Blackwell, Trzesniewski, & Dweck, 2007).

It is important to recognize that not all students have the same academic intelligence. Individuals with an incremental theory of intelligence assert that their intelligence is malleable (Aditomo, 2015) and that their intellectual ability can be further developed (Blackwell, Trzesniewski, & Dweck, 2007). Students who adopt an incremental theory of intelligence are more likely to see challenging problems as a learning experience and grow from them (Cury, Da Fonseca, Zahn, & Elliot, 2008, Liu, Chiu, Chen, & Lin, 2014).

A student's self-efficacy can have a significant impact on their learning style. As such, when teachers help students establish an incremental theory of intelligence at an early age, they can put students on the right path towards ownership of learning and academic growth. When individuals develop a growth mindset, this can result in the ability to persevere through challenging situations, as well as to work towards long-term goals (Hochanadel & Finamore, 2015). These are key learning skills that lead to college and career readiness (Conley, 2012).

Environmental Factors

When considering the students' attitudes towards learning, one must also look at the students' environments. Parents play a key role in developing a student's mindset (Rautiainen, Rätty, & Kasanen, 2016). Rautiainen, Rätty, and Kasanen (2016) designed a study in which they utilized questionnaires to determine the parents' implicit theory of intelligence and its relation to their child's academic proficiency. To measure the child's academic proficiency, teachers completed a ratings scale, which the researchers statistically analyzed. The results indicated that the child's performance was related to the parent's theory of intelligence. If the parent demonstrated an entity theory of intelligence, the child was more likely to perform poorly in school. The parents of high achieving students are more likely to adopt the entity theory of intelligence, believing that their child has gifted academic abilities, whereas parents of struggling students are more likely to adopt an incremental theory of intelligence, believing that their child has the ability to grow and succeed (Rautiainen et al., 2016).

The classroom environment is integral in establishing an incremental theory of intelligence in students. By homogeneously grouping students, teachers can have a negative impact on both struggling and advanced students due to either low or high expectations for achievement (Boaler, 2013). A high percentage of college students who took remedial

mathematics courses did not make it through the class, believing that they were not “math” people (Yeager & Dweck, 2012). When placing students in classes, educators must consider the messages they send to students. Teachers must be reflective in their practices, being cautious not to console students with low mathematics ability, which can actually impede student success in mathematics (Rattan, Good, & Dweck, 2012). Students who encounter environmental causes involving a negative experience in mathematics may end up with mathematics anxiety, which can lead to mathematics avoidance (Aarnos & Perkkilä, 2012).

When teachers heterogeneously group students and utilize an incremental theory of intelligence, the result may be a class of students who are willing to take risks and persevere through challenging problems (Allen & Schnell, 2016). Teachers must be careful, however, in their teaching methods in a mixed-ability classroom. Even though students may be heterogeneously grouped, teaching with a fixed mindset will hinder the success of the students (Burke & Williams, 2012).

Student Emotions

Intelligence can impact a student’s academic emotions. In a study of eighth grade students in Taiwan, students who fostered an incremental theory of intelligence demonstrated positive affect and better coping strategies when faced with challenging problems versus those students who held the entity theory (Shih, 2011). The students who adopted the entity theory had a negative affect and utilized avoidance strategies when faced with a challenge (Shih, 2011).

In another study of 1,147 students in secondary schools in the Philippines, King, McInerney, and Watkins (2012) investigated the relationship between implicit theories of intelligence and academic emotions utilizing a questionnaire and rating scale to determine levels of correlation between the two topics. Using statistical analysis, King et al. (2012) showed that

what students think about their intelligence is related to their feelings in school; more specifically, that having an entity theory of intelligence was a predictor of negative emotions such as anxiety, shame, boredom, and hopelessness towards academics. Individuals who possess an incremental theory of intelligence believe they have more control over their learning; therefore, their emotions regarding challenging problems are positive (King et al., 2012).

The research on implicit theories of intelligence and its impact on student emotion is limited to specific cultures and age groups. Further research suggests extending the studies to include different age groups, as well as cultures other than Taiwanese and Filipino (Shih, 2011; King, McInerney, & Watkins, 2012). Other methods should be considered as well, including interviews and both parent and teacher ratings (Shih, 2011).

Mathematics Anxiety

Students with academic anxiety have feelings of imminent danger in school related to the environment, which includes both teachers and academic subjects (Kohli & Gupta, 2013). Potential causes of academic anxiety include high expectations from parents as well as low self-esteem (Kohli & Gupta, 2013). To determine whether or not gender plays a role in academic anxiety, Kohli & Gupta (2013) conducted a study of 200 students between the ages of 13 and 16 years old and found that there is no difference in the level of anxiety between males and females. Although gender does not appear to play a role in academic anxiety, Kohli, Malik, and Mamta (2013) determined that the area a student lives in does impact levels of academic anxiety. Kohli, Malike, and Mamta (2013) conducted a study of 100 students between the ages of 14 and 16 years old, comparing levels of anxiety between students in urban and rural areas in India. The results indicated that students in urban areas demonstrate higher levels of academic anxiety than

rural students. This study further supported the notion that there is no statistical difference in levels of anxiety between urban males and females (Kohli, Malik, & Mamta, 2013).

Although the research on anxiety in elementary mathematics students is limited, studies show a link between mathematics anxiety and student performance (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). Ramirez, Chang, Maloney, Levine, and Beilock (2016) found that an increase in mathematics anxiety was negatively linked to the utilization of advanced mathematics strategies. Second grade students with higher levels of math anxiety have lower levels of performance of mathematical applications (Vukovic, Kieffer, Bailey, & Harari, 2013). Therefore, for some students, mathematics anxiety becomes an obstacle to learning (Vukovic et al., 2013). When students suffer from feelings of anxiety, their approach to solving mathematical problems will change. These feelings of anxiety can be reduced if students have control resources available to them such as learning to shift their mindset (Lyons & Beilock, 2012a). Kohli and Gupta (2013) argue that academic anxiety in moderation may help to motivate students to succeed; however, too much anxiety can have long-term consequences for the student that can include avoidance of a particular academic subject.

Teachers can help students realize their potential in mathematics by scaffolding support while utilizing advanced problem-solving strategies (Dweck, Chiu, & Hong, 1995). One obstacle to helping students realize their potential in mathematics lies in mathematics anxiety, which can begin as early as first and second grade (Ramirez, Chang, Maloney, Levine, & Beilock, 2013). Two potential causes of mathematics anxiety include dyscalculia and generational discomfort. Dyscalculia is the inability to recognize differences in the value of numbers or numbered sets (Devine, Hill, Carey, & Szucs, 2017).

When students suffer from dyscalculia, the inability to quickly solve basic mathematical problems causes stress for the student, which can result in anxiety (Devine et al., 2017).

Students with generational discomfort learn anxious feelings about math from their parents and teachers, which can result in mathematics anxiety (Maloney & Beilock, 2012). The purpose of this case study is to understand from the teachers' perspective how teaching practices along with student engagement, growth mindset, and development in mathematics differ after teachers engage in professional development on the topics of mathematics anxiety and growth mindset. Investigated for this study are the changes teachers notice in their teaching practices as well as their ability to address issues of mathematics anxiety in the classroom.

Review of Research Literature and Methodological Literature

Implicit Theories of Intelligence

What a student believes about their intelligence impacts whether or not they will approach or avoid challenging problems (Dweck, 1999, as cited in Liu, Chiu, Chen, & Lin, 2014). In their early research, Dweck and Leggett (1988) found that students tend to associate with one of two patterns of learning: a helpless pattern or a mastery-oriented pattern. Students with an entity theory of intelligence adopt the helpless pattern, tend to avoid challenging tasks, and withdraw when presented with obstacles (Dweck & Leggett, 1988). Individuals having an incremental theory of intelligence are those who adopt the mastery-oriented approach, value challenging situations, and utilize various strategies to work through failure instead of giving up (Dweck & Leggett, 1988). Dweck and Leggett (1988) conducted research that is utilized as a foundation for future research on implicit theories of intelligence and its impact on student learning.

Implicit Theories and Motivation

Why mindset plays an important role in interpreting an individual's emotions towards learning is explained using the theory of implicit theories of intelligence. When positive academic mindsets are developed they are shown to improve grades and increase student motivation (Rattan, Savani, Chugh, & Dweck, 2015). Individuals having an entity theory of intelligence have a tendency to utilize avoidance strategies when faced with challenging situations and have a negative self-concept based on academic ability (Shih, 2011). These students are more likely to exhibit feelings of anger, shame, boredom, anxiety, and helplessness (King, McInerney, & Watkins, 2012) and are also likely to adopt self-handicapping strategies to avoid the risk of failure (Shih, 2011). In fact, when faced with failure, individuals having an entity theory of intelligence have shown signs of anxiety, boredom, and defiance, deflecting from what they believe is an inability to be successful in a given situation (Dweck & Leggett, 1988). While individuals having an entity theory of intelligence struggle emotionally when faced with a challenge, individuals having an incremental theory of intelligence demonstrate a positive effect and the ability to implement coping strategies (Shih, 2011). The ability to see learning experiences as an opportunity for growth can reduce negative emotions when presented with a challenging task (King et al., 2012).

A student's motivation and ability to develop challenge-confronting situations can be impacted by what the student thinks about their ability in mathematics. By helping students to adopt an incremental theory of intelligence, educators can help them become more motivated to learn and to apply more effort in their work. Students are also likely to adopt learning goals that help motivate them to persevere through their tasks (Aditomo, 2015). This can be more challenging for students who suffer from anxiety issues, such as gelotophobia, which is a fear of

being laughed at (Liu, Chiu, Chen, & Lin, 2014). A recent study found that for students with low gelotophobia, an incremental theory of intelligence helped them to face challenge-confronting situations (Liu et al., 2014). This supports the notion that developing an incremental theory of intelligence can have a positive impact on students with anxiety-related issues in the classroom.

The Teacher's Role

Teachers are an integral part of creating positive mindsets in the classroom. It is beneficial for teachers to reflect on their personal mindset as this can affect not only the way they teach but also the way their students interpret feedback. Rattan, Good, and Dweck (2011) utilized surveys to conduct three studies of undergraduate students and one study of graduate students. The studies sought to measure how theories of mathematics intelligence impact a teacher's perception of a student's mathematics ability. Rattan et al. (2011) incorporated quantitative analysis and determined that teachers with a fixed mindset are more likely to label a student as having low mathematics ability after just one assessment. Often classroom teachers attempt to build confidence in students through comforting statements and praise. Educators must be aware, however, that comforting statements can have a negative effect on struggling students (Rattan et al., 2012). Struggling students may already view themselves as having low ability and by giving feedback in the form of comfort statements, teachers may actually be sending the message that they do not expect more from that student (Rattan et al., 2012).

Results of a study by Rattan, Good, and Dweck, (2012) indicate that students receiving comfort statements as reassurance for low ability were shown to have negative outcomes that included lower expectations for themselves. In contrast, praising students for being smart may also have a negative effect. Boaler (2013) referred to this as fixed mindset praise and pointed out

that students who believe they are smart will think they are no longer smart when they fail at a given task. What teachers should do is praise students for their effort including the strategies used, their ability to focus, and their perseverance on a given task (Yeager & Dweck, 2012). The responsibility of developing a positive mindset in the classroom falls upon the teacher. There are several strategies that educators can use to develop this mindset in students, including daily direct instruction on an incremental theory of intelligence (Liu, Chiu, Chen, & Lin, 2014). Administrators also need to consider offering professional development training to aid teachers in understanding how effective thinking skills are connected to growing intelligence and how to relay this vital information to students (Burke & Williams, 2012).

Another way teachers can foster fixed mindset beliefs is through ability grouping. For the purpose of this research, the focus is on mathematics given that the subject of mathematics is more likely to be associated with fixed mindset thinking (Boaler, 2013). Teachers homogeneously grouping students in mathematics based on ability can be detrimental for both struggling and advanced students (Boaler, 2013). By utilizing homogeneous groupings, teachers subconsciously suggest to struggling students that they are not smart enough to be in the advanced group, which is counterintuitive to recent research that shows the plasticity of the brain and a student's ability to grow and learn through effort and challenge (Boaler, 2013). Through ability grouping, teachers send students a message that the ability to be successful in mathematics is fixed, and it is an ability they do not have (Yeager, 2012, as cited in Yeager & Dweck, 2012). When students are heterogeneously grouped, both student achievement and participation increase (Boaler, 2013).

While teacher mindset is critical to the success of student achievement using incremental theories of intelligence, one must not overlook the role of parents as well. In order to help

students adopt a growth mindset in learning, it is helpful to understand the student's background and the support they receive from home. The theories of intelligence that parents adopt are indicative of their child's performance (Rautiainen, Raty, & Kasanen, 2016). Parents of struggling students tend to have an incremental theory of intelligence, perhaps because they want to believe that their child can grow in their learning. On the other hand, parents of successful students tend to adopt an entity theory of intelligence, indicating that perhaps they believe their child is naturally smart (Rautiainen et al., 2016).

Changing Mindsets

Individuals having an entity theory of intelligence struggle when faced with challenging tasks, and often utilize avoidance strategies in an attempt to get out of completing the work (Liu, Chiu, Chen, & Lin 2014; Shih, 2011). It is important to note that when students are given the necessary skills and strategies, their mindset can change resulting in greater persistence when faced with challenging tasks (Yeager & Dweck, 2012). In order to help students adopt challenge-confronting tendencies, teachers need to explicitly teach students how to adopt an incremental theory of intelligence. By explicitly teaching students mindset skills, teachers make students aware of their perception of ability and can increase their level of understanding regarding their intelligence (Burke & Williams, 2012).

