AN EXAMINATION OF ELEMENTARY MATH ANXIETY, SELF-EFFICACY, AND ACADEMIC ACHIEVEMENT

by

Kimberley Suzanne McMillian

A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Curriculum and Instruction

Charlotte

2017

Approved by:

____
Dr. Drew Polly

____
Dr. Bruce Van Sledright

____
Dr. Teresa Petty

____
Dr. Tracy Rock

ABSTRACT

KIMBERLEY SUZANNE MCMILLIAN. An examination of elementary math anxiety, self-efficacy, and academic achievement. (Under the direction of DR. DREW POLLY)

The study aims to explore the level of suburban 5th grade students' mathematics self-efficacy, math anxiety, and academic achievement, to discover the possible interconnections between these parameters. The measures used to evaluate each included the Math Anxiety Rating Scale, the Self-Efficacy Questionnaire, and the North Carolina End of Grade Assessment for the 2015-2016 school year. The 5th grade students (N=38) were divided into two clusters: 1) students with positive mathematical self: higher mathematics self-efficacy and self-concept and lower anxiety (n=7) and 2) students with negative mathematical self: lower mathematics self-efficacy and self-concept and higher anxiety (n=5).

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

Introduction

Self-efficacy can be affected by three domains: the cognitive, the motivational, and the emotional domain. The effects of self-efficacy beliefs on cognitive processes can take multiple forms. Most human behavior centers on the development of individual goals and setting personal goals are influenced by internal evaluation of individual capabilities. The stronger the perceived self-efficacy, the higher the goal challenges people set for themselves and the stronger their commitment to them. Personal beliefs of efficacy can also play a role in motivation. People motivate themselves and set personal goals based on their beliefs in their abilities and the probability of a positive outcome. Individuals anticipate likely outcomes of prospective actions, set goals for themselves, and plan courses of action. Self-efficacy beliefs contribute to motivation in several ways: they determine the goals people set for themselves, amount of effort expended, level of perseverance, and the amount of resilience to each failure. Generally, individuals who harbor self-doubts about their capabilities reduce their efforts or give up more quickly, when faced with obstacles and failures. In the emotional domain, those who believe they cannot manage tasks experience high anxiety. They tend to dwell on their deficiencies, may view many aspects of their environment as dangerous, and worry about things that rarely happen. Therefore, they distress themselves and impair their level of functioning.

The stronger the sense of self-efficacy the better-prepared are people in taking on mentally challenging activities.

Statement of the Problem

Recent accountability measures developed and implemented in the United States have led to an increased focus on the teaching and learning of mathematics in elementary classrooms. Therefore, research in learning mathematics has become necessary for classroom teachers to enable an individual's full development in today's complex society. Despite its importance in today’s society, mathematics is perceived by most elementary students as difficult, boring, impractical, and abstract (Ignacio, Nieto, & Barona, 2006). Therefore, students’ continued low performance level in mathematics and its relationship to the achievement gap has been a concern for a long time in many countries.

Multiple factors and variables affect students’ success in mathematics. Understanding these variables and factors, and identifying students’ deficits can be used to positively develop student remediation practices and increase knowledge concerning learning difficulties about mathematics. Of the many factors, attitudes in mathematics and mathematical fears or anxieties associated with certain types of problem sets are prevalent (Peker & Mirasyedioglu, 2008). It is generally believed that these attitudes and anxieties present themselves when students encounter mathematical tasks and determine mathematical successes and failures. A student’s constant failure in mathematics and their mathematics anxiety can lead to a form of self-fulfilling prophecy in which a student’s self-awareness of their ability in mathematics can undermine their actual ability, thus causing them to fail. Conversely, successful experiences in mathematics coursework can lead students to develop a positive attitude towards learning mathematics (Akinsola

& Olowojaiye, 2008; Biller, 1996). Therefore, the importance of measuring students' attitudes and anxieties in mathematics classes become increasingly important each day in the educational system (Gerçek, Yılmaz, & Soran, 2006).

Attitudes toward mathematics are formed early and career choices can be affected by mathematics performance. In many educational settings, students' attitudes and anxieties are often not considered, making their expected learning outcomes difficult to accurately assess, and learning opportunities are not properly administered. To achieve expected student outcomes, educators must strive to understand students' attitudes and anxieties as well as the measures that need to be taken to assist in overcoming them (Hancer, Uludag, & Yılmaz, 2007). Thus, one of the objectives of elementary mathematics education must include the students' improved attitudes towards performance and ability. Therefore, identification of elementary students experiencing poor mathematical self-efficacy and high math anxiety is crucial in the development of counseling, intervention programs, and curriculum assignments for struggling students. Previous behavioral studies focusing on individuals with poor self-efficacy have concentrated on adolescents and adults (Young & Menon, 2012); however, very few studies have focused on the data acquired from the self-efficacy ratings of younger students and the relationship to standardized test performance during the elementary school years. Therefore, through a mixed methods approach, the primary purpose of this study is to investigate perceptions and descriptions of the self-efficacy beliefs of fifth grade students that have experienced either success or failure on a high stakes assessment in Mathematics, as well as identify correlations between math anxiety, self-efficacy, and performance through observations, interviews, and artifacts.

Background of the Problem

For the youth in America who wish to go to college, math is a critical filter that has the ability to limit opportunities for high school and college students (Shapka, Domene, & Keating, 2007). Performance self-efficacy can influence the choice of activity, effort, persistence, learning, and achievement. Therefore, low mathematics grades/achievement have a significant impact on aspirations, may prohibit students from enrolling in advanced mathematics courses, limit career choices in the future, and affect a student's belief about their ability. This capacity to accomplish a task or to deal with the challenges of life can be linked to academic achievement (Bandura, 1977). Therefore, the lower the mathematics grade/achievement, the greater the decline in aspirations (Jinks & Morgan, 1999; Shapka et al., 2007); self-efficacy affects academic achievement and achievement affects self-efficacy.

Students with higher self-efficacy have higher aspirations, set goals, and see difficulties as challenges. Self-efficacy beliefs also determine the goals individuals set for themselves, the effort they expend, and their resiliency. Finally, self-efficacy regulates emotional states - the greater the self-efficacy, the lower the stress (Bandura, 1997). Data, from standardized tests at the individual level is more appropriate in tracking student achievement growth (Ding & Davison, 2005). Therefore, it is possible to use standardized assessment results to determine mathematics achievement (Steiner & Ashcraft, 2012).

Under the spotlight of No Child Left Behind, schools and districts now report mathematics performance for all student populations according to gender, race, language, and socioeconomic status. Although some states and school systems have disaggregated achievement data in this way for some time, most schools have simply reported overall school or district averages (Haycock, 2001). These overall school average scores tend to limit the information educators glean from data as compared to that which has been disaggregated. When performance data is reported for every population of students, it reveals that many of our students, especially in urban and rural schools of poverty, are not learning mathematics at the same rate when compared nationally (Burchinal et al., 2011). Therefore, a gap exists between students of different socioeconomic and racial backgrounds.

For many years, researchers have studied the achievement gap with little success in eliminating it. With the exception of a few promising examples, the achievement gap has endured and the reality is that too many students never have an opportunity to develop their mathematical knowledge to its fullest potential (Lee, 2004). Between 1977 and 1988, the achievement gap between African American and White students was cut in half (Haycock, 2001). Unfortunately, the progress came to a halt in 1988 and the gap began to widen. Different groups of students complete high school and post-secondary education at significantly different rates. Approximately 76% of White students graduate compared to 71% African American students (Haycock, 2001). By the end of high school, African American students have obtained math skills that are equivalent to those of White students in the eighth grade (Haycock, 2001). Recent evidence also indicates only 23% of all seniors in high school are proficient in mathematics, while many have wide discrepancies in preparation for mathematics and need remedial coursework their first semester in college (Steiner & Ashcraft, 2012).

Purpose and Significance of the Study

The researcher hopes the results of this mixed methods study will influence educational practices involving elementary student learning in mathematics and encourage educators to promote positive experiences in mathematics classrooms at the elementary level. Negative experiences account for the majority of the aversion to mathematics in the public school system with anxiety making up for the rest. Initiatives have been put into place to promote excellence, but positive experiences must also be included for all children to succeed.

Only 7% of Americans reported a positive experience in mathematics while attending classes in kindergarten through college and an estimated 67% fear and/or loathe the subject (Furner & Duffy, 2002). This negative association toward mathematics has led to increased research into the causes and prevalence of math anxiety within the classroom setting. While the National Council for Teachers of Mathematics (NCCTM) stresses, “excellence in mathematics education requires high expectations and strong support for students,” many researchers and educators are asking how this can be accomplished if research related to mathematics is indicating such high numbers of low self-concept in performance (NCCTM, 2008).

Much of the research in the relationship between mathematics and performance has been linked to cognitive, personal, or environmental issues. Cognitive issues are explained as the result of low mathematical aptitude. Personal issues are explained as individually perceived confidences in the ability to regulate emotion during a stressful event (Galla & Wood, 2012). Finally, environmental causes can be related to covert and overt behaviors exhibited by classroom teachers (Furner & Duffy, 2002). Therefore, much of the research on mathematics has concentrated on the relationship between teachers and math self-efficacy that have only explored the level of teacher efficacy when teaching the subject matter and not on the effect this has on a student or their performance on standardized tests.

The second issue involves the relationship between mathematics self-efficacy and academic performance of children in mathematics. The nature of this relationship is becoming increasingly important due to the prevalence of standardized test data used to evaluate learning. This researcher has found a dearth of research on the relationship between academic performance in mathematics and mathematics self-efficacy in elementary school children. Research conducted by Galla and Wood (2012) examined emotional self-efficacy of children ages five to twelve to determine whether math anxiety and self-efficacy affect academic performance. They found that there is a negative correlation between math anxiety and performance.

Using Albert Bandura's Self Efficacy Theory, Social Cognitive Theory, and Daryl Bem's Self-perception Theory, this study's results will add to the research that establishes a link between self-efficacy and academic success and support claims that children have the ability to effectively and flexibly manage their thoughts, feelings, and actions when navigating social and learning environments.

Overview of Methodology

This mixed method study investigates (a) the levels of self-efficacy in upper elementary students as compared to academic achievement, (b) the correlation between self-efficacy and math anxiety, and (c) the characteristics elementary students exhibit at differing levels of anxiety and self-efficacy. Participants from a Title I school in the southeastern United States were selected from a math anxiety and self-efficacy survey administered by the regular education mathematics teacher. Selected students were observed during two class periods to document characteristics - physical and verbal - that were exhibited while performing a mathematical task from previously taught material. Once the observations were performed, interviews with these students were conducted to assist in further explanations of these characteristics and possible relationships between self-efficacy, academic achievement, and anxiety in a mathematics classroom. Once the data was collected and organized, themes were identified to answer the following research questions:

1. What is the correlation between self-efficacy and math anxiety?
2. What is the correlation between math performance vs. self-efficacy?
3. What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?
4. What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?

Study Limitations

This study can be limited in that the participants were purposefully selected rather than randomly selected. With "purposeful selection" of participants, there is always the chance that the participants may not reflect the opinions and views of the greater population. The study can be considered limited because the participants were chosen from a very small group of students. Another limitation that could affect this study is that teachers at the elementary school were White females and they may not have been able to make meaningful connections with each individual student. Therefore, some students could have missed the personal attention they required. This study may also be limited by researcher-bias. Because this researcher has some strong opinions about this topic, it may be difficult to ignore certain biases and opinions about this subject. Therefore, as a way of controlling for limitations, this study was open to outside scrutiny to avoid any subjectivity.

Secondly, the presence of a researcher observing a classroom can affect the behavior of the teacher. It is possible that the participant teacher deviated from his/her normal approach with students. Students themselves may have been self-conscious and/or behaved in a manner that was not typical of their ordinary style. Observations were made over three class periods a month apart to reduce the observation effect and in essence to make the cameras and researcher become a part of the classroom environment. In addition, since the participants were not aware of the actual purpose of the study during data collection, this might have reduced the possibility of behaving or responding in a manner that would "please" the researcher.

Study Delimitations

This study was delimited to self-perceptions of elementary students and the characteristics they exhibited. Conclusions should not be extended beyond these characteristics students exhibited and the self-efficacy of the students in this study. To ensure the protection of the participants in this study, the researcher carefully followed the guidelines outlined by the Institutional Review Board (IRB). The first consideration involved collecting signed informed consent statements from all participants. The following safeguards were outlined in the informed consent statement:

- Participants’ real names will not be used in the data collection or in the written report. Instead, pseudonyms will be assigned to all participants in all verbal and written records and reports.
- All materials will be locked in file cabinet to safeguard confidentiality.
- No audiotapes, transcription notes, field notes, or observation notes will be used for any purpose other than for the purpose of this study. When this study is completed, all related materials will be destroyed.
- Participation in this study will be strictly on a voluntary basis. Participants have the right to withdraw from this study at any time without penalty.

Along with the above listed safeguards, proper permission was secured from the data collection sites giving permission to do the study in the school. In addition, a timeline was provided indicating the projected times when each phase of this study would take place. Therefore, the information gained from this study might be helpful in learning more about the phenomena of mathematics self-efficacy and anxiety, and its findings might be beneficial to the education process of all students, including African American students, and to the educational field at large.

Definition of Terms

Academic achievement. This represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university.

Achievement gap. This gap refers to any significant and persistent disparity in academic performance or educational attainment between different groups of students, such as white students and minorities, for example, or students from higher-income and lower-income households.

Anxiety. This is a feeling of worry, nervousness, or unease, typically about an imminent event or something with an uncertain outcome.

Attitude. This is a manner, disposition, feeling, position, etc., with regard to a person or thing, tendency or orientation, especially of the mind.

Behavioral modelling. This is the precise demonstration of a desired behavior, the purposeful and positive, teaching healthier ways of behaving.

Common Core State. This is an educational initiative in the United States that dictates what K–12 students should know in English language arts and mathematics at the end of each grade.

Competence. This is the ability to do something successfully or efficiently.

Cooperative learning. This is a successful teaching strategy of small teams, each with students of different ability levels that use a variety of learning activities to improve their understanding of a subject.

End of Grade Test (EOG). These are assessments administered to all students in grades 3-8 and are designed to measure students' performance on the goals, objectives, and grade-level competencies specified in the North Carolina Standard Course of Study.

Expectancies. The values that the person places on given outcomes, incentives, and present outcomes of change that have functional meaning.

Expectations. Anticipatory outcomes of a behavior or model positive outcomes of healthful behavior.

Mastery experiences. This relates to actual performance of a behavior or task and is believed to be the most powerful source of information influencing self-efficacy (Bandura, Adams, & Beyer, 1977).

Mathematics. This is the abstract science of number, quantity, and space. Mathematics may be studied in its own right (pure mathematics), or as it is applied to other disciplines such as physics and engineering (applied mathematics).

Mathematics achievement. Used in psychology, education, and communication, this term holds that portions of an individual's knowledge acquisition can be directly related to observing others within the context of social interactions, experiences, and outside media influences.