The effect of explicitly teaching growth mindset was explored in a study by Paunesku et al., (2015). As part of that study, 13 different high schools were selected from across the nation to determine whether or not a large-scale mindset intervention would be effective in increasing academic achievement. During the study, a total of 1,500 underperforming students were explicitly taught mindset strategies, viewing two 45-minute videos regarding growth mindset and sense of purpose (Paunesku et al., 2015). Findings indicated that the students who participated in

the study increased their GPA in core academic subjects (Paunesku et al., 2015). The results of this study suggest that mindset interventions can be performed via intervention videos on a large scale and result in increased student achievement (Paunesku et al., 2015).

When students were divided into two groups, one receiving mathematics skills intervention and the other receiving incremental theory intervention, the students in the incremental theory group showed an increase in scores, whereas the students in the mathematics skills group did not show an increase (Yeager & Dweck, 2012). Burke and Williams (2012) found that students who received intervention collaboratively showed greater growth than those who worked independently. Once students receive intervention, they demonstrate immediate benefit from developing a growth mindset, showing increased performance in target areas (Boaler, 2013).

Student Performance

How students perceive challenges will determine the amount of effort they put into a given task. Individuals having an entity theory of intelligence are more likely to focus on performance goals, attempting to prove their ability, whereas individuals having an incremental theory of intelligence are focused on improving their ability (Dweck & Leggett, 1988). Students who identify with the entity theory of intelligence are more likely to feel as though success is out of their control due to their limited ability (King, McInerney, & Watkins, 2012). These students are also more likely to believe that the more effort a person puts into a task the lower their ability is, and the less effort they have to put into a task the higher their ability is (Dweck & Leggett, 1988). However, new synapses are formed within the brain each time a mistake is made, and each time a synapse makes a connection, growth occurs within the brain (Dweck, 2012, as cited

in Boaler, 2013). When students are continuously getting their work correct, they are not forming new connections; therefore, brain growth is not occurring (Boaler, 2013).

It is best for students to be given open-ended tasks, which provides the opportunity to work through a challenge in a multitude of ways, forming new connections in their brain as they go (Boaler, 2013). When educators help students establish an incremental theory of intelligence, students can develop skills and strategies to persevere when faced with challenging tasks (Hochanadel & Finamore, 2015). As the curriculum becomes more rigorous, students need to be taught the appropriate mindset to tackle the increasingly challenging work, because if this is not addressed, student performance will continue to decline (Yeager & Dweck, 2012).

In order to determine whether or not socio-economic status played a role in mindset, Claro, Paunesku, and Dweck (2016) conducted a study of 168,203 tenth grade students in Chile. The study examined whether or not economically disadvantaged students were more likely to have a fixed mindset than a growth mindset. The results of the study indicated that students from the lowest income families were twice as likely as students from higher income families to have a fixed mindset (Claro et al., 2016). Students from lower income families also demonstrated lower achievement than their higher achievement, growth mindset counterparts (Claro et al., 2016). A fixed mindset is more detrimental to students who encounter other barriers to success, such as poverty (Claro et al., 2016), however mindset interventions can reduce achievement gaps including racial, gender, and socioeconomic gaps (Blackwell, Trzesniewski, & Dweck, 2007, Rattan, Savai, Chugh, & Dweck, 2015).

In an effort to understand overconfidence in students, Ehrlinger, Mitchum, and Dweck (2016) conducted a study of 53 university psychology students to determine if students who held an entity theory of intelligence were more likely to be overconfident than those who hold an

incremental theory of intelligence. Students who had an entity theory of intelligence were more likely to be overconfident, and tended to redirect their attention from difficult tasks, sticking with those in which they knew they could demonstrate success (Ehrlinger et al., 2016). The students who were overconfident exhibited poor study choices, which impeded student learning. Students with an incremental theory of intelligence showed greater accuracy in their self-assessments. Providing growth mindset interventions for students with an entity theory of intelligence may result in an improvement in self-assessment, thus reducing incidences of overconfidence (Ehrlinger et al., 2016).

The Impact of Mathematics Anxiety on Learning and Performance

When a student has math anxiety, the negative feelings affect not only their academic performance, but also how they learn (Vukovic, Kieffer, Bailey, & Harari, 2013). It is necessary for educators to develop a key understanding of mathematics anxiety and how it affects students' learning and performance (Maloney & Beilock, 2012) because a student with mathematics anxiety can change their attitude towards mathematics in early childhood (Ramirez, Gunderson, Levine, & Beilock, 2013). Ramirez, Gunderson, Levine, & Beilock (2013) determined that students with high working memory are more likely to be affected by mathematics anxiety than students with low working memory. The reasoning behind this is that students with high working memory utilize more advanced cognitive strategies when solving problems, whereas students with low working memory need to rely on more basic methods that do not depend on high working memory, such as counting on fingers or illustrating their mathematics.

Anxiety consumes the cognitive resources the student would usually use in mathematics, in students with high working memory, reducing their ability to use mathematics applications (Ramirez, Gunderson, Levine, & Beilock, 2013). Students with high working memory have a

greater capacity to utilize problem-solving skills and apply reasoning to various situations (Engle, 2002, Ramirez et al., 2013). Students with a lower working memory have a limited capacity, making more difficult to work through challenging tasks (Ramirez et al., 2013). These students are more accustomed to using rudimentary methods in mathematics to solve problems (Vukovic, Kieffer, Bailey, & Harari, 2013), and have learned shortcuts to overcome an inability store problem-solving strategies in the working memory (Ramirez et al., 2013).

Mathematics anxiety impairs the learning of mathematics in students with high working memory. While they can utilize other methods to check their work on basic mathematics problems, the application of mathematics strategies on open-ended problems requires advanced thinking skills that are limited due to mathematics anxiety (Vukovic et al., 2013). Students with high working memory and high mathematics anxiety are more likely than their peers to use avoidance strategies when faced with challenging tasks (Vukovic et al., 2013). To prevent mathematics loss over the elementary years, it is beneficial to approach the issue of mathematics anxiety at an early age.

Mathematics Achievement and Performance

Mathematics anxiety is linked to mathematics achievement as early as first and second grade (Ramirez, Gunderson, Levine, & Beilock, 2013). Students with high working memory and high mathematics anxiety demonstrate a lower level of progress in mathematics applications (Vukovic, Kieffer, Bailey, & Harari, 2013) and tend to get lower scores on standardized mathematics tests (Wu, Amin, Barth, Malcarne, & Menon, 2012). A negative relationship between mathematics anxiety and mathematics achievement is present in children with high working memory but not in children with low working memory (Ramirez et al., 2013). A negative correlation exists between mathematics anxiety and calculation skills in mathematical

applications, with mathematics anxiety negatively affecting a student's ability to use advanced problem-solving strategies, particularly for students with high working memory (Ramirez, Chang, Maloney, Levine, & Beilock, 2016; Vukovic et al., 2013). Mathematics anxiety can impact a student's ability to solve mathematics problems that require complex verbal reasoning and problem-solving, which are required skills for mathematics achievement (Wu et al., 2012).

Mathematics Anxiety and Brain Research

Neuroscientists have delved into researching mathematics anxiety and the inner workings of the brain both as children approach mathematics problems and while they are performing mathematical computations (Young, Wu, & Menon, 2012). What some scientists have found is that mathematics anxiety is related to a decrease in cognitive information processing resources while students are working through a mathematics task (Young et al., 2012). In studying how the brain interprets mathematics in children with mathematics anxiety, researchers found that children with high mathematics anxiety showed a reduction in cortical and subcortical areas that are typically associated with mathematics and number reasoning, as well as hyperactivity and connectivity of the amygdala, which is the part of the brain that processes negative emotions (Young et al., 2012).

The greater the mathematics anxiety, the greater the neural activity is in regions that are involved in pain processing (Lyons & Beilock, 2012b). Lyons and Beilock (2012b) have shown through their research that simply anticipating a math event triggers the neural regions involved in pain processing, with neural evidence showing a negative relationship between mathematics anxiety and mathematics competence before the mathematics even begins. To help students succeed in mathematics, teachers can play an integral role in alleviating mathematics anxiety. Neuroscientists suggest that an intervention program that focuses on the control of

negative emotional responses will be more effective for students than a typical mathematics skills intervention program (Lyons & Beilock, 2012a).

The Role of Teachers and Parents on a Student's Mathematics Anxiety

Environmental factors contribute to a student's mathematics anxiety, which can include feelings of mathematics anxiety stemming from parents and teachers. In a study of mathematics anxiety in parents who regularly helped their children with mathematics homework, researchers found that high mathematics anxiety in parents resulted in mathematics anxiety in their children by the end of the year (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Additionally, these students showed a decrease in mathematics achievement by the end of the year (Maloney et al., 2015). Haimovitz and Dweck (2016) found in a recent study that parents who have a failure mindset (the belief that failure is devastating) are more likely to have children who believe they cannot improve their intelligence. Parents with a failure mindset may benefit from a mindset intervention, helping them to see how failure can help their children learn (Haimovitz & Dweck, 2016). Educators can demonstrate methods for how to react to setbacks in a more positive manner, and by reacting to failure in a more positive way, parents may help their children develop a growth mindset, learning to persevere through challenging tasks (Haimovitz & Dweck, 2016). Teachers also must consider their impact on student learning and cast their own mathematics anxieties aside to avoid negative interactions with students regarding mathematics (Ramirez, Chang, Maloney, Levine, & Beilock, 2016).

Several strategies are available for teachers to assist students with alleviating any potential mathematics anxiety. When creating lesson plans, teachers need to take children's mathematics anxieties into consideration just as they would mathematics procedures and assignments (Ramirez, Gunderson, Levine, & Beilock, 2013). When educators develop

interventions for students at the onset of mathematics anxiety, they can prevent long-term effects of mathematics anxiety (Ramirez et al., 2013). Educators must keep in mind that some students will require more teacher support when learning mathematics applications in inquiry-based learning (Vukovic, Kieffer, Bailey, & Harari, 2013). Interventions can include teaching students how to use cognitive control resources to recognize mathematics anxiety before it can affect a student's mathematics performance (Lyons & Beilock, 2012a). Teachers can also provide positive assessments of mathematics learning including positive learning experiences in their daily mathematics routines and open mathematics learning (Aarnos & Perkkilä, 2012). It is also recommended that teachers provide support and interventions for parents such as worksheets or tools to alleviate the stress of trying to work through mathematics problems that utilize unfamiliar mathematics strategies (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). College and university instructors should consider adding a component to their programs that include training on mathematics anxiety, reinforcing the idea that in order for students to be successful in mathematics they must have the right mindset. For existing teachers, administrators should consider professional development on mathematics anxiety, providing resources to help teachers identify mathematics anxiety in students as well as how to support those students (Beilock & Maloney, 2015).

Treatment and Intervention of Mathematics Anxiety

In order for students to be successful in mathematics, they must have the right mindset (Beilock & Maloney, 2015). Mathematics self-concept, which is how a person perceives himself or herself in mathematics, was the strongest predictor of mathematics anxiety in second graders (Jameson, 2014). This supports the notion that educators must address the mindset of students in order to help them overcome their negative feelings towards mathematics and succeed. Levels

of mathematics deficits in students with high mathematics anxiety was determined by how the students responded to and reinterpreted an anxious response, not by the significance of their response (Lyons & Beilock, 2012a). Students with high levels of mathematics anxiety can overcome their deficits by increasing their control resources before the mathematics instruction begins (Lyons & Beilock, 2012a), or in other words by utilizing cognitive reappraisal, a way in which to change the way a stimulus is interpreted (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). It is essential for educators to address the anxiety itself through cognitive reappraisals, as changing the teaching of mathematical skills in and of themselves will likely not have an effect on these students (Maloney & Beilock, 2012). When a student's anxiety is under control, students will be able to see their performance levels increase (Maloney & Beilock, 2012).

Effective Professional Development

Effective professional development not only increases the knowledge of teachers, but also helps the presenter understand the effect the professional development has on students (Earley & Porritt, 2014). At the onset of professional development, teachers should be given specific goals and clear learning outcomes in order to outline their learning path (Earley & Porritt, 2014). Streamlining the professional development sessions so that teachers are working towards a single goal can allow the presenter of the professional development to develop deeper and more meaningful conversations among colleagues (Kintz, Lane, Gotwals, & Cisterna, 2015), as peer collaboration is essential to the success of teacher learning experiences (Ching & Hursh, 2014; Earley & Porritt, 2014). When administrators allow for peer modeling in their schools, they can enhance a teacher's experience, boosting their confidence to try new things as they see it in action (Ching & Hursh, 2014). One strategy that can be effective in training teachers is to

record lessons and utilize the videos as a point of discussion for student learning. Additionally, having the presenter provide teachers with resources they can use right away has been shown to be more effective than requiring teachers to find their own resources based on what they have learned in a professional development session (Desimone & Garet, 2015).

There are several components that can make professional development sessions effective. In addition to having a clear focus that is aligned with the curriculum and goals of the school, the professional development presenter should ensure that teachers are engaged in the learning process, allow them to attend sessions that are spread out over a period of time, and encourage participation from teachers that share a collaborative role within a school or community (Desimone & Garet, 2015). By providing a time period over which the professional development will be delivered, as well as an evaluative component to determine student impact, presenters have demonstrated positive impacts on teachers' learning and implementation of the material (Earley & Porritt, 2014).

When designing a professional development program, the instructor must first consider how students will learn as a result of the program, and then develop an impact evaluation tool to determine what student learning occurred by the end of the learning experience. It is essential for educators to measure the learning and experiences of children based on the professional development so that they may determine the effectiveness of the professional development and determine changes that should be made to future professional development programs (Earley & Porritt, 2014).

Implementation of Professional Development

An effective form of professional development involves having teachers participate in a professional learning community. The goal of a professional learning community is to change a

teacher's theories and assumptions regarding student learning by focusing on student work and data (Stewart, 2014). A similar model of professional learning is the Community of Practice model, where teachers work together in teacher learning communities (Kennedy, 2014b) to create an understanding of the subject matter, and share their knowledge and expertise with one another to increase the overall knowledge of the group (Kennedy, 2014a). An effective teacher learning community positively impacts both teaching practices and student learning (Kintz, Lane, Gotwals, & Cisterna, 2015).