Math anxiety. A feeling of tension, apprehension, or fear about one’s ability to do math, which subsequently interferes with performance thereof.

Math Anxiety Rating Scale (MARS-E). This is an abbreviated (25-item version) of the original.

Mathematics Anxiety Rating Scale (MARS). This is an instrument developed by Richardson and Suinn (for reference- see comments). The purpose of the study was to develop abbreviated version of MARS, and to find whether certain specific backgrounds (gender, socio-economic status) and academic variables can predict math anxiety.

Organized activity. These are activities that can be characterized by structure, adult-supervision, and an emphasis on skill-building.

Performance Assessment Task. These are grade-level formative performance assessment tasks with accompanying scoring rubrics and discussion of student work samples. They are aligned to the Common Core State Standards for Mathematics.

Reciprocal determination. This is a theory set forth by psychologist Albert Bandura that a person's behavior both influences and is influenced by personal factors and the social environment.

Scale Score. This is a conversion of a student's raw score on a test or a version of the test to a common scale that allows for a numerical comparison between students.

Self-concept. This is a collection of beliefs about oneself that includes elements such as academic performance, gender roles, sexual identity, and racial identity.

Self-efficacy. This refers to an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments (Bandura, 1977, 1986, 1997). Self-efficacy reflects confidence in the ability to exert control over one's own motivation, behavior, and social environment.

Self-Efficacy Questionnaire. A questionnaire developed to measure self-confidence or belief in one's ability in decision-making.

Self-esteem. This is a realistic respect for or favorable impression of oneself, self-respect, anxiety, distress, or uneasiness of mind caused by fear of danger or misfortune.

Self-perception. The idea that you have about the kind of person you are.

Self-Perception Theory. A theory proposed by Daryl Bem, suggests that people develop attitudes and opinions by observing their own behavior and drawing conclusions from it.

Self-Regulation. A person or group that governs or polices itself without outside assistance or influence.

Social Cognitive Theory. A theory used in psychology, education, and communication, holds that portions of an individual's knowledge acquisition can be directly related to observing others within the context of social interactions, experiences, and outside media influences.

Student. The level of a student’s performance on the North Carolina End of Grade Assessment (NCEOG) given during the month May. The five scoring categories are Advanced, Proficient, Partially Proficient, and Unsatisfactory.

Vicarious experiences. This refers to knowledge or information about a skill or behavior derived from seeing the performance of others.

Vicarious reinforcement punishment. This is the tendency to repeat or duplicate behaviors for which others are being rewarded

CHAPTER 2

LITERATURE REVIEW

Overview

This chapter includes a synthesis of literature on self-efficacy and mathematics achievement at the elementary school level. The literatures were summarized in the following three aspects: (a) self-efficacy and studies related to self-efficacy theories, (b) research regarding cooperative learning models and the elementary students, and (c) research related to self-efficacy, academic achievement, mathematics, and anxiety. Within these categories, additional information and research on Albert Bandura's Self Efficacy Theory, Social Learning Theory, Best Practices in elementary mathematics education, anxiety, and their intersectionality are included in this section.

Self-Efficacy and Related Theories

Self-efficacy is defined as a person's belief about his or her ability and capacity to accomplish a task or to deal with the challenges of life (Bandura, 1976). Research in the area of self-concept indicates that self-efficacy is linked to academic achievement on the basis of Albert Bandura's (1976) Social Cognitive Theory (SCT), which proposes that self-efficacy motivates perseverance and persistence, as well as promotes self-regulation and self-correction (Komarraju & Madler, 2013). Therefore, self-efficacious students are confident in their ability to meet school requirements, plan and organize their activities, perceive difficulties as challenges, and persist in their efforts (Zuffiano et al., 2013.)

Students displaying different levels of self-efficacy in the educational setting tend to select peers who share the same interests in achievement and contribute to creating conditions that foster similar learning outcomes (Zuffiano et al., 2013). Self-efficacy and the relationship to academics has emerged as an important construct in education as it focuses on how students initiate, monitor, and control learning (Metallidou & Vlachou, 2007).

Academic self-efficacy reflects a student's perceived competence with respect to tasks in the academic or educational setting (Schunk & Pajares, 2002). Although researchers have established academic self-efficacy as a predictor of academic performance, less is known about specific characteristics of students exhibiting self-regulation strategies that might explain this relationship. Hence, this gap in the literature is addressed by examining the characteristics exhibited by self-efficacious and non-self-efficacious students in an elementary setting to explain the link between self-efficacy and academic achievement. Specifically, Bandura’s SCT, Bem’s Self Perception Theory, and Social Learning Theory provide a framework to hypothesize that students with stronger academic self-efficacy would be more likely to exhibit specific characteristics, such as successfully managing their resources, setting and pursuing high goals, and reporting higher academic achievement.

Self-efficacy has a greater predictive value of learning and achievement outcomes in cognitive domains in mathematics as compared to other academic settings (Pajares & Valiante, 1999). Therefore, it is the purpose of this literature review to discuss the theoretical theory driving this study and illuminate recent research in the area of self-efficacy and academic achievement of fifth grade students in the Southern United States.

The choice to recruit fifth grade students for this study was tied to research that indicated fifth graders develop separate verbal and mathematical self-concepts by age ten due to their growing ability to differentiate their competence (Marsh, 1986).

Success in classroom performance assumes the “will” and “skill” to complete a task through motivation, cognition, and metacognition (Metallidou & Vlachou, 2007). Self-efficacy theorists consider the link between self-efficacy and academic success that has established a body of research supporting children’s ability to effectively and flexibly manage their thoughts, feelings, and actions when navigating social and learning environments (McClelland & Cameron, 2011). For the purpose of this research, the basis for the theoretical foundations in self-efficacy beliefs are founded in Albert Bandura’s Social Cognitive Theory and Social Learning Theory, and Daryl Bem’s Self Perception Theory.

Albert Bandura’s Research in Self Efficacy

Bandura’s (1997) theory on self-efficacy was centered on the belief that individuals possess characteristics that enables them to exercise control over their thoughts, feelings, and actions. Through an internalization process, an individual self regulates behavior, plans interventions, and participates in self-regulation. Evaluating the knowledge gained from experiences, individuals make choices and tend to engage in tasks they feel competent and confident in completing successfully, while avoiding those they do not (Pajares, 1996). Motivating factors in self-efficacy include theory about self-concept, the association of success and failure, expectancy value, goals, and schema (Pajares, 1996). Unless individuals believe that they can produce desired outcomes, there is little incentive to act. Therefore, these beliefs can affect aspirations, commitments, goals, motivation, and perseverance during the formative years (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). Additionally, Bandura's et al. (1996) research indicated that children's beliefs in their efficacy could affect academic motivation, interest level, and academic achievement. Two of Bandura's theories in learning are used as theoretic backdrops of this study.

Social Cognitive Theory (SCT)

The concept of self-efficacy is most associated with psychologist Albert Bandura's (1977) Social Cognitive Theory, which stated that certain factors are central to human functioning. The research in this area focused on how these self-regulating factors operate within learning contexts, and emphasized the role of observational learning, social experience, and personal factors, known as reciprocal determination, in the development of one's personality (Pajares & Usher, 2008). Self-regulation allows individuals to evaluate thought processes and the results of their actions in order to plan successfully (Pajares & Usher, 2008). Similar to self-efficacy, self-regulation allows organized and successful learners to set goals, seek assistance, and use effective strategies to manage their time.

According to SCT, a person's self-efficacy can affect the choices they make, the amount of effort they expend, and the amount of perseverance they display in a task. Self-efficacy beliefs are created and developed as students gather and interpret information from mastery experiences and indirect or vicarious experiences. Therefore, self-efficacy is considered fluid and can change depending on the task (Usher & Pajares, 2008). Mastering a task or showing improvement in a skill over time can prove to be powerful when individuals succeed. Conversely, if an individual fails at a task when a great effort has been invested, it could undermine self-efficacy (Bandura, 1977). Pajares and Usher (2008) found this to be true in their research on mastery and vicarious learning experiences. When students tend to compare themselves to past experiences or other individuals, they begin to make judgments about themselves, which affects self-efficacy. In their study, Pajares and Usher (2008) determined negative outcomes associated with negative physiology might become more prevalent as children progress through school. Students were also found to make judgments and alter self-efficacy beliefs following a model of success or failure.

Self-efficacy is influenced by environmental factors such as the child's appraisal of their own ability (Bandura et al., 1996). Therefore, a low sense of academic and efficacy can increase the propensity to disengage socially and academically (Bandura et al., 1996). In other words, unless an individual believes they can produce a desired outcome, there is little incentive to complete an activity. In Bandura's SCT, one's attitudes, aptitudes, and cognitive abilities are comprised of what is known as the self-system (Bandura et al., 1996). This system is key in the perception of situations and the behavioral responses elicited in different situations. Bandura's self-efficacy is an essential part of this self-system.

Individuals with strong self-efficacy tend to display characteristics that allow a deeper interest in activities, consider challenging problems as tasks to be mastered, recover rapidly from setbacks and disappointments, and develop a strong commitment to activities (Zimmerman & Martinez-Ponz, 1990). In contrast, those with a weak sense of self-efficacy tend to develop low self confidence in ability, avoid challenging tasks, doubt their ability to complete difficult tasks, and emphasize personal faults/failures and negative outcomes (Bandura et al., 1996).

Bandura's et al. (1996) research has also developed key components of self-efficacy to include environmental, situational, and behavioral components. An explanation for each component is found in Table 1.

Table 1

Key Components of Self-Efficacy.

Component	Definition	Example
Environmental	Factors physically external to the person; Provides opportunities and social support (Bandura et al., 1996).	How people interpret the results of their own behavior informs and alters their environments and the personal factors they possess which, in turn, inform and alter subsequent behavior
Situational	Perception of the environment; correct misperceptions and promote healthful forms	Situational factors could include factors such as competing demands
Behavioral capability	Knowledge and skill to perform a given behavior; promote mastery learning through skills training (Zimmerman & Martinez-Ponz, 1990)	A person with a high level of self-efficacy in a responsive environment will be successful. Their positive attitude toward their abilities coupled with environmental change promotes success and improves long-term motivation.

In addition to the components of self-efficacy in SCT, Bandura (1977) outlines four sources of self-efficacy to include mastery experiences, social modelling, social persuasion, and psychological responses. Table 2 examines these sources in more detail.

Table 2

Sources of Self-Efficacy

Source	Definition
Mastery Experiences	Successfully completing activities strengthens self-efficacy. However, unsuccessfully dealing with a challenge can weaken self-efficacy.
Social Modeling	Observing others successfully completing an activity is an additional source of self-efficacy. Viewing others succeed through continued efforts, raises the belief one can acquire the skills to master comparable activities and succeed.
Social Persuasion	Similar to social modeling, Bandura alleged that persuasion can be utilized to create a positive belief system for success. He asserted that overcoming self-doubt and focusing on giving their best effort to the task at hand shaped one's positive self-efficacy.
Psychological Responses	Responses and emotional reactions to situations play a role in self-efficacy. Physical responses, dispositions, emotional situations, and levels of stress can affect how a one perceives personal abilities in a particular situation (Bandura, 1977; Martinelli, Bartholomeu, Caliatto, & De Grecci, 2009).

Self-efficacy is an important prediction of student success in academic domains. To assess and compare potential academic self-efficacy in class discussion to exam scores, Gaylon, Blondin, Yaw, Nalls, and Williams (2011) utilized an adaptation of Wood and Locke’s (1987) measure of academic self-efficacy to determine predictive self-efficacy. Certain levels of self-efficacy were deemed predictive based on participation and exam score at all three levels of self-efficacy, but the relationship differed. Overall, students with high self-efficacy were equally likely to be in the low or high GPA group, but students with low GPAs tended to regard themselves as academically skilled. Therefore, student judgment was less predictive of their exam performance.

Social Learning Theory

Social Learning Theory occurs when an individual’s behavior is altered after observing a behavioral model (Myers & Thyer, 1994). The observation of the behavioral model can affect the individual’s own behavior through positive or negative consequences - called vicarious reinforcement punishment. This is very similar to Albert Bandura's Social Cognitive Theory.

The guiding principles behind Social Learning Theory involve the individual observer and a model behavior. A model behavior is a behavior that is seen as coveted and enviable. The principles driving the theory include:

- Enviable traits: The individual observer will imitate a model behavior if it possesses characteristics such as talent, intelligence, power, good looks, or popularity. These are traits the individual observer finds attractive or desirable.
- Positive relations: The individual observer will react to the way another individual treats others and will imitate this behavior. When the model behavior is rewarded, the individual observer is more likely to imitate the rewarded behavior and vice versa.
- Imitation versus acquisition: A difference exists between an individual observer imitating a behavior and acquiring a behavior. Through their observations, the individual observer can acquire the behavior without performing it. The individual observer may then later, in situations where there is an incentive to do so, display the behavior (Bandura, 1977).

Therefore, the learning processes required by the observer involve four separate processes:

- Attention: the individual cannot learn unless they pay attention to what is happening around them and this is influenced by characteristics of the model. Similar to the description above, an individual is influenced by such characteristics as how much one likes or identifies with the model, and by characteristics of the observer.

- Retention: The individual observer must recognize the observed behavior and remember it later. This process depends on the observer's ability to retain the information in a form to recall later or rehearse the actions.
- Production: The individual observer must be physically and intellectually capable of reproducing the model behavior. In some cases, the individual observer possesses the necessary responses, but fails to reproduce the actions due to an un-acquired skill.
- Motivation: The individual observer will perform the act only if they have some motivation or reason. The promise of reinforcement or punishment becomes most important in this process (Bandura, 1976).

In learning theory, anxiety is seen both as a response to learned cues and as a drive, or motivator, of behavior. Most learning theorists maintain that anxiety is derived from reaction to pain. Therefore, anxiety could be reduced by removing or avoiding the source(s) of the situation(s) that have produced unwanted outcomes (Bandura, 1977). Therefore, in relation to math anxiety, the anxiety may be a reaction to the cues that math as a subject is a difficult one and it is only the genius that does well in it. It has been hypothesized that most students develop math anxiety as a function of what they have been able to learn from their immediate environment about mathematics (Pajares & Usher, 2008). However, the criticism is that, even in an environment where positive cues are given about math as a subject, many students still display characteristics of math anxiety.

Self-Perception Theory

Self-perception theory represents one of the most influential theories of how self-knowledge develops. Developed by social psychologist Daryl Bem (1967), self-perception theory consists of two basic claims. First, the theory claims that people develop their own attitudes and beliefs by inferring them from their own behavior and/or the circumstances under which they occur (Bem, 1967). Therefore, a student who observes that he or she constantly reads nonfiction books about animals may develop an interest in zoology or animals. The second claim involves internal cues. When internal cues are weak, the individual is considered an outside observer and must rely upon external cues to make inferences on the behavioral characteristics of a subject (Bem, 1967). In this case, an individual's conclusion will be reinforced if there are no external incentives to explain their behavior (i.e., grades), and they have no prior opinions regarding the subject. Thus, an individual uses their behavior and the circumstances in which it occurs to infer their own beliefs and attitudes. Therefore, the self-perception theory is a process of inferring attitudes based on the observation of one's own behavior. The theory asserts that a person functions as an observer of his/her own behavior, and then makes an assignment to either a situational or a dispositional source (Bem, 1972).