Utilizing technology in professional development can be a beneficial medium for the presenter to relay information to teachers. Utilizing online features to implement professional development allows the presenter to accommodate for differences in teacher schedules, provide links to online resources and videos within the program, and can be done at the participant's own pace (Fishman et al., 2013). While studies show that there is no significant difference in the effectiveness of face-to-face learning versus online learning, presenters provide opportunities for collegial discussions and reflections relating to the topic in face-to-face learning, which may not occur online (Fishman et al., 2013).

Professional Development and the Impact on Student Learning

The goal of professional development for educators is to improve student learning. This can be done by changing teachers' mindsets and actions, which in turn results in an increase in student learning experiences (Earley & Porritt, 2014). By focusing on content specific professional development that enables teachers to further develop their teaching skills, student achievement can be increased (Desimone, Smith, & Phillips, 2013). In order to show a relationship between teacher learning, implementation in the classroom, and student learning, educators need to assess students' academic needs in order to make learning effective (Fishman

et al., 2013). When developing professional development, instructors should design their program based on the expected student outcomes, not on what teachers are expected to know, which provides a clear path for teacher and student learning by giving both teachers and students concise goals to work towards (Earley & Porritt, 2014).

Review of Methodological Issues

The purpose of a case study is to address a complex question that requires a multiple method approach in order to arrive at a conclusion that can be applied to other situations (Keen & Packwood, 1995). Case studies are commonly utilized in education and the social sciences, using multiple methods to explore in depth what occurs in real-world situations (Amerson, 2011). Research questions developed for case studies are in the form of either an explanatory, exploratory, or descriptive questions. When using explanatory questions, the researcher seeks to explain how or why a phenomenon occurred. Conversely, the researcher determines what occurred when using descriptive questions (Yin, 2012). Exploratory case studies questions are used to explore the phenomenon that forms the basis for the case (Zainel, 2007). The use of rich descriptions and details are a unique characteristic of case studies (Yin, 2012). A concern in case study research is the lack of rigor. Researchers correct for this by providing thorough detailed description of the process and steps to control for the influences of bias in the findings and conclusions (Yin, 1994).

One of the many benefits of using a case study is the ability to triangulate data through the use of multiple research methods including both qualitative and quantitative (Yin, 2012). By incorporating evidence from at least three different sources, a stronger argument, can be established thus developing construct validity (Amerson, 2011). Examples of evidence that could potentially be used in a case study include interviews, archival data, observations, and

documents (Yin, 2012). Observations in a natural environment are made, such as a classroom, or interviews conducted through fieldwork (Soukup, Lamb, Sevdalis, & Green, 2017).

Observations in a natural setting are conducted where there is no control over the environment (Soukup et al., 2017). An understanding of the interactions among people within the environment is gained during observations (Muhall, 2003; Laitinen, Kaunonen, & Astedt-Kurki, 2014) and potentially issues are seen through a different perspective (McCurdy & Uldam, 2014). While observing the participant, it is helpful for the observer to utilize an observation checklist, which provides structure for taking notes during the observation (Laitinen et al., 2014).

An in-depth look at a participant's understanding of an issue can be gained using qualitative data such as interviews. The interview allows researchers to gain a more detailed response than through a survey due the ability to interact directly with the participant during data collection and ask follow up questions (Jackson, Drummond, & Camara, 2007). Open-ended questions allow for flexibility. Follow-up questions are asked to provide clarity (Jackson, Drummond, & Camara, 2007).

In qualitative research, interviews are used to gather detailed information through direct conversations with the participants. During an interview, both the participant and the interviewer work together to construct meaning for the purpose of the study (Rosetto, 2014). Either open-ended or semi-structured interview questions are used that have been established based on a specific topic of research or more broad questions that allow for natural conversation on the topic (Curry, Nembhard, & Bradley, 2009).

Insight into how individuals perceive various situations are gained through the rich information gathered in interviews. Through this process, the participant has the opportunity to share additional perspectives (Curry, Nembhard, & Bradley, 2009). Throughout the interview

process, it is necessary to build a rapport with the participants so they will provide honest responses. It is important to be flexible in questioning, utilize good listening skills, and use language that is non-judgmental (Currey et al., 2009).

Once interviews have been completed, member checking is used to build credibility and trustworthiness for the study. During member checking, each participant receives a copy of the interview (Carlson, 2010; Birt, Scott, Cavers, Campbell, & Walter, 2016). Member checking allows the participant to have a voice in the research process (Carlson, 2010). During this process the researcher reflects upon the interview to determine what is important from the perspective of the participant (Madill & Sullivan, 2017).

After reviewing the interview data, the participant has the opportunity to change their response (Birt, Scott, Cavers, Campbell, & Walter, 2016). The process of member checking builds trustworthiness and ensures that the data was collected, analyzed, and reported accurately (Carlson, 2010). It is necessary to have an accurate description of the study in order to build credibility (Birt et al., 2016).

There are several methods used to analyze data, which can establish internal validity (Amerson, 2011). These methods include pattern matching, explanation building, and chronology. Pattern matching requires making a prediction as to the outcome of the study, and then once the study is complete, looking for patterns between the predicted outcome and the actual outcome (Yin, 2012). Explanation building is used in response to an open-ended research question, requiring using the data that has been collected to build an explanation in response to the research question (Yin, 2012). Using chronology, the researcher simply places a series of events in order, which can explain relationships between variables in a study (Yin, 2012). In

order to establish external validity, either a theory is developed for a single-case study or replications are used in multiple case studies (Amerson, 2011).

Coding is a method researchers utilize to organize and sort qualitative data (Stuckey, 2015). The transcribed data is indexed to help locate specific topics in a text (Glaser & Laudel, 2013). Coding this way is based on the grounded theory of methodology (Glaswer & Laudel, 2013), and is used to categorize and organize data by grouping similar information together (Stuckey, 2015). The research questions are used as the guiding question when generating codes, ensuring consistency in the coding schema. Codes can be established using a priori, which is an established set of codes based on what the questions are asking, or they can be emergent, evolving from the data naturally (Stuckey, 2015). There may be a need for hierarchical codes, including sub-codes to appropriately group the data (Glaser & Laudel, 2013).

A coding dictionary is created, which can add to the credibility of the study by providing a trail of evidence (Glaser & Laudel, 2013). Memos are used to keep informal records of how the codes were developed and how decisions were made to add to the credibility of the study (Glaser & Laudel, 2013). Keeping memos helps establish transparency throughout the process and allows for reflection at the end of the study (Stuckey, 2015). Several issues must be considered when conducting a case study. The first issue is the reputation of case studies. Case studies have been viewed as a last resort method due to the idea that developing a case study is a beginning phase in research and not a stand-alone research method (Yin, 2014). Contemporary scholars refute this idea, showing that the use of systematic procedures fulfill the requirements of a study without utilizing other methods (Yin, 2012). The introduction of bias can limit the generalizability of the results of the study to other situations (Yin, 2012). Research theory must be identified to guide the research design (Yin, 2012).

The researcher needs to be aware of the potential for the Hawthorne effect to occur when observing participants (McCambridge, Witton, & Elbourne, 2014). The Hawthorne effect refers to when participants are aware they are going to be observed, and as a result they may change their behavior to reflect what they believe the observer is looking for, which can cause bias and impact the results of the study (McCambridge et al., 2014). An impersonal role needs to be taken to obtain objective findings in research (Jackson, Drummond, & Camara, 2007). Several challenges may occur during the member checking process, which includes a low response rate from the participants. It is expected that the participants will take the time to review the interview, however the participants may not provide a response at all, or they may hesitate to provide honest feedback for fear of causing hard feelings (Varpio, Ajjawi, Monrouxe, O'Brien, & Rees, 2017). Another potential issue with member checking is the amount of time that can pass between the interview itself and the member checking, which can impede the participant's ability to accurately recall the conversation (Varpio et al., 2017).

Synthesis of Research Findings

Implicit theories of intelligence can impact student emotions (King, McInerney, & Watkins, 2012) and motivation (Aditomo, 2015) towards academics. Students with an entity theory of intelligence may fear failure, resorting to avoidance behaviors which can result in anxiety (Shih, 2011), while students who adopt an incremental theory of intelligence pursue learning goals and see challenges as a way to prove their ability (Dweck & Leggett, 1988). Researchers have shown that student mindsets can be changed through intervention strategies and have proven to be more effective in student growth than a skills intervention in mathematics (Yeager & Dweck, 2012).

The subject of mathematics is more prone to fixed ability thinking in both teachers and students (Boaler, 2013), which can lead to academic anxiety (Dweck & Leggett, 1988). How students learn and perform can be impacted by mathematics anxiety (Vukovic, Kieffer, Bailey, & Harari, 2013), therefore educators need to address the role of anxiety in mathematics so that they may better understand how students learn and perform mathematics (Maloney & Beilock, 2012). Mathematics anxiety is related to mathematics achievement as early as first and second grade (Ramirez, Gunderson, Levine, & Beilock, 2013) and impacts a student's ability to solve mathematics problems requiring advanced problem-solving skills (Wu, Amin, Barth, Malcarne, & Menon, 2012). Students with high working memory have a higher incidence of mathematics anxiety versus students with low working memory. This is due to the fact that students with high working memory rely on their working memory to process advanced strategies; however, the anxiety reduces the cognitive resources students need for mathematics (Ramirez et al., 2013).

Studies in neuroscience found that simply anticipating a mathematics activity activates the neural areas of the brain that process pain, and the higher the anxiety, the greater the neural response (Lyons & Beilock, 2012a). The studies support the notion that interventions that focus on the control of negative emotional responses will have a greater impact on student success in mathematics than a mathematics skills intervention (Lyons & Beilock, 2012b). Cognitive reappraisal is one method students may use to change their interpretation of the negative stimulus (Ramirez, Chang, Maloney, Levine, & Beilock, 2016) and can be used by highly mathematics anxious students to ramp up the control resources before the mathematics instruction begins (Lyons & Beilock, 2012b). Once the anxiety is regulated, teachers and students will see an increase in performance (Maloney & Beilock, 2012), showing that being successful in mathematics requires a student to have the proper mindset (Beilock & Maloney, 2015).

Critique of Previous Research

The relationship between mathematics anxiety in second grade students and their mathematics performance was investigated. Findings indicated that mathematics anxiety impacts children's calculation skills and mathematics applications, resulting in lower gains for students with high working memory (Vukovic, Kieffer, Bailey, & Harari, 2013). Future research is needed to determine what role instruction plays in reducing a child's mathematics anxiety. Personal and environmental variables could reliably predict increased levels of mathematics anxiety in children, with studies indicating that self-concept was the greatest predictor of mathematics anxiety in children (Jameson, 2014). A combination of surveys and questionnaires were used to analyze data; however, adding an element of performance data to the study to determine the relationship between mathematics anxiety and student performance is recommended (Jameson, 2014). Students with high mathematics anxiety using advanced mathematics strategies were studied. Findings indicated that high mathematics anxiety resulted in less use of advanced problem-solving strategies, negatively impacting student achievement (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). Ramirez, Chang, Maloney, Levine, and Beilock (2016) suggested that investigating cognitive appraisal as an intervention to reduce mathematics anxiety could have a positive impact on student performance.

Summary

Mathematics anxiety is a concept that has been researched in adolescents and adults, but there is limited research on the impact of mathematics anxiety on elementary students. Mathematics anxiety begins as early as first grade and can significantly impact student mathematics achievement (Ramirez, Gunderson, Levine, & Beilock, 2013). Students with high working memory are more likely to suffer negative effects from mathematics anxiety, which

include a decrease in mathematics achievement (Vukovic, Kieffer, Bailey, & Harari, 2012). Carol Dweck asserts that students with an incremental theory of intelligence are more likely to adopt learning goals and grow as learners (Aditomo, 2015). Educators have a responsibility to utilize teaching strategies that will support student learning, taking children's mathematics anxieties into consideration when planning lessons (Ramirez et al., 2013). Included in this chapter was the conceptual framework, a review of the literature, a review of the methodological review and issues, as well as a synthesis of research findings and a critique of the research. The following chapter describes the research methodology for this study, including the population sample, data collection tools, and data analysis methods.

Chapter 3: Methodology

Mathematics anxiety is an obstacle students need to overcome in order to be successful in math. Researchers Lyons and Beilock (2012a) define mathematics anxiety as having a fear or feelings of apprehension about performing in mathematics. These feelings are linked to a delay in acquiring core mathematics and number concepts, which results in lower mathematics competence (Lyons & Beilock, 2012a). When teachers alleviate mathematics anxiety in students at an early age, students begin to view mistakes as learning experiences. As a result, students are able to engage in learning math applications as opposed to giving up out of frustration. The ability to work through math problems enables students to later pursue higher education and career fields that involve mathematics, without the fear of failure. Although a great deal of research has been done on this topic in teens and adults, little research has been done on mathematics anxiety in the elementary grades (Ramirez, Gunderson, Levine, & Beilock, 2013).

Student mindset has also been shown to impact student performance in mathematics (Blackwell, Trzesniewski, & Dweck, 2007). Implicit theories of intelligence refer to the belief that intelligence is malleable, resulting in a positive mindset towards learning (Rattan, Good, & Dweck, 2012). Students who developed an incremental theory of intelligence as a result of intervention demonstrate an increase in motivation, as well as academic performance (Blackwell, Trzesniewski, & Dweck, 2007). This single exploratory case study was designed to add to the knowledge of mathematics anxiety and growth mindset, from the perspective of teachers. The intent of the study was to explore how professional development on the topics of incremental theories of intelligence and mathematics anxiety affects the planning and instruction in mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers.

Research Questions

The research questions for this study were as follows:

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher's ability to address issues of mathematics anxiety in the classroom?

RQ2: How does adjusting teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student's grit as perceived by the teacher?

Purpose and Design of the Study

This study was designed as an exploratory case study. In a case study, the researcher seeks to describe an activity at a certain time and place, and to gather information from a variety of perspectives using several different data instruments (Yin, 2014). A case study was deemed the most appropriate methodology for this study, allowing the researcher to collect data on the impact of professional development on the planning and instruction of mathematics, as well as potential shifts in student mindset as perceived by the teacher. Case studies use multiple methods to explore a topic more deeply, and are commonly used to conduct research in education (Amerson, 2011). For this study, teachers from three different grade levels were interviewed and observed to gather evidence from various perspectives within the school. In case studies, explanatory questions are used in case studies to determine how a phenomenon occurred (Yin, 2012). For this study, I, as the researcher and conductor of the professional development, utilized evidence such as interviews and observations to answer the research questions (Yin, 2012). During the study, I made observations in a natural environment, which in

this study is the classroom, and interviews were conducted through fieldwork (Soukup, Lamb, Sevdalis, & Green, 2017). By conducting observations in the natural environment, there is no control over what was occurring in the natural environment, as in this study when examining the student learning and resulting perceptions of teachers after the professional development (Soukup et. al., 2017).

Research Population and Sampling Method

The single exploratory case study was conducted in a newly established elementary school located in a suburban neighborhood in the northeast region of the United States. The elementary school had a population of 448 students, 18 classroom teachers, two administrators, and one lead teacher. Each classroom teacher had approximately 25 students in their class.

The professional development on mathematics anxiety and growth mindset was implemented for all staff members; however, purposive sampling was used to select the participants for the study. Purposive sampling involves selecting participants based on their knowledge and experience in a given area (Bagnasco, Ghirotto, & Sasso, 2014) with the sample being selected prior to the data collection (Charmaz, 1990, as cited in Bagnasco et. al., 2014). The decisions regarding purposive sampling are guided by best practices (Bagnasco et. al., 2014). Although the professional development was delivered to all staff members, only mathematics teachers of students in grades two through five were invited to participate in the study, resulting in a potential sample of 10 participants. Letters were placed in the mailboxes of all teachers in grades two through five explaining the study and requesting their participation. Stapled to the letters were the consent forms for the participants to sign, which included a detailed explanation of the risks involved in the study, as well as a statement giving participants

the right to withdraw from the study at any time. Of the staff, a total of six teachers in grades three through five agreed to participate in the study.

Professional Development

The professional development session on growth mindset consisted of a one-hour face-to-face session where participants received resources and strategies to identify mindset and mathematics anxiety in students, as well as strategies to develop a growth mindset in students. During the professional development session, participants learned about the research on incremental and entity theories of intelligence (growth and fixed mindset), as well as strategies to provide growth mindset interventions in their classrooms. Staff members learned about the short-term and long-term negative effects of mathematics anxiety and fixed mindset on students, and how developing a growth mindset may help students overcome these barriers to learning. Staff members participated in small group activities including scenarios to help them understand how to address these issues in the classroom, and left the professional development with access to additional resources via a website developed for this study.

Instrumentation

Growth Mindset Survey

PERTS (n.d.) granted permission to use the online Growth Mindset Survey for this study. The purpose of the Growth Mindset Survey (PERTS, n.d.) was to determine the mindset of staff members in the building. In order to utilize the survey, an email address was provided to survey.perts.net, at which point links to access both the survey and the results were emailed. To access the survey, staff members scanned a QR code with their mobile devices. This survey instrument required staff members to respond to three statements using a Likert scale, with

responses ranging from strongly disagree to strongly agree. The results of the survey were automatically generated once responses were submitted.

Interviews

Prior to the professional development session I conducted initial interviews with each participant. The interview consisted of five questions that were established after reviewing the literature on mathematics anxiety and growth mindset to help determine teacher beliefs prior to the professional development session. Interview questions are listed in Appendix B. The information gathered during the interviews established a baseline to compare post-professional development results. Responses from teachers allowed me to gather information on the teachers' prior knowledge of growth mindset and their beliefs on the topic so the professional development could be tailored to meet their needs. Also, the results of the interviews were used to establish a baseline as to where teachers were in their understanding and practice of growth mindset prior to the training.

At the conclusion of the study I conducted semi-structured face-to-face interviews with the participants using open-ended questions developed prior to the interview. However, the conversational tone used during the interviews allowed the participant to deviate from the established questions and provide deeper insight into their perceptions (Irvine, Drew, & Sainsbury, 2013, as cited in Brown & Danaher, 2017). The focus of the interview was to gain an understanding from the perspective of the teachers as to how the professional development affected the teaching and planning of mathematics, and what changes in student mindset and grit participants may have noticed since implementing growth mindset interventions. A list of the semi-structured interview questions is included in Appendix C.

Observations

The *Checklist of Growth Mindset Teaching Practices*, with permission from PERTS (n.d.), was the instrument used to examine how growth mindset teaching practices are being implemented in the classroom. Sun, Boaler, Dweck, & Stipeck (2015) developed this data collection instrument based on seminal research conducted by Jo Boaler (1998, 2013) that was designed to show the relationship between classroom practices and student perceptions regarding mathematics ability. The structured checklist is a result of qualitative research conducted on growth mindset practices in the classroom setting (PERTS, n.d.). Sun et al. (2015) collected data over a period of one year through classroom observations, artifact collection, and semi-structured interviews of seven teachers from four different schools. A copy of the *Checklist of Growth Mindset Teaching Practices* checklist is included in Appendix D.

Data Collection

Three data sources were used in this study: an online growth mindset survey, interviews, and observations. In order to collect data from the interviews, questions that focused on the goal of the research were established prior to meeting with the participants.

Growth Mindset Survey

During the professional development, staff members took a Growth Mindset Survey. Twenty-two staff members participated in the survey. At the conclusion of the professional development, staff members were given the link to the survey so that they may administer the survey to their students.

Interviews

Prior to the professional development session, I conducted semi-structured interviews with each participant. The data collected from these interviews was used to tailor the

professional development to accurately meet the needs of teachers, as well as provide a baseline to more effectively compare changes in mindset after the professional development was delivered. Semi-structured interviews were also conducted at the conclusion of the study. The purpose of those interviews was to determine the effectiveness of the professional development on the planning and instruction, as well as understanding teacher perceptions of its impact on students with mathematics anxiety. Questions were created based on research on the topics of mathematics anxiety and growth mindset to capture the overall effect of the professional development.

All interviews were recorded for the purpose of transcribing and coding the data, with permission being granted by the participants when signing the initial consent form. The member checking process allowed participants to change or withdraw their answers after reviewing their responses (Birt, Scott, Cavers, Campbell, & Walter, 2016). After the interviews, the member checking process resulted in no changes being made to the data. Audio recordings were deleted after the transcription of the data.

Observations

Four weeks after the professional development session, I observed participants in their classrooms during the mathematics block. Participants had the ability to opt out of the observation portion of the study, yet remain a part of the overall study. None of the participants opted out of the observation portion of this study. The *Checklist of Growth Mindset Teaching Practices* (PERTS, n.d.) was utilized as the basis for good teaching practices using growth mindset in the classroom. Anecdotal notes were recorded throughout the observation to determine if and how the practices were being implemented in the classroom.

Identification of Attributes

Several attributes were investigated and observed during this study. One attribute is mathematics anxiety, which refers to feelings of fear or apprehension about performing mathematics (Lyons & Beilock, 2012a). Another attribute is the entity theory of intelligence, also known as a fixed mindset. This refers to the belief that an individual's intelligence will not change regardless of the amount of effort that is put in to learning (Boaler, 2013). Additionally, an incremental theory of intelligence, otherwise known as growth mindset, refers to the belief that intelligence is malleable, and can change with an increase in practice and effort (Boaler, 2013). Another attribute, grit, is defined as a student's ability to persevere when encountering challenging tasks (Hochanadel & Finamore, 2015).

Data Analysis

Growth Mindset Survey

Descriptive statistics were used to analyze the data collected in the Growth Mindset Survey administered at the beginning of the professional development session. The results of the online survey were immediately available on the website after the staff members completed the survey, which I accessed via a link provided by PERTS (n.d.). During the professional development staff members viewed the results of the Growth Mindset Survey within the presentation. After the professional development, teachers administered the survey to their students and shared the findings with students.

Interviews

The data analysis software, ATLAS.ti., was used to code the data collected via the interviews and observations. Throughout the process, I utilized research bracketing. I kept a journal of how decisions regarding themes, categorization, and patterns have emerged in order to

establish reasoning behind the process (Tufford & Newman, 2010). I recorded methodological notes throughout the process, exploring the process of the research, and making observations throughout the study, which allowed me to think more deeply about the process (Tufford & Newman, 2010).

The grounded theory of constant comparison was utilized to develop categories and codes by continuously comparing texts to previously coded data. This allowed for adjustment of codes, as well as consistency in the process (Ryan & Bernard, 2003). Throughout the process, each category was given a descriptive label, and sub-categories were created based on recurring themes. This process was repeated until no new themes or categories could be established. Cross-indexing was required for statements that fit more than one category, and there was data that did not fit in any category and was not used in the study. Once the categories and themes were established, patterns and relationships among the data were sought reflecting on what new information developed as a result of the study. The information from the results of the study was synthesized to develop meaning and assess how this meaning aligns with the research questions (Taylor-Powell & Renner, 2003).

Observations

During the observations, growth mindset behaviors were documented using the Checklist for Growth Mindset Practices (PERTS, n.d.). At the conclusion of the observations, the percentage of each practice observed was calculated to determine which practices were most prevalent among the participants, and which were not present. Anecdotal notes were recorded during the observations, and these notes were coded using ATLAS.ti.

Limitations of the Study

One of the downfalls of researchers performing a qualitative case study is the challenge in generalizing the results to a greater population due to small sample sizes. A limitation of this particular study is the small population sample due to the limited number of teachers available within the elementary school. The small sample size and single study site present challenges in generalizing the results to a greater population. Since the researcher designed and presented the professional development, as well as conducted the research, there is potential for bias on the part of the researcher. One benefit to being closely tied to the study was understanding the staff members and the needs of the school community. Another limitation of the study is the duration of the time period. Due to other professional development programs and mandatory testing, the duration of the study period was only five weeks, limiting the amount of data that can be collected in this time period.

Validation

Credibility

Member checking was used to increase the trustworthiness in the study. Member checking allows participants to ensure their responses were interpreted correctly without bias from the researcher, as well as clarify any ambiguous statements (Birt, Scott, Cavers, Campbell, & Walter, 2016; Jackson, Drummond, & Camara, 2007). This helps to control for bias.

Case studies that lack a definitive procedure are not rigorous enough (Yin, 2014). To further strengthen study validity, copious notes were taken and study procedures described in-depth. Interviews were conducted until saturation was achieved (Yin, 2014; Fusch & Ness, 2015). These factors must be taken into consideration to maintain the sanctity of the data collected, resulting in a credible and trustworthy study.

Research bracketing was used for this study. Bracketing aided the researcher in reducing the effects of presuppositions on the process and results of the research (Tufford & Newman, 2010). This allowed me to reflect upon the decisions that are made throughout the process, making me aware of preconceptions they may have and how these preconceptions may impact any interpretation of the results. The goal in research was to set aside the researcher's belief in order to analyze participant responses with an open mind. Triangulation of data was used to establish a stronger argument and establish credibility, providing a rich description of the overall study (Creswell, 2013). For the study, a compilation of the data from the interviews, observations, personal journal, and documents was used to answer the research questions for this study.

Dependability

In qualitative research, it is necessary for researchers to demonstrate confirmability of the research process. In order to show confirmability researchers must show their study is dependable (Byrne, 2001). This is achieved by maintaining an audit trail throughout the study (Byrne, 2001). The audit trail can consist of methodological notes, interview transcripts, data interpretation, and journals (Byrne, 2001). Research bracketing adds to the confirmability of the study through the process of keeping methodological notes.

Expected Findings

The goal of this research was to explore how professional development on the topics of mathematics anxiety and incremental theories of intelligence affects the planning and instruction in mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by the teacher. To accomplish this, the interviews and observations were analyzed. I expected to find that participants would be more likely to identify students with mathematics

anxiety in their classroom, and as a result take levels of anxiety into consideration when planning and instructing mathematics lessons. Additionally, I anticipated that teachers would see an increase in student perseverance after delivering growth mindset interventions in the mathematics classroom.

Ethical Issues

While conducting a study, researchers must be aware of ethical issues they may encounter, as well as how to address them. In order to help researchers conduct ethical research, the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research created the Belmont Report as a result of the atrocious treatment of human subjects by researchers during World War II (Adams & Miles, 2013). Researchers are to follow three principles in research: respect for persons, beneficence, and justice (Adams & Miles, 2013). During the study, the researcher followed these three principles of research to avoid mistreatment of the subjects.

Conflict of Interest Assessment

Throughout the study I held a position as both the principal investigator and classroom teacher. In order to avoid potential bias in the study I opted to not teach mathematics this year. During the study bias could have emerged due to the existing personal and professional relationships with colleagues, however measures such as research bracketing and member checking were taken to reduce bias in the study. As there were no financial obligations within this study there was no potential for a financial conflict of interest.

Researcher's Position

As principal investigator, I designed and conducted the professional development, as well as conducted all interviews and observations. I also transcribed, coded, and analyzed the data.

During the study I did not have any authority or evaluative control over any staff members in the building, nor did any participant receive compensation for their participation in the study.