An empirical demonstration of the self-perception process was conducted by Chaiken and Baldwin (1981). Two groups were formed in which Group 1 held strong, consistent attitudes on pro-environmental issues, and Group two held weak and inconsistent views on the same issues. Researchers asked the participants to respond to a questionnaire and support either pro-environment or anti-environment behavioral statements. They were able to encourage subjects to respond in particular ways by using the terms “frequently” or “occasionally” in their questions. For example, when the term “occasionally” was used – as in the question, “Do you occasionally carpool?” – the subjects were more likely to answer “yes” and perceive themselves as pro-environmentalists. When the term “frequently” was used – as in the question “Do you frequently carpool?” – the respondents were more likely to answer “no” and feel that their attitudes were anti-environment.

Results of the Chaiken and Baldwin (1981) demonstration indicated that those subjects who had been encouraged to report pro-environmental behaviors later rated themselves as more pro-environmental than those who had been encouraged to report anti-environmental behaviors. However, this finding only held true for those whose initial attitudes were weak and inconsistent. Thus, participants in Group 1 whose attitudes had initially been strong did not show any significant shift in attitude.

Academic Achievement, the Elementary Classroom, and Elementary Learning Models

Increased attention by political stakeholders and school leaders has led to a greater emphasis on accountability and performance at all levels of educations. Evaluating student performance on standardized assessments have become the measuring stick by which the quality of educational systems are measured. Students begin standardized testing practices as early as the third grade in the United States and researchers are beginning to use this information to identify achievement factors to gain insight into improving school effectiveness. Basque and Bouchammu’s (2003) research has identified five themes in literature that are fundamental for achievement: academic oriented strategy, cooperation, strong school leadership, frequent monitoring, and learning time and structure. These five themes centered on a clear focus of the mastery of a subject and strong communication and cooperation among staff. The results of their study indicated prior achievement predicted achievement in the eighth grade and school location was significant in predicting student outcomes in mathematics. Contrary to many studies, Basque and Bouchammu (2003) found that certain variables, such as teacher years of experience, do not predict student success in mathematics.

Academic Achievement and the Achievement Gap

Academic achievement of elementary students, according to the most recent research, can be a predictor for future performance in higher education and determine career paths. Therefore, the relationship between the achievement gap between students of color and White students and self-efficacy, math anxiety, and academic performance has implications for elementary teachers. Results of national assessment data indicates that mathematics performance continues to lag behind other countries and the gap in ethnic groups is widening. Research on the achievement gap also indicates that this could be attributed to self-concept, past academic performance, math anxiety, and/or course of study choices. Therefore, understanding the history of the achievement gap, accountability measures, and its relationship to anxiety and self-concept is an important piece for this study.

Since the enactment of the Elementary and Secondary Education Act of 1965, students have been involved in standardized testing to ensure that they were being well taught. In 2001, Congress passed the No Child Left Behind (NCLB) legislation, which required public schools receiving federal funding to administer a statewide standardized test. Due to the legislations increased accountability of schools and teachers, more focus than ever before has been placed on the achievement gap in schools. The NCLB legislation measures trends in student performance, differences in demographic subgroups, and the expectation that all children will perform on grade level and no achievement gap would exist by the 2013-2014 school year (Wenglinsky, 2004). The act allowed the individual states to administer their own standardized assessments and isolate the scores between the subgroups based on race and program (Haycock, 2001). Each assessment must be comparable to the National Assessment of Educational Progress (NAEP).

John Coleman (1960) summarized the racial inequalities in student outcomes in his report which led to a national awareness of schools' struggle to reduce the achievement gap between White students and students of color. The NAEP is a national assessment administered to 9, 13, and 17 year olds every one or two years in math, reading, science, and civics. Since its implementation in 1970 and 1971, it has become one of the most recent measures to evaluate the achievement gap between students of color and White students in public schools across the nation (Vanneman, Hamilton, & Anderson, 2009). As a result of new mandates and assessment data from the NAEP, educators saw the achievement gap narrow substantially from 1978 to 1986 (Lee, 2004). The reason for the reduction of the gap was based on the trend data from the 1978-1986 NAEP tests, which showed that White students achievement level was flat while African American achievement grew substantially. Unfortunately, information obtained by evaluating the data from the 1988 NAEP test showed the previous narrowing achievement gap had begun to widen after 1986 (Haycock, 2001). Researchers soon discovered that by the early 1990's, African American students' achievement levels had become sluggish while the White students' achievement levels grew (Lee, 2004).

The achievement gap in elementary schools can be attributed to many factors, but researchers agreed that the most influential factors are socioeconomic status, parental characteristics, and school characteristics (Burchinal et al., 2011). Research explained that nearly 90% of the discrepancy in student math scores can be predicted based on only knowing the number of parents in the home, level of parent education, poverty rate by state, and the characteristics of the community the child lives in (Evans, 2005). Research also indicated that the achievement gap can be identified as early as three years of age (Burchinal et al., 2011). The suggestion of this achievement gap before students enter kindergarten has provoked states to implement strategies to combat the gap in early elementary school (Wenglinsky, 2004).

Researchers conducted the Study of Early Childhood and Youth Development to assess 314 students ranging in age from 4 to 11 years of age. The researchers found that differences in family structure, type and availability of childcare, and schooling experience largely explained the differences in achievement between African American students and White students. Assessments were also given at 6, 15, 24, 36 and 54 months, as well as grades one, three, and five. Information acquired from standardized tests, observations of students, and reports of behavior were used to determine the presence or absence of the achievement gap. This information led to the discovery of a race gap by the age of 3 with both school and family characteristics related to the widening of the gap (Burchinal et al., 2011). Likewise, Fryer and Levitt (2013) analyzed the data from the Early Childhood Longitudinal Study of the Kindergarten Cohort and found that the gap grew noticeably from the time students had entered kindergarten to the time they graduated fifth grade (Koretz & Kim, 2007). Researchers again found that they could predict the achievement gap by the third grade and even discovered that the gap widens as much as two times the rate in the most capable students in the classroom as compared to those in the lower performing students (Viadero, 2008).

Vanneman, Hamilton, Anderson, Rahman and NCES (2009) addressed the Black-White achievement gap in more detail in his article *Achievement Gaps: How Black and White Students in Public Schools Perform in Mathematics and Reading on the NAEP Statistical Analysis Report*. He specifically targeted how extensive the gap was on a state and national level. He observed significant score differences in results from the National Assessment of Educational Performance, or the NAEP, as well as the Long Term NAEP. He agreed with current and past research, which stated that there was a significant achievement gap, but explained that students were making gains in reading and math achievement scores. He went on to explain that these gains were not significant enough to close the achievement gap completely by the 2014 NCLB deadline (Vanneman et al., 2009). In addition, research indicated that more than half of African American males scored a level I or II on the state administered end of grade exam as compared to 20% of the White students (Dulaney & Bethune, 1995).

The question remains: does self-efficacy influence academic achievement or vice versa? Very few studies have addressed this issue at the elementary level because much of the research data have involved high school students. Hampton and Mason (2003) examined the semester grades and quantitative data of 278 high school students - many of them identified as learning disabled - to determine a correlation between self-efficacy for self-regulated learning and math semester grades. Their findings posited that male students have a stronger mastery of the subjects as well as students identified as learning disabled. These learning-disabled students also have stronger vicarious experience and social persuasions but weaker physiological indexes. Funding inequalities do exist between schools and systems and researchers can agree that this, coupled with home characteristics, contribute to the achievement gap. They also agree that a gap exists between students of color and White students' performance on standardized tests in school as soon as kindergarten and the achievement gap widens as the students' progress through fifth grade.

Research on the achievement gap, math anxiety, and self-efficacy suggests that there may be a link between vicarious experiences, self-regulation, academic performance, and the achievement gap that will eventually affect self-efficacy for African American students and other students of color. If these students are anxious or exhibit characteristics of low self-efficacy, they will not perform well in their mathematics courses. Therefore, finding this link between the achievement gap and self-concept can add to the perplexing issue of the achievement gap in schools today and create a new avenue for exploring solutions to the gap by shifting the focus from the external factors of socioeconomic status and parental educational levels to the internal factor of self-regulation and self-concept.

Upper Elementary School

Upper elementary refers to the students enrolled in grades four and five at the elementary level. These students range from 8- to 12-years of age. The 8- to 12-year-old age span is typically designated as part of middle childhood - the time between early childhood and young adolescence. Typically, middle childhood includes children 6 to 12 years old, but research indicates that children who are 6 to 8 differ markedly from 10- to 12-year-old children. They differ cognitively, socially, and physically (Collins, 2005), and early childhood research indicates that children up to age 8 should be considered young children (Bredekamp & Copple, 1997; National Association for the Education of Young Children, 2007).

Children in the upper grades also exhibit attitudes that are more independent and develop their ideals about their performance from their immediate environment, including parents and teachers, as opposed to the remote environment (historical, fictional, or famous individuals). Girls, especially, are more likely than boys to draw ideals from the immediate environment (Hawkes, 1973). Hawkes (1973) determined the greatest relationship exists between the sex of the chooser and the ideal chosen. Due to this research and the research of Pringle (1965) and Havighurst (1955), educational research saw a re-emergence of cooperative learning strategies within the classroom.

Student-Centered Learning

Student-centered instruction often features: a) an emphasis on knowledge and skills associated with traditional content areas (i.e., mathematics, science, English, and history) as well as 21st century skills (problem solving, critical thinking, and communication), b) instructional activities that actively engage students in sense-making by building on their prior learning and connecting to personal experience, often through collaborative group work, c) a learning environment characterized by trust and strong relationships between and among the teacher and students and d) a focus on the individual through differentiation, scaffolding, and opportunity for choice.

One concept that is the focus of student centered learning involves organized activities. The term, organized activity, refers to activities that can be characterized by structure, adult-supervision, and an emphasis on skill building (Eccles & Gootman, 2002; Larson, 2000; Roth & Brooks-Gunn, 2003). These activities have regular and scheduled meetings, maintain developmentally appropriate expectations and rules for participants in the classroom setting, involve small groups, offer supervision and guidance from adults, and are focused on developing specific skills and achieving certain goals. These activities are often characterized by challenging and complex tasks that increase as participants' abilities develop (Csikszentmihalyi, 1990; Larson, 1994).

Research, that has examined the effects of organized activities, focused on the psychological, social, and emotional development through participation. These activities can be associated with higher academic aspirations and increased positive attitudes (Troutman & Dufur, 2007). Most recently, organized activities have been linked to academic achievement in high school students. Morris (2015) examined the Educational Longitudinal Study of 2002 to determine a correlation between organized activities and academic achievement. Morris found that increased time spent on these types of tasks was associated with gains in mathematical achievement in disadvantaged students only. Therefore, higher ability students are less likely to improve than lower ability students, especially when disadvantaged students have been exposed to additional instructional time (Ding & Davison, 2005).

Cooperative Learning Models and Achievement

Upper elementary students in grade 3-8 bear the burden of accountability due to state requirements in English language arts and mathematics demands. Therefore, much of the testing results fall to the students ages 8 through 12. There is little research to evaluate the impact of educational accountability on schools, teachers, and students. Teachers do report that accountability affects how they teach, impacts curriculum, instruction, and instructional time. A comparison of instructional time spent in the classroom pre-accountability and post accountability indicates the curriculum has not narrowed but has changed from a child centered teaching model to a generic teaching model where 90% of class time emphasized memorization of facts, whole class teacher-directed instruction, and worksheets (Anderson, 2009). These results indicated teachers and students needed to move to an instructional model, which emphasized meaningful learning and teaching as conversation.

There is a growing movement toward using cooperative learning in small groups in mathematics. Research into problem solving groups found that students learn from non-routine problem solving where procedures are not readily available (Garduno, 2001). Small group problem solving, work together for a common goal while students are exposed to ideas that may differ from their own (Garduno, 2001). Some studies argue that small group problem solving models may hinder higher achieving students due to the exposure to lower achieving students, but that the highest achieving students in cooperative learning groups benefit academically from making sure their peers understand the material (Garduno, 2001).

One such cooperative learning model is the Math Workshop Model of Instruction. This workshop model is similar to writer's workshop and creates flexible environments where students learn, share, and explore concepts at their own rate (Hueman, 2008). The instruction is differentiated, scaffolded, and structured to support children's learning with varying cognitive structures. The workshop model for any subject was designed around the philosophy that children need ample time to work, reflect, and share. The research is based on the theory that children learn best when they are actively involved in mathematics, it promotes developmental growth, and gives children a deeper understanding of mathematics when they construct their own thinking (Walters et al., 2014). These experiences in a mathematics classroom can also motivate students to work at an optimal level of understanding and development as well as give them time to reflect and experience mathematics (Garduno, 2001).

Math workshop is generally more student led, and less teacher led instruction. Much of the instruction that is delivered by the teacher is done in the mini-lesson for about fifteen minutes at the beginning of a class. The teacher then pulls small groups together to reinforce the skill or introduce a new skill. Students rotate through activities, problem-solving tasks, or choice activities while the teacher pulls additional groups together to review or introduce a skill. Any tasks or group work in a math workshop are students led. Students learn to discuss, defend, and verify strategies while working problems.

Self-Efficacy and Academic Achievement

Good teachers have the ability to transform mathematics classrooms into lively, engaging learning environments. The global economy requires its employees to make sense of and tackle complex problems, work collaboratively, use high-level mathematics, reasoning skills, and communicate ideas effectively. Students in the United States are currently ranked 36th out of 65 in the global educational systems and below average in mathematics performance on the 2012 Program for International Student Assessment

(PISA) (Walters et al., 2014). Therefore, examining student groups to determine the relationship between academics and self-efficacy can assist in developing curriculum and lessons that enhances self-esteem, develops positive student/teacher relationships, promotes mastery, and sets higher expectations.

Mathematics achievement related to successes and failures are influenced by a student's self-concept through self-evaluation and the evaluation of others (Helmke & Aken, 1995). Much of the research in this area relies on Bandura's Social Cognitive Theory. Therefore, self-efficacy motivates perseverance and persistence as well as promoting self-regulation and self-correction (Komarraju & Nadler, 2013). Students who have been found to have high self-efficacy and confidence in their academic performance are more likely to believe that intelligence is fluid and is determined by effort. This proves that student self-efficacy can be developed and improved (Komarraju & Nadler, 2013).

Self-Efficacy and Mathematics Achievement

Self-efficacy has been regarded as a consistent predictor of academic achievement and influences the processes of motivation, self-regulation, self-perception, expectancy of results, and the choices and interests of students. It has also been considered as a reliable predictor of academic outcome with implications in child development (Martinelli et al., 2009). Therefore, much of the research in this area has been influenced by the development of rating scales for individuals and researchers to research perceived self-efficacy.