Ethical Issues of the Proposed Study

In addition to following the principles of the Belmont Report, bias on the part of the researcher was avoided through research bracketing. Research bracketing includes completing a journal of the methodological procedures throughout the study (Tufford & Newman, 2010). It is important to note that I conducted both the professional development and the study. In order to avoid bias, it was necessary to report the various perspectives of the staff, respecting each participant's viewpoint, as it is important to accurately report the data that was collected from the staff with disregard to my perspective on the professional development.

Summary

Described in this chapter was the methodology used to explore what affect, if any, professional development on the topics of mathematics anxiety and incremental theories of intelligence had on the planning and instruction of mathematics, as well as student mindset and grit as perceived by the teacher. This was an exploratory case study performed at one suburban elementary school in the northeastern United States. Multiple sources including interviews, observations, and questionnaires, all of which were used to formulate a response to the research questions. Chapter 4 includes a summary of the findings and results of the study.

Chapter 4: Review of the Findings

Students suffering from mathematics anxiety demonstrate a decrease in cognitive information processing resources when working through mathematics problems (Young, Wu, & Menon, 2012). Mathematics anxiety can trigger negative emotions as well as a pain response even when simply anticipating the mathematics task (Lyons & Beilock, 2012b). Anxiety when working with mathematics can begin as early as first and second grade (Ramirez, Gunderson, Levine, & Beilock, 2013). However, little research has been done on mathematics anxiety in elementary age students. Neuroscientists suggest that an intervention program that addresses controlling negative emotional responses to mathematics will be more affective in alleviating mathematics anxiety than traditional mathematics skills interventions (Lyons & Beilock, 2012a).

There is a link between mathematics anxiety and student performance (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). One way to alleviate mathematics anxiety is through changing students' mindsets and thus altering a student's negative reactions to mathematics. A student's mindset can significantly impact student achievement in mathematics. Burke and Williams (2012) showed a positive relationship between perseverance and the belief that intelligence is malleable when working through tasks that involve active thinking skills.

The teacher's mindset also plays a vital role in the success of the student. Teachers with a fixed mindset are more likely to identify a student as low ability after just one assessment (Rattan, Good, & Dweck, 2012). Helping teachers to identify and adjust their mindsets may have positive impacts on student mindset and achievement. Educators must also be cautious of the language they use when they interact with students in the classroom. Providing students praise for being smart can have adverse effects on the student, particularly when they fail at a given task. Boaler (2013) calls labeling students as smart fixed mindset praise, and stated that

failure of a task may result in the students believing they are no longer intelligent. Strategies teachers can use to develop a growth mindset in students include process praise, praising effort, and praising the students' ability to focus and persevere on a task (Yeager & Dweck, 2012).

During the coding process grit emerged from the data as an unexpected theme. Grit is defined as a student's ability to persevere when encountering challenging tasks (Hochanadel & Finamore, 2015). Duckworth, Peterson, Matthews, and Kelly (2007) defined grit as the perseverance and passion for long-term goals. Individuals who display grit are more likely to maintain effort, even if they have failed at a task in the past. Duckworth et al. (2007) found that students with higher levels of grit achieved higher levels of education than those who did not have grit.

The purpose of this case study was to explore how professional development on the topics of incremental theories of intelligence and mathematics anxiety affects the planning and instruction in mathematics by classroom teachers, as well as changes in student mindset and grit as perceived by teachers. Included in this chapter is a description of the sample, an outline of the professional development provided to all staff members, instrumentation, study findings, data analysis, and a summary of the findings.

Specifically, this study was designed to answer the following research questions:

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher's ability to address issues of mathematics anxiety in the classroom?

RQ2: How does the adjustment of teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student's grit as perceived by the teacher?

Description of the Sample

All teachers of students in grades two to five were invited to participate in the study. Out of the 10 teachers invited, six teachers agreed to participate in the study. Of the six participants, five were female and one was male. Three participants had 10 years or less teaching experience, with the remaining participants having 14 years or more. The specific demographics of the participants are indicated in Table 1.

Table 1

Participant Demographics

Grade Level	Teacher	Years of Experience
3	T1	35
3	T2	14
3	T3	10
4	T4	18
4	T5	10
5	T6	9

Professional Development on Mathematics Anxiety and Growth Mindset

I conducted a one-hour-long professional development session for all classroom teachers and support staff. Mathematics anxiety was defined along with explanations of its relationship to student achievement. Statistics were provided to the staff, which included the percentage of college age students in both community and four-year colleges suffering from mathematics anxiety as well as the percentage of high school students who are college and career ready in the field of mathematics. I also discussed how this topic connects to their classrooms, specifically, how it can impact the students in their classroom. Information was shared regarding brain

research and how mathematics anxiety impacts a student's ability to learn and process new information. Teachers learned not only how these factors influence student learning today, but also how it can impact future college and career choices. Staff members were provided a tool, with permission from the originator, to aid in diagnosing mathematics anxiety in their students.

I explained the differences between growth and fixed mindsets, identified ways teachers can foster a growth mindset in their classrooms, and discussed strategies that can be used in their classrooms to develop a growth mindset culture. To practice these strategies, teachers were divided into small groups and asked to work through scenarios to determine how to appropriately respond to various situations using growth mindset practices. A website was created with various mindset and math anxiety resources for teachers to reference and use.

Instrumentation

Interviews were held before the professional development presentation on the topics of mathematics anxiety to provide insights into the participants' understanding of mathematics anxiety and growth mindset. I learned through these interviews that most participants believed that a lack of number sense and a lack of confidence were the greatest inhibitors of learning mathematics, regardless of the grade level. A few participants mentioned that perseverance was also an issue. This helped me understand some of the challenges faced by teachers within the building when teaching mathematics, so I specifically included data supporting the claim that mathematics anxiety impacts a student's ability to learn and process mathematics (Young, Wu, & Menon, 2012). Within the building, teachers and staff members typically take a mathematics skills intervention approach in the classroom when students are struggling with mathematics. In order to shift the mindset of the staff regarding mathematics interventions, I included information regarding brain research, which states that helping students control negative emotions towards

mathematics will be more effective than typical mathematics skills interventions (Lyons & Beilock, 2012b).

Approximately five weeks after the professional development session, I scheduled times to observe the participants' classrooms for a period of 30 minutes during their mathematics block. According to Gargani and Strong (2014), observers can determine the effectiveness of a teacher after only 20 minutes. Observation times were scheduled based on my availability during the day as well as the participants' scheduled mathematics blocks. During the observations, a Checklist for Growth Mindset Practices (PERTS, n.d.) was used to determine what growth mindset practices were present at that time. This was done via a Google Form based on the checklist, by clicking the box next to the mindset practices that were being observed. I also added a section for anecdotal notes. Anecdotal notes were specifically recorded to support teacher observations based on the checklist, and I only recorded those things that were being observed.

After the observations, I reviewed the anecdotal notes to look for any instances of me recording interpretations of what was occurring in the classroom, and those notes were removed from the study to avoid bias on my part. During the observations, I noted that some teachers demonstrated more active use of growth mindset practices than others, but all teachers utilized at least some practices in their classroom. Some teachers appeared to be more comfortable working with students using growth mindset practices than others. After each observation, I reviewed and organized the data in the form, then copied and pasted the anecdotal notes into a Word document for ease of use. The anecdotal notes were then uploaded to ATLAS.ti and coded. One week after the observations, one-on-one interviews were scheduled with the participants. The interviews lasted approximately 35 minutes. I recorded the interviews with the

iPad and then transcribed them. Member checking was utilized to ensure trustworthiness in the study; however, none of the participants required changes to their responses. Responses were uploaded to ATLAS.ti and coded.

Study Findings

At the onset of the professional development, all staff members (including the study participants) completed an online survey from *perts.net*, which was designed to measure the mindset of staff members within the building as a collective whole. Staff members volunteered to complete the survey anonymously, and the results indicated that although no staff members had a fixed mindset, 57% of the staff has an intermediate mindset, meaning they are balanced between a fixed and growth mindset.

Participant Observations

The results of the participant observations indicated that the greatest strengths in the area of growth mindset among all participants included emphasizing a goal of learning and creating an environment that embraces intellectual struggle. The weakest areas of growth mindset practices included avoiding labeling students as smart, affirming high standards, a belief that all students can succeed, and creating opportunities to publicly introspect and celebrate mistakes. It is important to note that it may not be possible for all behaviors to be observed over a 30-minute period, which may contribute to some mindset practices scoring lower than others. The percentage of teachers displaying each mindset practice during their 30-minute observation is indicated in Table 2.

Table 2

Mindset Practices Based on Classroom Observations

Mindset Practice	Percentage of Teachers Demonstrating Use of Practice
Uses mixed ability grouping	50%
Emphasizes high expectations for all students	66.7%
Avoids labeling students as “smart” or “being a math person”	0%
Acknowledges different students publicly for excellence	66.7%
Emphasizes goal of learning throughout the lesson, in addition to lesson outcomes	83.3%
Creates an environment where intellectual struggle is embraced	83.3%
Creates opportunities to celebrate and publicly introspect about mistakes	33.3%
Provides praise that focuses on the process rather than correctness or speed	66.7%
Provides descriptive feedback that focuses students on improvement opportunities	50%
When students are struggling, affirms high standards and provide reassurance that they believe in their ability to succeed	33.3%
Structures assignments so that revisions are allowed (or required) (e.g. first draft of essay is not graded)	50%

Encourages help-seeking and collaboration, but not as a shortcut around struggle

66.7%

Data Analysis and Findings

Coding Process

Once the data collection completed, all documents were uploaded to ATLAS.ti for the coding process. First, the pre-professional development interviews were coded using pre-determined codes that included inhibitors, ability to shift prior to the professional development, addressing factors, teacher mindset prior to the professional development, confidence, and teaching obstacles. The post-professional development interviews were then coded and additional codes were added based on the statements provided in the interviews. As additional codes were added, I utilized the grounded theory of constant comparison to ensure all data was thoroughly reviewed, and no more codes could be developed. A total of 51 codes were identified, which were then each written on a sticky note and grouped according to commonalities.

Initially, five themes emerged from the data. Codes were organized by color in ATLAS.ti and downloaded the themes and matching codes into an Excel document. Screenshots of the initial categorization of the codes is displayed in Appendix E. Once the codes were categorized by theme, the themes were reviewed by creating a table in a Word document and attaching quotations from each code to its corresponding theme. After careful review, the themes were broken down further, and codes were reviewed to look more deeply and establish new themes.

Themes

Five themes and seven sub-themes were identified, as are indicated in Table 3.

Table 3

Study Themes and Sub-Themes

Theme	Sub-Theme
Embracing Mistakes	
Shifting Mindset	Student Mindset Shift in Student Mindset Shift in Teacher Mindset
Developing Grit	Perseverance Confidence
Developing a Growth Mindset	
Preparing for Mathematics Mentally	Connecting Learning Mathematics Anxiety

Embracing Mistakes

An important element of establishing a growth mindset is to embrace mistakes. I addressed the importance of celebrating mistakes while learning, helping students to understand that this is an essential part of the learning process. Additional resources were provided to the participants to help them adopt this mindset in their classrooms. During the one-on-one interviews, several participants noted that during the mathematics block they now focus more on embracing mistakes as part of their lesson. T2 shared her thinking about students projecting their work on the board during her post-professional development interview:

air playing [projecting] their work with mistakes and without mistakes. I've noticed this year I'll say, 'I didn't get to cut your name off or even if it's not right, you got a one,

could you please share it because a lot of people got a one on this'. This year there's a lot of kids that say "Yup, I failed it, but you can still airplay mine" So it just makes it, what I did exactly I don't know.

T3 utilized resources that were shared via a professional development website, and adopted the mindset that mistakes are beautiful:

When we did that PD I explored the youcubed.org site afterwards and there's some really good lessons on there, and the whole mistakes are beautiful, notion - that lesson was really eye opening for a lot of my kids and has been really applicable across the board in all the content areas because they're seeing how when you make a mistake it's not because you're dumb or you're stupid it's because you're growing in your own learning... And it's evidence that you're trying, versus someone who's just sitting there not doing anything. So there are a lot of little exit tickets that I'll give here and there, and I'll use the Class Kick app a lot of times for them to, for me to formative assess them throughout the week. And I'll usually create a slide or a place where they can upload a picture of a beautiful mistake that they made, so a lot of times when they're working in small groups or in partners they have their iPads and they're taking pictures of each problem that they encountered as they're doing their game or whatever, for accountability purposes for me to see that they're on track, but also because then they can catch or capture their beautiful mistakes and then later talk about what they learned from that mistake and how it helped them improve in their learning and understanding.

T5 also shared how she has shifted her instruction to include praising mistakes during instructional time:

The way we embrace the mistakes and talk it up and I know for me that's new to come out every instance and say, you know, stop and say, this is a perfect example, you did just what I wanted you to do. Like that's the perfect mistake to make, or but also, kind of thinking ahead, like what mistakes they are going to make so that you can be ready to have that teachable moment and know what to do in that moment.

Shifting Mindsets

Both student and teacher mindset were discussed in the interviews with participants. Initially, in the pre-professional development interviews, the participants indicated the importance of student mindsets when learning mathematics. During the post-professional development interviews, most teachers shared their observations of a shift in student mindset, as well as a shift in their own mindset, since attending the professional development. The theme "Shifting Mindsets" emerged from the data. This data was divided up further into the sub-themes of student mindset, shifting student mindset, and shifting teacher mindset.

Student mindset. Participants were asked how they believed student mindset impacted learning in mathematics. T5 stated, "I think it plays a big part in it because that self-fulfilling prophecy you know, if I can't do it, I can't do it." T4 shared a similar perspective in her response:

I think if you think you can you can, and if you think you can't, you can't. And so students that say they can't do math generally can't do math and students that have some confidence and think they have some skills generally can do math.

T3's class of students is a more advanced performing group, and she shared her thoughts on how this group's mindset impacts their learning:

This group that I have is a higher abled group, and there's a lot of perfectionism in here. There's a lot of fear of not getting it right, and that's almost getting in the way of them being successful at times.