Self-efficacy has been defined as an individual's belief in their capabilities to exercise control over their level of functioning and environmental demands and can be affected by personal accomplishments, vicarious learning, social persuasion, and anxiety (Bandura, 1977). A person's belief in their capabilities to exercise control over their level of functioning and environmental demands relates to an individual's conviction of their own competence to attain a desired goal (Galla & Wood, 2012). Unless people believe they can produce desired results, there is little incentive to act. These beliefs affect academic motivation, interest level, and achievement, as well as shape career aspirations and pursuits during formative years (Bandura et al., 1996).

Over the past decade, researchers have sought answers to the questions involving self-concept and math anxiety. Research into math anxiety and self-concept are studies that explore the idea that students' belief in their competencies are the most influential predictors of math anxiety (Ahmed, Minnaert, Kuyper, & Van der Werf, 2004). The most dominant view of the relationship between self-concept and math anxiety is that low self-concept results in high math anxiety and vice versa (Ahmed et al., 2004). This self-concept involves a student's self-evaluation of their abilities and performance as well as the capability to deal with the demands of the mathematical task they are being asked to complete. A second view of the relationship describes the distorted self-image of individuals experiencing high levels of math anxiety and deciding their performance is inadequate (Ahmed et al., 2004). A final view of the relationship describes the assumption of math anxiety and self-concept as reciprocal. A similar study by Nunez-Pena, Suarez-Pellicioni, and Bono (2012) found that when students were administered the Math Anxiety Rating Scale (MARS) and the State-Trait Anxiety Inventory (STAI), low performance was related to math anxiety and negative attitudes.

Investigations into the relationship between sources of math related self-efficacy, interest, and preference in mathematics coursework has been examined to determine how self-efficacy affects achievement and learning patterns (Ozyurek, 2007). Research on the subject has determined that social models play a role in the self-efficacy of students as they compare themselves to others and make judgments about their abilities (Usher & Pajares, 2008). Therefore, when efforts in mathematics are more successful, they lead to increased motivation, confidence, and effort.

Motivation, primarily concerned with the persistence of behavior, is also rooted in cognitive activities (Bandura, 1997). Through cognitive representation of outcomes, individuals can generate motivators of behavior. A cognitively based source of motivation works by influencing goal setting and self-evaluative. Perceived negative inconsistencies between performance and expectations create dissatisfactions that motivate changes in behavior. Individuals often are no longer satisfied with performance and make future goals dependent on higher attainments (Bandura, 1977).

Perception of self-efficacy has a considerable impact on human development and on its adaptations. Self-efficacy has been defined as a personal judgment of the ability to organize and execute actions with the purpose of reaching desired objectives. Self-efficacy beliefs are built in
different domains beginning with the interpretation of the information gathered from the four following sources: direct experience, vicarious experience, social persuasion, and emotional state (Martinelli et al., 2009). Perceived self-efficacy has influence on choice of behaviors and settings, but through expectations of success, can affect coping efforts. Those who persist in activities that are in fact relatively safe will have experiences that

reinforce their sense of efficacy, eventually eliminating their protective behavior. Expectations of efficacy are based on four major sources of information: performance accomplishments, vicarious experience, verbal persuasion, and physiological states (Bandura, 1977).

0Bandura’s (1997) social cognitive theory emphasizes the self-regulation feature of human behavior without disregarding the role of environmental factors. One of the essential concepts of this theory of self-regulation concerns the indispensable self-efficacy beliefs in this process (Martinelli et al., 2009).

An outcome expectancy is defined as a person's estimate that a given behavior will lead to certain outcomes. An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes. Outcome and efficacy expectations are differentiated, because individuals can believe that a particular course of action will produce certain outcomes, but if they entertain serious doubts about whether they can perform the necessary activities such information does not influence their behavior. (Bandura, 1977)

Zimmerman and Martinez-Pons (1990) developed a model to explain self-regulated learning based on Bandura’s theory of social cognition. Their work includes three classes of determinants that include personal processes, environment, and behavior. Based on these three determinants, student’s self-efficacy perceptions can be related to self-monitoring, academic motivation, and academic achievement. Students in the study used strategies associated with self-perceptions of mathematics and verbal efficacy to regulate learning. Like similar studies in the field, their work indicated that gifted students displayed higher levels of self-efficacy and made greater use of learning strategies designed to regulate personal, environmental, and behavioral functions. Their study also noted a relationship between motivation, anxiety, and test scores for both fifth and sixth graders, but lacked more information on the subject.

Cognitive processes play a significant role in the acquisition and retention of new behavior patterns, and much of human behavior is developed through modeling (Bandura, 1977). Individuals process and synthesize feedback from sequences of events over long intervals about situational circumstances and the actions necessary to produce an outcome and the capacity to represent future consequences is determined through motivation (Bandura, 1977).

Gender, Mathematics, Self-Efficacy, and Anxiety

Theorists have debated whether gender is a factor in differences in math ability. The purpose of Miller and Bichsel's (2003) study was to determine whether gender moderates anxiety in relation to different types of mathematical performance. The study identified two types of anxiety – state (anxiety in specific situations) and trait (anxious in all situations). Findings indicate that anxiety disrupts verbal and working memory as related to mathematical performance. Results of the study also indicated that math anxiety was a significant factor in predicting variance in applied and basic math performance. Likewise, a study of 226 undergrad students found that adult learners self-report lower levels of math self-efficacy and increased levels of math anxiety (Jameson & Fusco, 2014). Jameson and Fusco (2014) administered the math self-efficacy scale and the Self-Description Questionnaire to examine the difference in math anxiety, self-concept, and self-efficacy between adult learners and traditional college students. Their initial findings indicated that adult learners had significantly lower levels of math self-efficacy but the levels of anxiety or concept did not differ. These findings suggested that there was an inverse relationship and learners were experiencing negative self-perception that may have affected their learning (Jameson & Fusco, 2014). Students with poor spatial abilities have been found to be more likely to struggle with math – resulting in negative experiences in mathematics courses (Maloney, Waechter, Rusko, & Fugelsang, 2012). In a study to determine whether a relationship exists between gender, math anxiety, and spatial processing ability, Maloney et al. (2012) determined gender on math anxiety is mediated by spatial processing abilities. The study was conducted at two different times with different undergraduate students being administered the AMAS and OSIQ, which exacted similar results.

Anxiety is associated with a biasing of attention toward a threat related to information and a negative association can exist between children's anxiety and academic performance (Galla & Wood, 2012). Math anxiety associated with number manipulation and problem solving, is a significant factor in avoidance of educational tracks and career choices involving mathematics (Ahmed, Minnaert, Keyper, & Van der Werf, 2011). Therefore, emotional self-efficacy and individual perceived confidence in ability can regulate negative emotion in or during stressful events (Galla & Wood, 2012).

More than 20% of the population suffers from math anxiety as it relates to competence (Ahmed et al., 2011). Thus, self-concept equals self-evaluation of individual knowledge and the capability to deal with demands of the environment. To investigate the relationship between low self-concept and math anxiety as well as predictors of math anxiety, Ahmed et al. (2011) administered the math self-concept scale, math anxiety emotional questionnaire, and national test data for prior achievement to 495 seventh graders in the Netherlands. Their study found low levels of self-concept equal higher anxiety, which is consistent with other studies in related areas.

Although detrimental effects of math anxiety on adult learners are well understood, few studies have examined the effects on younger children who are beginning to learn mathematics in formal educational settings. Using the newer MAQ (Math Anxiety Questionnaire) and SEMA measures, Wu, Barth, Amin, Malcome, and Menon (2012) were able to examine the relationship between math anxiety and achievement in second and third grade students. They determined math anxiety at this age was significant and negatively correlated with proficiency, even in data from students performing above grade level (Wu et al., 2012).