Shifting student mindset. After attending the professional development session and having approximately five weeks to implement growth mindset strategies in their classrooms, teachers noticed a shift in student mindset. These responses collectively established the sub-theme "Shifting Student Mindset." T3 noticed a change in student mindset after teaching students the power of "Yet" in her classroom:

We have kind of established that idea of the power of "Yet" in here and it's been cool because I've seen the kids begin to correct each other, like "I don't get this!" Someone else will chime in from across the room, "YET!"

T4 noticed a shift in student mindset through the conversations students have with each other during their mathematics block. She stated, "Like I said when there are mistakes I don't hear the 'Oh, you're wrong' It's the 'It's ok, your brain is growing today'." T3 shared her observations of students shifting their attitudes towards mathematics:

You know some kids come in and they tell you right off the bat that they don't like reading or they don't like math, and I feel like through them understanding that the struggle is helping them learn, helping them understand that, has kind of changed their perspective, so when we get to the math now, there's a lot less of the groaning and they're pretty eager. They get excited about it a lot more than they did at the beginning of the year.

T5 noticed small changes in student mindset in mathematics since attending the professional development:

And I think you know they're kind of getting to the point where they're like it's ok not to know something and it's really cool when I don't. They're also starting to realize when something's hard and then you understand it, like that's a really good feeling, so they're starting to find successes with that, so it's almost like everything that I've been preaching for them to practice, they're like, "Oh, OK!" so it's like slow and coming but it's like, I see improvement with it every day. A little bit, like somebody approaches a problem differently or this person doesn't cry because they got it wrong. It's just little things.

Shifting teacher mindset. Participants shared their thoughts regarding a shift in teacher mindset since attending the professional development. T2 stated that she is more willing to take risks in the classroom:

So when I'm, like I feel more of let me just give it to them, like sometimes I'd stand up there in the past I've thought do I really want to put this up here? Pffft, no. But now I'm like, why not? Why not? Let's put it up there! So I've been challenging myself of just let's, let's just try it.

T3 shared her self-reflection on learning about teacher mindset:

how my own mindset was more fixed through that initial survey that we first took versus growth, and so it really kind of helped to open my eyes in that way and just kind of changed how I think about things around here, and so I would just say thank you for sharing that! It was very helpful and beneficial.

T4 adjusted her approach to teaching and quickly noticed a difference in her students. She shared, "So I think this year spending a lot, a whole lot more time and rethinking my approach to teaching is already even after just two days ensuring better understanding than last year." T6 noted they already had a growth mindset prior to the professional development, and the

information shared confirmed that what they were doing was right. T5 shared that they had a growth mindset prior to the professional development, however now they were more focused on implementing growth mindset strategies for their students. T1 did not share whether or not the professional development had an impact on their mindset.

Developing Grit

The theme “Developing Grit” emerged from the data after careful review by the researcher. Within that theme, two sub-themes emerged: perseverance and confidence. During the pre-professional development, several teachers noted a lack of perseverance as a barrier to helping students succeed. T5 shared her thoughts on perseverance and how it impacts student mindset:

And it’s not always the mindset, it’s the perseverance aspect because most of them when something gets hard or frustrating, we don’t have to do it anymore or you know if I cry, nobody is going to make me do it, or if I sit here and do nothing who’s going to make me do it and that’s the kind of the bigger mindset that these kids have.

After the professional development, T1 noticed a change in perseverance while students were taking a mathematics benchmark:

I was really impressed with the perseverance of a lot of them. Because while I thought it was very developmentally appropriate, it still took a lot of stamina, and a lot of conceptual understanding and really thinking and persevering through two-part problems and at the beginning of the year when I gave a similar diagnostic there was a lot of shutting down and just not even trying to work problems out, but I saw through the benchmark, there was definitely more effort and a lot more perseverance.

Participants noted confidence as an issue that inhibits student learning in mathematics. When asked about the biggest obstacle teachers face when teaching mathematics, T6 stated that confidence was the biggest problem. After implementing growth mindset strategies, T3 shared her belief that there had been an increase in the level of confidence within the classroom. T3 stated, “So I feel like the climate of the class has really evolved in a way that has made them feel more confident.”

Developing A Growth Mindset

During the interviews, teachers shared several strategies they used for developing a growth mindset. T4 shared her strategy for overcoming negative attitudes towards learning in mathematics:

When students moan and groan that they are learning something new I try to make light of it, I try to say “Oh, yes!” I try to say something like, “Oh yes. . . you’re teaching me something new today! My brain is going to grow!” Or I just try to be really encouraging and tell them this is the next step, it’s not, we’re going to work through this, I’m going to support you in this, it might be challenging at first but you’ll get better at it.

T2 helps students develop positive attitudes towards learning by helping them overcome moments of failure:

or just say “I like how you did that!” Even if “Billy” doesn’t really know how to do it, at least find something that he can do and I think just getting them around their peers so they have those moments of failure and those moments of feeling good, hopefully they can just continue feeling good and keep making mistakes, but knowing that’s ok, I’ve done this before. Just giving those opportunities for failure, and to feel good about themselves.

T3 adopts the power of “yet” in her classroom, and allows for peer collaboration to reduce mathematics anxiety:

the power of yet, I feel like in the small group learning they have, they feel a little bit more comfortable sometimes with taking the risks so I try to plan a lot where they're in small groups or with partners, just seeing how they really learn a lot more from each other sometimes than they even learn from me when I'm standing in front of the group. So I try to make sure I have plenty of opportunities for them to work with their peers because I think that helps establish that comfort and reduce that anxiety. And just the goal setting being huge for that growth mindset.

Preparing for Mathematics Mentally

During the interviews, the participants discussed what teachers believe students need to be able to do in order to be successful in math. In both the pre- and post-professional development sessions, participants shared their belief that mathematics not only involves number sense, it requires a level of mental preparation in order to be successful. The theme “Preparing for Mathematics Mentally” emerged from participant responses, and the theme was further broken down into sub-themes, which included connecting learning and mathematics anxiety.

T5 discussed an experience she had in her classroom regarding a lesson on place value and how students failed to see a connection between mathematics and real world experiences:

I think they don't always see the connection, like how it's going, and why it's important. And when you try to tell them about money and like we're trying to do millions place, and I'm like how are you guys going to be millionaires if you don't know how to write numbers to the millions. And you know, they just don't see how it's connected to life, so it's not important, it's hard, I'm not going to do it.

T1 discussed strategies she is using in her classroom to help students be successful. This year, she has noticed that students struggle to connect their learning in mathematics, which she plans to address in the near future:

So just giving them a lot of pictures and a lot of visualizing experiences, and drawing, and using real things so they can see it. And connections too, which they are not the strongest on, the connections, which is something we need to move into - the connecting piece.

Participants also discussed ways in which they are helping students overcome mathematics anxiety in the classroom. T3 helps her students feel comfortable in the classroom by offering a “pass option” to prevent them feeling as if they are being put on the spot:

there’s always that pass option, you know, if you’re really not sure. It’s not like they’re on the spot and cameras, lights are on them. They have that option and I always come back to them then and make sure that they were listening and that they’ve, you know, that they can talk about their thinking after they’ve had time to hear some of the other ideas. I feel like in those ways they’ve been able to overcome anxieties that they may have had.

T2 has noticed a shift in the climate of her classroom since introducing growth mindset strategies in her classroom:

I see them trying. The effort is there. They’re still wanting to do what they think is right - they’re not taking the time, but they’re not heavy breathing when they have to do something. They kind of feel like “Ok, I’ll give this a try”. So, it just doesn’t feel that heavy weight of anxiety as much, you can kind of just feel it.

Research Questions

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher's ability to address issues of mathematics anxiety in the classroom?

During the interviews, teachers reflected on their shift in teaching practices after the professional development. Many teachers embraced the notion that making mistakes helps students grow in their learning, and discussed how they adopted this mindset practice in their classroom. T1 shared how she began utilizing mistakes as a growth tool in the day-to-day practices in her classroom:

They were putting down random things, and I know if they are coached through it they, and probably just minor tweaking, they can get it. So I think using those mistakes as a growth tool, and not making them feel bad about that, and some of them will, but I think that's part of the growth too, you have to get past that, you know mistake is not the end of the world, there are very few mistakes in life that we can't work together to fix.

T5 discussed how she reminds students each day that making mistakes helps their brain grow. She stated:

The way we embrace the mistakes and talk it up and I know for me that's new to come out every instance and say, you know, stop and say, this is a perfect example, you did just what I wanted you to do. Like that's the perfect mistake to make, or but also, kind of thinking ahead, like what mistakes they are going to make so that you can be ready to have that teachable moment and know what to do in that moment.

T2 noted that developing a growth mindset in her classroom has required her to shift her own mindset. She stated, "I think I'm more controlling than I ever thought I was, and to let go of my

way is hard, so I've been trying." T6 shared his thoughts on the growth mindset portion of the professional development:

I pretty much had the growth mindset, I think that you just confirmed that what I'm doing is the right, and I've picked up little tweaks just trying to make sure I constantly focus on the growth mindset and not to forget about it.

Several teachers noted that they focus more on building confidence among their students during the mathematics block by using growth mindset strategies. T4 shared one change she made to her teaching practices:

having them work with a partner because lots of times they learn, they will learn and feel confidence when they're working with a partner instead of when they're just with me because sometimes they feel like they need to be right, whereas when they're working with another classmate they don't always feel like they need to be right when they are with them.

T6 motivates his students to succeed by reminding them of the small steps they make in mathematics, and "constantly telling them they can do this." Additionally, he deliberately structures his lesson to help students build both stamina and confidence during mathematics:

[I am] constantly give them challenging problems to get them to learn how to persevere. I'm constantly trying to build in math facts, embed them into the lesson whenever possible, and I'm trying to build their confidence every time they get something right, or they get a step right.

T4 also helps develop confidence in her students by providing them with mental mathematics strategies, as well as "pushing them to think of more than one way that they can solve a problem."

RQ2: How does adjusting teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

After the professional development, teachers noticed a shift in student mindset. Students began to show excitement towards math, and were more willing to take risks in the classroom. T4 noticed a shift in student mindset after implementing growth mindset practices shared on youcubed.org:

I think that using some of the mindset videos that we have by Jo Boaler, I think at the beginning of the year that really helped them change their own mindsets and it also probably helped me change it a lot too because now one of my favorite comments around here is when I make a mistake or one of them makes a mistake and I'll say, did you figure out where you made your mistake? And they'll say yes! And one of their classmates will say, "That's ok! Your brain grew today!" And I just, I love that they have adopted that mindset. I want to continue, my goal, well, I might be getting ahead of myself, but I really want to go back and finish watching the videos we didn't get to because I think they were so powerful.

T5 discussed how students were more willing to take risks in her classroom:

I think they're more willing to take chances of being wrong, you know, or, when we do the math review work they just come up and do it, and you know, it's not do you want to do it, it's you are doing it, you're explaining it. I think the number talks have helped with that, you know.

Teachers also noticed a shift in students' attitudes towards math in general. T6 noticed that students are getting excited for math, where "typically in math it's that they think that they stink, and they can't do anything right." T4 shared, "I think just their general attitude. I have

some students in the beginning of the year, one in particular that told me she wasn't good at math, and she's coming around and saying, "I'm beginning to like math." T4 also noticed that students are encouraging each other more, and T6 has noticed an increase in student confidence since implementing growth mindset strategies in mathematics.

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student's grit as perceived by the teacher?

Since implementing growth mindset practices, participants noticed an increase in perseverance when students approached challenging problems. T5 shared an experience she had with two of her students who were struggling with a mathematics problem:

I had a couple of girls because we were doing word problems and you know they just psyched themselves out before they even knew what it's asking because it's a word problem. 'Oh these are too hard, I can't do these'. I said you just have to practice, the first part is reading. We did some strategies the read, write draw, or read draw write, whatever it is, and kept practicing and practicing. I said you know it's a really great feeling when something is difficult and hard and you push through it and then you finally get it and the light bulb comes on, that's a really successful great feeling. And like two of the girls like halfway through were like, you're right! Now that we get it, it does feel great! And I was like, see!

T1 has a class that consists of 14 boys and three girls, and initially perseverance was an issue in mathematics. In her post-professional development interview, she stated, "I do think they are developing the perseverance skills that will make them successful."

Several teachers remarked on the link between perseverance and confidence. T2 believes that confidence has led to students persevering in mathematics, stating, "So I think that they are

pushing themselves more than I've seen in past years because they're feeling more confident with things." T3 believes that by fostering a growth mindset in her classroom, students are more confident overall. T2 not only noticed an increase in perseverance, she also noticed a decrease in anxiety:

I see them trying. The effort is there. They're still wanting to do what they think is right - they're not taking the time, but they're not - heavy breathing when they have to do something. They kind of feel like "Ok, I'll give this a try". So, it just doesn't feel that heavy weight of anxiety as much, you can kind of just feel it.

Summary of the Findings

In this chapter, I presented the data analysis and findings to explore the affect of professional development on the topics of mathematics anxiety and professional development on teacher planning and instruction, as well as student mindset and grit as perceived by the teacher. The qualitative data collected through interviews and observations over a five-week period provided sufficient evidence to answer each of the three research questions.

Participants shared ways in which the professional development impacted their planning and teaching practices in mathematics. Several teachers discussed a shift in their approach to mathematics, explaining how they now embrace mistakes in the classroom, adopting mistakes as part of the learning process. Teachers also shared how the process of utilizing growth mindset practices in the classroom is helping to build student confidence in mathematics. As a result of the professional development, a few teachers came to the conclusion that they held more of a fixed mindset than they realized. As a result of this, those teachers have adjusted their teaching practices to reflect more of a growth mindset in their classrooms.

As teachers implemented growth mindset strategies in their classrooms, they began to notice a shift in student mindset. Teachers noticed that as they embraced mistakes as part of the learning process, students were more willing to take risks in the classroom. Additionally, teachers noted that student attitudes towards math are improving as well. According to the participants, students now look forward to mathematics and are also more likely to encourage each other during class.

Students are also demonstrating perseverance when working through tasks in mathematics. Teachers noted that since establishing growth mindset practices in their classrooms, students are exhibiting more confidence, which they believe is helping students to persevere through challenging tasks. One teacher noted that students are beginning to value the intrinsic rewards of being successful in mathematics when they persevere. Another teacher shared that as a result of implementing growth mindset practices, students are putting forth more effort, and there is less anxiety in her classroom. In Chapter 5, I will discuss the findings of this study, as well as the implications and recommendations for future research.

Chapter 5: Discussion and Conclusion

Mathematics anxiety is an obstacle to learning for some students (Vukovic, Kieffer, Bailey, & Harari, 2013). Symptoms of mathematics anxiety appear as early as first and second grade (Ramirez, Chang, Maloney, Levine, & Beilock, 2013). Research suggests that students with higher levels of mathematics anxiety will have lower levels of mathematics performance (Vukovic et al., 2013). It is possible for students with mathematics anxiety to change their attitude towards mathematics in early childhood (Ramirez, Gunderson, Levine, & Beilock, 2013), and if students have additional control resources available such as shifting mindsets, their feelings of anxiety may be reduced (Lyons & Beilock, 2012a).

Individuals who develop an incremental theory of intelligence believe that intelligence is malleable and can change with increased practice and effort (Boaler, 2013). Students with an incremental theory of intelligence feel as though they have more control over their learning, resulting in positive emotions towards academics (King, McInerney, & Watkins, 2012). The purpose of this study was to explore how professional development on the topics of growth mindset and mathematics anxiety affects the planning and instruction by teachers of mathematics, as well as student mindset and grit as perceived by teachers in one suburban elementary school.

In Chapter 5, a review of the research methods, as well as the findings from the study will be discussed. There is also an analysis of the data collected and a discussion of the results as they relate to the literature. How this study impacts practice and recommendations for future research will also be shared.

Summary of the Results

A single qualitative exploratory case study was conducted in a suburban elementary school in the northeast region of the United States. The school has a student population of approximately 448 students, 18 classroom teachers, two administrators, and one lead teacher. All mathematics teachers of students in grades two through five were invited to participate in the study. Out of 11 possible participants, six classroom teachers agreed to participate in the study.

Qualitative data was collected using pre-professional development interviews, observations, and post-professional development interviews. The research questions were as follows:

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher's ability to address issues of mathematics anxiety in the classroom?

RQ2: How does adjusting teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student's grit as perceived by the teacher?

Once the data was collected and coded using the grounded theory of constant comparison, five themes and eight sub-themes were identified from the research. Data was analyzed that related to each of the three research questions. This analysis and reflection on the data provided a deeper understanding of the implications of using growth mindset strategies in the mathematics classroom.

Table 4

Study Themes and Sub-Themes

Theme	Sub-Theme
Embracing Mistakes	
Shifting Mindset	Student Mindset Shift in Student Mindset Shift in Teacher Mindset
Developing Grit	Perseverance Confidence
Developing a Growth Mindset	
Preparing for Mathematics Mentally	Connecting Learning Mathematics Anxiety

Discussion

Research Question 1: The Impact of Professional Development on Teaching Practices

RQ1: How does professional development offered to teachers on growth mindset affect teaching practices and a teacher’s ability to address issues of mathematics anxiety in the classroom?

The study results indicated that participants noted several changes in their approach to teaching mathematics after attending the professional development. Some teachers began to notice a shift in their own mindset after the training, enabling them to adjust their teaching practices to foster a growth mindset in their classroom. Participants are focusing more on building student confidence as a result of the professional development. To accomplish this, they are using strategies in their instruction such as embedding confidence building in lessons, allowing for peer collaboration, and encouraging students to think of multiple ways to solve mathematics problems.

During the interviews, one participant discussed how the professional development helped him/her realize their mindset was more fixed than previously realized. Another participant shared how he/she did not realize how controlling they were in the classroom, and since the professional development, he/she has been working on releasing that control. The teacher has been more open to growth mindset practices in the classroom, particularly taking risks as the teacher, which in turn is encouraging the students to take risks as well. Teachers have become more reflective in terms of their mindset, rethinking their approach to teaching mathematics to include growth mindset strategies during instructional time.

Teachers adjusted their teaching practices to foster a growth mindset in their classrooms by embracing mistakes. Teachers utilized several strategies to embrace mistakes including math talks, displaying student work with mistakes to allow for reflection, and having students independently reflect on mistakes as part of the learning process. Many participants hold daily math talks at the beginning of their mathematics block. During this talk, teachers share a mathematics problem and students take turns discussing what the problem is asking, then share different strategies that could be used to solve the problem. While conducting math talks during the study, teachers encouraged students to share their thinking and held back from correcting student mistakes. During discussions, the teacher and students worked together through the learning process to help students utilize mistakes as a growth tool. Teachers also noted that they plan ahead as to what mistakes they think students may make so they can help the students work through them with confidence. T2 stated:

Well, not to put mindful in there, but just being more mindful of this is my expectation, this is what I would like as my result, but just know that it's not going to be as easy as

what I expect. So, just getting myself ready for some failure helps me so I can just, you know, and just knowing where they come from has helped.

This shift in their approach to teaching shows that prior to the professional development, teachers viewed mistakes as proof that students did not understand a concept; however, after the professional development teachers valued mistakes as a part of the learning process and adjusted their teaching practices accordingly.

Research Question 2: Adjusting Teaching Practices to Impact Student Mindset

RQ2: How does adjusting teaching practices using growth mindset strategies impact student mindset as perceived by the teacher?

During the interviews prior to the professional development, teachers acknowledged that mindset was important to student success in mathematics. Teachers recognized that many students were coming to their classes at the beginning of the year with a fixed mindset, already believing that they are not good at math. T3 stated, “I think that’s one of the hardest things because some of them just come in with this idea that math is hard and they are not, you know, why even bother, why try.”

To help students overcome fixed mindset thinking, participants shared videos from youcubed.org with their students, helping students to see how making mistakes helps their brain to grow and make new connections while learning. In doing so, teachers helped students understand the power of “yet,” meaning that while they may not understand a concept at the time, with practice they will get it eventually. By adopting the power of “yet” thinking, teachers noticed a shift in the culture of their classrooms. T4 shared, “Like I said when there are mistakes I don’t hear the ‘Oh, you’re wrong’ It’s the ‘It’s ok, your brain is growing today’.” T6 also

noticed a shift in confidence as a result of implementing growth mindset strategies: “And the confidence, yes. There has been a great difference.”

According to participants, students have gained an understanding that mistakes are allowing their brain to grow. As a result of this, students are more willing to take risks in the classroom, and are more willing to participate in class discussions. Participants have also noticed an increase in excitement for mathematics as compared to the beginning of the year.

Research Question 3: Impact of Growth Mindset Strategies on Student Grit

RQ3: How does adjusting teaching practices using growth mindset strategies impact a student’s grit as perceived by the teacher?

During the interviews prior to the professional development session, teachers regarded a lack of confidence as one of the biggest obstacles in a student’s ability to learn mathematics. After the professional development, participants have placed a greater emphasis on building confidence in students through math talks, peer collaboration, and reinforcing the idea that mistakes are a part of the learning process. Participants are now including growth mindset strategies in their daily lessons with the intent of building student confidence.

Participants noticed that students are developing more confidence, as well as the ability to persevere through challenging tasks. The teachers noticed that students were pushing themselves more in math, and had stamina when faced with age-appropriate math tasks. T2 stated that there they no longer “feel that heavy weight of anxiety as much, you can kind of just feel it.” T5 shared how students persevered through a difficult problem and then benefited from the intrinsic rewards of being successful. By giving students permission to make mistakes, students were less likely to give up quickly when they did make mistakes, knowing that this was a part of the learning process and not a sign of failure.

Results as Related to the Literature

The findings from this study supported literature on growth mindset. As part of the professional development session, staff members participated in an online survey to determine their mindset. The results of this survey indicated that only 43% of the staff had a growth mindset, and 57% had an intermediate mindset. An intermediate mindset occurs when individuals hold a mindset that is between a fixed and growth mindset. According to Rattan, Good, and Dweck (2012), teachers who have a fixed mindset are more likely to identify a student as having low ability after only one assessment. Teachers must also be careful to avoid fixed mindset praise, such as labeling students as smart, or grouping students by ability (Boaler, 2013).

Embracing Mistakes

During the professional development, teachers were provided information explaining how new synapses are formed in the human brain when mistakes are made in mathematics (Dweck, 2012, as cited in Boaler, 2013). If students are constantly solving problems correctly, new synapses are not formed; therefore, students' brains are not growing (Boaler, 2013). After the professional development, participants began embracing mistakes as a part of their daily instructional practices. T4 stated, "I know we want students to be accurate but we really focus on the 'It's ok to make mistakes in here' now more so than I think I ever have in the past."

Since teachers began embracing mistakes as part of their daily practice, students are more willing to take risks in the classroom, celebrating their mistakes as they occur, and being reflective in the impact the mistakes had on their learning. Teachers have noticed an increase in students will to attempt different strategies to solve problems, as well as share their mathematical thinking with the class without a fear of being incorrect. T3 stated:

When we did that PD I explored the youcubed site afterwards and there's some really good lessons on there, and the whole mistakes are beautiful, notion - that lesson was really eye opening for a lot of my kids and has been really applicable across the board in all the content areas because they're seeing how when you make a mistake it's not because you're dumb or you're stupid it's because you're growing in your own learning.

Participants noticed an overall increase in the students' willingness to take risks and confront challenging tasks after implementing growth mindset strategies in their classrooms.

Shifting Mindset

According to Burke and Williams (2012), when students are explicitly taught skills to develop a growth mindset, their understanding of intelligence will improve. In teaching students the skills to develop growth mindset, educators can help shift student mindset by providing students with the scientific reasoning behind the brain's plasticity and its ability to grow (Yeager & Dweck, 2012). T4 noted how the mindset of their class has shifted since gaining an understanding of how the brain works when it is learning:

I think it's, I think that using some of the mindset videos that we have by Jo Boaler, I think at the beginning of the year that really helped them change their own mindsets. And it also probably helped me change it a lot too because now one of my favorite comments around here is when I make a mistake or one of them makes a mistake and I'll say, 'Did you figure out where you made your mistake?' and they'll say 'Yes', and one of their classmates will say, 'That's ok! Your brain grew today!' And I just, I love that they have adopted that mindset.

A fixed mindset can result in students believing they are “dumb” when attempting to work through challenges, impacting even those high-achieving students. Prior to the professional development session, T3 shared:

This group that I have is a higher abled group, and there’s a lot of perfectionism in here. There’s a lot of fear of not getting it right, and that’s almost getting in the way of them being successful at times.

During the final interview after the professional development, T3 shared their observations on how the mindset of the class has shifted:

Like when we took our benchmark on PreVLearn, I was really impressed with the perseverance of a lot of them. Because while I thought it was very developmentally appropriate, it still took a lot of stamina, and a lot of conceptual understanding and really thinking and persevering through two-part problems and at the beginning of the year when I gave a similar diagnostic there was a lot of shutting down and just not even trying to work problems out, but I saw through the benchmark, there was definitely more effort and a lot more perseverance.

After explicitly teaching growth mindset strategies to their students, most participants noticed an overall shift in student mindset when approaching challenging tasks in the mathematics classroom. Additionally, a few participants shared that their mindset shifted as a result of the professional development as well.

Developing Grit

Burke and Williams’ (2012) research showed a positive relationship between perseverance and the belief that intelligence is malleable when working on tasks that involve active thinking skills. Students who believe their intelligence is fixed may give up on

challenging tasks more easily, lacking the motivation they need to persevere (Burke & Williams, 2012). Participants implemented growth mindset practices into their daily instruction, providing feedback that was mindful and encouraging students to embrace mistakes as part of the learning process. Teachers noticed an increase in perseverance on age-appropriate challenging tasks as a result of these practices.

Participants noted at the beginning of the study that student mindset impacted their ability to perform in the classroom. T5 shared, “It’s just almost like it’s so ingrained from like even if you are seeing it in third grade it’s so ingrained from like the very beginning that math is hard, I don’t like it, I’m not good at it”. By the end of the study, teachers were noticing an increase in confidence as well as perseverance in mathematics. When faced with a challenging problem, negative emotions can be reduced if students are able to see the learning experience as an opportunity for growth (King, McInerney, & Watkins, 2012).

Developing a Growth Mindset

As the rigor in mathematics increases, it becomes even more imperative that students develop a growth mindset in mathematics to handle the increasingly challenging work, otherwise student performance will continue to decline (Yeager & Dweck, 2012). As a strategy to develop growth mindset, most participants acknowledged adopting the power of “yet” in their classrooms to help students understand that with consistent practice they would eventually become successful at a given skill. According to Boaler (2013), after receiving an intervention students show an immediate benefit from developing a growth mindset, demonstrating improved performance in target areas. When asked if there has been a difference in student achievement after providing growth mindset intervention in the classroom, T4 shared the following:

Well, it's hard to tell whether it's because of the math mindset, growth mindset, or if it's because they've had more practice with it, it's really hard to tell whether that is, but absolutely. I've seen students that came in here that didn't know how to do two digit by one digit multiplication problems that are now successfully solving two digit times two digit problems and four digit times one digit and they're even challenging themselves to, 'Oh, well would this strategy work with a five digit times five digit problem?' 'Well I would use a calculator personally, but you can try!' So, I think that they are pushing themselves more than I've seen in past years because they're feeling more confident with things.

T4 shared that it was a little too early to tell if there is a difference in achievement, but there has been an increase in student confidence when approaching challenging problems. T6 noted the following:

Yes. Well, it's baby steps. There's certain kids that I don't see it in achievement but I see it in effort. For example, there is one student that did nothing, but I'm seeing her work now. So, she's getting toward the achievement aspect of the correct answer, but before she was doing nothing at all. And I have seen some people, yes, there's a couple specific kids.

After the professional development, participants shared that they took on a positive approach to student learning, providing encouragement and recognizing even small steps in student learning. Teachers established a safe learning place, giving students opportunities to share their thinking without judgment, particularly during daily math talks. T2 discussed how they became more mindful of their expectations, and accepted that there was going to be some failure before the students gained mastery of a skill. T2 stated:

Even if “Billy” doesn’t really know how to do it, at least find something that he can do and I think just getting them around their peers so they have those moments of failure and those moments of feeling good, hopefully they can just continue feeling good and keep making mistakes, but knowing that’s ok, I’ve done this before. Just giving those opportunities for failure, and to feel good about themselves.

Yeager and Dweck (2012) stated that teachers should praise students for their effort, strategies used, ability to focus, and perseverance when working through a challenging task.

Preparing for Mathematics Mentally

Students who have mathematics anxiety demonstrate negative feelings that affect both their academic performance and how they learn (Vukovic, Kieffer, Bailey, & Harari, 2013). According to Ramirez, Gunderson, Levine, and Beilock (2013), teachers need to consider mathematics anxiety as an essential part of lesson planning, just as they would mathematics procedures and assignments. After attending the professional development session, T3 reflected on how mathematics anxiety impacts student learning. T3 stated, “So when I went to your PD it was helpful in seeing how math anxiety really does impact kids a lot more than I realized.” T3 now gives students the option to listen to the math talks in class, and participate when ready. T3 shared:

there’s always that pass option, you know, if you’re really not sure. It’s not like they’re on the spot and cameras, lights are on them. They have that option and I always come back to them then and make sure that they were listening and that they’ve, you know, that they can talk about their thinking after they’ve had time to hear some of the other ideas. I feel like in those ways they’ve been able to overcome anxieties that they may have had.

Participants recognized anxiety in students when faced with challenging tasks in mathematics. When discussing students with anxiety, T1 shared that “they feel like they’re not successful and they either shut down or they just have maybe some behaviors that you think are behaviors but really they are just trying to avoid.” Blackwell, Trzesniewski, and Dweck (2007) stated that students with a fixed mindset are afraid of making mistakes and attempt to avoid situations that could result in failure. Since using growth mindset strategies, T1 has noticed a difference in student performance, noting that students are now persevering through challenging tasks.

After implementing growth mindset interventions, T6 noticed a difference in how students approached mathematics, stating, “I do see the growth mindset working because they are getting excited, and typically in math it’s that they think that they stink, and they can’t do anything right.” By helping students overcome mathematics anxiety at a young age, teachers may help to prevent long-term effects of mathematics anxiety (Ramirez, Gunderson, Levine, & Beilock, 2013). Maloney and Beilock (2012) stated that it is essential for educators to utilize cognitive reappraisals to address mathematics anxiety because changing the teaching of mathematical skills by alone will likely not effect students with mathematics anxiety.

Limitations

This study was conducted in one suburban elementary school in the northeast region of the United States. Purposive sampling was used, generating a sample size of only six participants. Due to a small sample size, there is a challenge in generalizing the results of this study to a greater population.

The duration of the study covered a period of five weeks, which included the professional development, observations, and post-professional development interviews. During the

interviews with the participants, several participants noted that they could not accurately state whether or not there was an increase in student achievement as it was too early to tell what impact the growth mindset interventions had on achievement. A few of the participants stated that they would be able to more accurately answer that question at the end of the school year.

During the study, there was a shift in the administration in the building and a temporary administrator was assigned to the building. Without permanent leadership, it is unknown how this study will impact the staff on a long-term basis. Decisions will need to be made by the future administration to determine whether or not to continue utilizing growth mindset interventions in the mathematics classroom.

Implications

According to studies, students with a positive academic mindset also show increased student motivation for learning (Rattan, Savani, Chugh, & Dweck, 2015). The results of this study support previous research on growth mindset. In this study, participants noticed an increase in student motivation as well as confidence after growth mindset interventions were implemented in the classroom. Participants also noted that students who were previously hesitant to perform mathematical tasks were more willing to attempt to solve problems after the interventions, and students who previously did not like mathematics began to look forward to the mathematics block.

Implications for Teachers

Understanding an individual's mindset is essential to quality teaching. At the onset of the school year, teachers need to reflect on their own mindset, and how they will approach teaching mathematics. Both the teacher and the student need to understand that mindset impacts performance; therefore, teachers should consider explicitly teaching growth mindset strategies

and embedding these strategies in their daily mathematics instruction. These strategies include praising mistakes and guiding students in how to reflect upon their mistakes and learn from them.

To help students be successful in mathematics, teachers need to teach students how to engage in productive struggle, encouraging them to take risks and persevere through challenging tasks. Increasing student exposure to open-ended challenging math tasks will build both confidence and perseverance in mathematics. It is important to allow students to celebrate their achievements, no matter how small, which in turn helps build confidence.

Implications for Administration

During the professional development session, I conducted a survey on the mindset of the entire staff. The results of the survey indicated a lack of growth mindset in 57% of the staff. A fixed mindset can be detrimental to the growth of the students, because when teachers with a fixed mindset believe that students have low ability in a certain subject, students can suffer from a decrease in both confidence and perseverance (Yeager & Dweck, 2012). All teachers who participated in this study noticed an increase in confidence and/or perseverance after implementing growth mindset strategies in their classrooms. In order to maximize student growth in mathematics, it would be beneficial for all teachers to continue to receive professional development on both mathematics anxiety and growth mindset, providing teachers with the resources to alleviate mathematics anxiety and increase student confidence and perseverance.

Recommendations for Further Research

Based on the results of my study, several recommendations for future research developed. This study was only offered to teachers of students in grades two through five, with teachers in grades three through five agreeing to participate in the study. During an interview,

one of the participants asked when did we begin to lose students in math – at what point do they lose their confidence in mathematics? Based on this conversation, I would recommend conducting a study with students and teachers in grades K-2 to determine how many students are affected by mathematics anxiety in kindergarten as compared to second grade. Additionally, it would be interesting to see how many teachers in the primary grades have mathematics anxiety themselves, and how that may or may not impact their students' levels of anxiety.

During another interview a participant mentioned that their class was a higher-level math class that struggled with perfectionism and was afraid to take risks prior to the growth mindset interventions. Boaler's (2013) research stated that students performing at higher levels in mathematics could have a fixed mindset, fearing failure instead of establishing learning goals. Another aspect to research is whether or not students who perform at high levels in mathematics are more or less likely to suffer from mathematics anxiety.

During the interviews, several teachers stated that their students had difficulty making connections in mathematics, both between mathematical concepts and connecting math to real-world situations. A potential research topic may be to determine whether students with mathematics anxiety are more likely to struggle with making connections between mathematical concepts than students without mathematics anxiety. With the increase in complexity of problem-solving skills required of students today, the results of this study could shed light on the processing skills that students with mathematics anxiety are capable of, compared to those without mathematics anxiety.

As stated previously, this study was limited to one elementary school, with a sample of only six participants. It is recommended that this study be replicated across several schools with a larger sample size in order to generalize the results to a greater population. Additionally, this

study was limited a five-week period, which the participants noted was not enough time to determine whether or not the growth mindset intervention impacted student achievement. I recommend replicating this study for the duration of one school year to determine the long-term effects of growth mindset interventions on students with mathematics anxiety.

Conclusion

This chapter focused on the findings, discussion of the results as related to the literature, limitations, implications, and recommendations for future research as related to a study of professional development on the topics of mathematics anxiety and growth mindset. The study was conducted over a five-week period at one suburban elementary school in the northeastern region of the United States. Participants found the professional development to be impactful to their teaching practices, and beneficial to their students in the forms of confidence and perseverance.

Several staff members shared that they will again implement growth mindset interventions at the beginning of the next school year. One staff member commented on their desire to see the difference in their upcoming students next year, knowing that all third graders received growth mindset interventions. Their belief was that as more students benefit from growth mindset interventions, their mathematics abilities will increase as they are promoted through each grade.

This study has shown through the collection, coding, and triangulation of data that the professional development on the topics of mathematics anxiety and growth mindset impacted the teaching and planning of mathematics. As a result of the professional development, participants implemented growth mindset interventions in their classroom, using strategies such as embracing mistakes, encouraging students, and allowing for peer collaboration. By the end of the study,

participants noticed an increase in both confidence and perseverance in their students, as well as an increase in motivation in those students who were reluctant learners at the beginning of the year. Prior research indicated that mindsets can be changed, and that mathematics anxiety can be alleviated through the use of cognitive reappraisals. The results of this study effectively support this research. Teachers who develop a cognitive understanding of their students' levels of anxiety may be able to effectively address issues of mathematics anxiety using growth mindset interventions.

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Appendices

Appendix A: Statement of Original Work

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

Statement of academic integrity.

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

Explanations:

What does “fraudulent” mean?

“Fraudulent” work is any material submitted for evaluation that is falsely or improperly presented as one’s own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate’s final work without full and complete documentation.

What is “unauthorized” assistance?

“Unauthorized assistance” refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another’s work during an online test
 - Use of unauthorized notes or personal assistance in an online exam setting
 - Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University- Portland Academic Integrity Policy during the development and writing of this dissertation.
2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*

Lisa V. Hatcher

Digital Signature

Lisa Hatcher

Name (Typed)

March 1, 2018

Date

Appendix B

Pre-Professional Development Interview Questions

1. What factors do you believe inhibit math growth in your classroom?
2. How do you address those factors when you are planning and teaching math?
3. What are your thoughts on how student mindset impacts learning in the classroom?
4. As an educator, what obstacles do you face when you teach math?
5. What do you do when you have a student who will not attempt to solve a math problem during class?

Appendix C

Post-Professional Development Interview Questions

1. What strategies do you use or plan to use in planning mathematics to account for students who experience mathematics anxiety?
2. What strategies do you use to establish a growth mindset culture in the classroom?
3. How has your planning and instruction of mathematics changed since attending the professional development?
4. How has the mindset of students as perceived by the teachers changed since implementing growth mindset strategies?
5. After utilizing growth mindset strategies in mathematics for a period of four weeks or more, what difference, if any, did you notice in student achievement?
6. Is there anything else regarding growth mindset and mathematics anxiety that you would like to share with me?

Appendix D

Checklist of Growth Mindset Practices (adapted from Sun, 2015)

Classroom: _____

Mindset Practice	Anecdotal Notes
Uses mixed ability grouping	
Emphasizes high expectations for all students	
Avoids labeling students as “smart” or “being a math person”	
Acknowledges different students publicly for excellence	
Emphasizes goal of learning throughout the lesson, in addition to lesson outcomes	
Creates an environment where intellectual struggle is embraced	
Creates opportunities to celebrate and publicly introspect about mistakes	
Provides praise that focuses on the process rather than correctness or speed	
Provides descriptive feedback that focuses students on improvement opportunities	
When students are struggling, affirms high standards and provide reassurance that they believe in their ability to succeed	

Structures assignments so that revisions are allowed (or required) (e.g. first draft of essay is not graded)	
Encourages help-seeking and collaboration, but not as a shortcut around struggle	

Sun, K.L. (2015). There's no limit: Mathematics teaching for a growth mindset (Unpublished doctoral dissertation). Stanford University, Stanford, CA.

Appendix E

Categorizing Themes

Theme: Achievement			Theme: Student Mindset		
Color	Name	Groundedness	Color	Name	Groundedness
Dark Green	Achievement	5	Purple	Ability to Shift - Pre	2
Dark Green	Active Thinking Skills	3	Purple	Collaboration	12
Dark Green	Confidence	23	Purple	Embrace Mistakes	3
Dark Green	Connections	4	Purple	Impact of Student Mindset - Pre	10
Dark Green	Effort	3	Purple	Intellectual Struggle	7
Dark Green	Math Talks	9	Purple	Introspect Mistakes	5
Dark Green	Perseverance	5	Purple	Making Mistakes	9
Dark Green	Practicing Math	2	Purple	Math Excitement	6
Dark Green	Student Conversations	8	Purple	Power of Yet	5
Dark Green	Student improvement	2	Purple	Risk Taking	5
Dark Green	Student Questioning	3	Purple	Shift in student mindset	2
Dark Green	Students challenging themselves	2	Purple	Student Attitude	3
			Purple	Student change in mindset	3
			Purple	Student Engagement	3
			Purple	Student Mindset	3

Theme: Teacher Planning			Theme: Developing a Growth Mindset		
Color	Name	Groundedness	Color	Name	Groundedness
Yellow	Accuracy Goal	5	Turquoise	Encourage students	7
Yellow	Addressing Factors	11	Turquoise	Fixed Mindset Teacher Talk	9
Yellow	High Standards	1	Turquoise	GM Culture	7
Yellow	Inhibitors	14	Turquoise	Growth Mindset Teacher Talk	14
Yellow	Learning Goal	7	Turquoise	Mindset Videos	3
Yellow	Math Anxiety	6	Turquoise	Positive Reinforcement	3
Yellow	Math Strategies	13	Turquoise	Praise Process	10
Yellow	Number Sense	9	Turquoise	Student Labeling	2
Yellow	Planning	2	Turquoise	Teacher Mindset	8
Yellow	Reluctant Learner	14	Turquoise	Teaching Mindset	3
Yellow	Student Groupings	10			
Yellow	Student History	2			
Yellow	Teacher Reflection	3			
Yellow	Teaching Obstacles - Pre	8			