There is a belief that developing a better understanding of the causes and implications of math anxiety is the key to improving achievement. Math anxiety affects academic performance, career choices, and course choices. There is also evidence that anxiety disrupts student performance by wreaking havoc on working memory. Students retain limited amounts of information while working on a task and block out distractions and irrelevant information. Student anxiety due to foreign concepts and procedures causes internal pressures to increase. Students struggle with problems dealing with regrouping and long division. Math anxious students tend to focus more on their worries and inadequacies rather than the task at hand (Cavanaugh, 2007). There exists a combination of research examining the consequences of math anxiety, math competence, working memory, and performance. Ashcraft and Kirk (2001) determined that math anxious individuals enroll in fewer math courses, earn lower grades, and working memory capacity is negatively associated with math anxiety. High math anxiety individuals have difficulty with addition problems involving carrying operations due to the load on working memory.

To determine whether negative attitudes and feelings toward math would affect performance in a college course, as well as the relationship between negative attitudes and feeling towards mathematics, Nunez-Pena, Suarez-Pelliciono, and Bono (2013) developed a study involving 193 research design students at the University of Barcelona. After the collection of personal contact data, high school information questionnaires, mathematics attitudes questionnaires, MARS, and the state/trait anxiety inventory, the researchers determined math anxiety and negative attitudes could affect performance and students who do not successfully pass a course show higher levels of anxiety (Nunez-Pena et al., 2013).

Purpose Statement

The purpose of this study is to investigate the relationship between self-efficacy, mathematics performance, and math anxiety in an elementary classroom, determine the physical and verbal characteristics exhibited by students while performing mathematical tasks, and determine the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics. For the purpose of this research, the following research questions will be addressed:

1. What is the correlation between self-efficacy and math anxiety?
2. What is the correlation between math performance vs. self-efficacy?
3. What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?

4. What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?

Conclusion

Self-efficacy can be defined as an individual's perception of their abilities to successfully perform a task. Albert Bandura's work in the 20th century on Social Cognitive Theory has encouraged current researchers in the field of education to investigate a correlation between self-efficacy and academic achievement. Research has shown that early social interaction and the quality of those interactions provides the basis for development (Vygotsky, Reiber, & Carton, 1987). While teachers are an important part in facilitating learning, cooperative learning models, self-efficacy, and vicarious learning experiences account for the majority of academic success.

Review of the literature illustrates the value of understanding the characteristics of self-regulated learning especially considering the poor mathematics performance of a number of students and the ever-increasing achievement gap issues. Students who are actively engaged in their learning display higher levels of motivation and academic achievement than those who are passively engaged (Schunk & Zimmerman, 1997). Multiple research studies have supported the positive relationship between students displaying high levels of both self-efficacy and metacognition (Martinelli et al., 2009; Ozyurek, 2007; Rahmani, 2011; Usher & Pajares, 2008). The current research study investigated the relationship between self-efficacy, a component of Social Cognitive Theory, and the characteristics of young children in a mathematics classroom.

Due to a lack of research at the elementary level on the subject of self-efficacy and mathematics achievement, this research was needed to understand the characteristics exhibited by younger students that can affect their self-efficacy as well as their peers. It is for this reason that a mixed methods design was chosen. The purpose of this study was to investigate and study six students' beliefs about self-efficacy and their academic achievement in a mathematics classroom. The study was conducted at a Title I elementary school in the southern United States. This study investigated the characteristics that contributed to student performance in the classroom and their beliefs about their performance. The study also investigated the correlation between self-efficacy and mathematics anxiety. The following questions were addressed within the research:

1. What is the correlation between self-efficacy and math anxiety?
2. What is the correlation between math performance vs. self-efficacy?
3. What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?
4. What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematic

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Introduction

During the 2016-17 school year, a purposeful sample of elementary school students' mathematical experiences were explored through an examination of surveys, individual interviews, and observations in order to develop a mixed methods study to determine the following: (a) the perceptions of fifth grade students regarding the correlation between self-efficacy, math anxiety, and mathematics performance; (b) how self-efficacy influences their performance in mathematics; and (c) the characteristics each fifth grade student exhibits that might contribute to self-efficacy in mathematics. To answer the first two research questions in this study, the Math Anxiety Rating Scale for Elementary students, created by Suinn, Taylor, and Edwards (1988), was administered to a group of students in conjunction with the Self-Efficacy Questionnaire for Children, to find a correlation between math anxiety, self-efficacy, and academic achievement. It was also used to identify a sub group of students with varying levels of self-efficacy and math anxiety to participate in observation and interview data. To participate in the sub group, students were required to have combined scores on the efficacy and anxiety scales greater than 25 points from the mean. Using this criteria, twelve students were chosen to participate. To identify perceptions and characteristics of students with varying levels of self-efficacy and math anxiety, these twelve students were observed completing a mathematical task in their regular mathematics classroom and later interviewed. There was also particular interest in how these relationships influence one another in the context of closing the achievement gap.

Purpose

The purpose of this study was to utilize a mixed methods approach to examine the correlations between math anxiety, self-efficacy, and academic performance, as well as identification of self-efficacy perceptions and physical characteristics exhibited by fifth grade students that had experienced either success or failure on a high stakes assessment in mathematics. A self-efficacy survey and a math anxiety rating scale was administered to a purposeful sample of 38 fifth grade students in a suburban area near an urban center in North Carolina. The Likert-type questions on both surveys asked respondents to select one of several responses that were ranked in order of strength. This ordinal data was hand calculated by finding the sum of the responses. Once calculated, the survey provided opportunities for the researcher to identify 30 students to participate in observations who met the following criteria: (a) students had to have completed both surveys in their entirety, (b) students had to have taken the NCEOG in May of 2016, and (c) students had to be present on the day of the interviews and observations. Once the 30 students were identified, further conditions were used to identify a small purposeful sample for interviews. The conditions included the above-mentioned criteria, as well as students combined scores on the SEQ-C and the MARS-E had to fall outside of the mean score by at least 25 points. Twelve students met the criteria. These participants were used to investigate the characteristics and perceptions of students with different levels of math anxiety and self-efficacy through observations and semi structured interviews in order to answer the following research questions:

1. What is the correlation between self-efficacy and math anxiety?
2. What is the correlation between math performance vs. self-efficacy?

3. What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?
4. What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?

Design Approach

Quantitative Data Collection

Quantitative research is a method of inquiry used in deductive research. The goal is to test theories or hypotheses to gather information or examine relationships among variables (Creswell, Klassen, Plano, & Smith, 2011). The variables are measured and numerical data is the result. This data can be analyzed statistically and can provide measurable evidence, efficient data collection procedures, compare groups, and provide insight into experiences. This method can also generalize a set of results from a sample to an entire population.

Quantitative research methods are often used to determine "how many" and/or "how often" to target an audience to determine what proportion of the sample has certain behaviors, attitudes, and whether specific behaviors occur at a statistically significant level (Creswell et al., 2011). One common technique for gathering quantitative data is to survey a large group through the use of a questionnaire that contains closed-ended questions. Surveys can be conducted face-to-face, by mail, computer, or phone and can be self-administered or administered by an interviewer.

Qualitative Data Collection

As opposed to quantitative research, the strength of qualitative research is its focus on the narratives and descriptions of the human lived experiences for the purpose of theory-development research. It is a systematic and thorough form of inquiry that uses methods of data collection such as in-depth interviews, observation, and review of documents (surveys). Qualitative data helps researchers understand processes over time, provides detailed information about context, and emphasizes the voices of participants using quotes and storytelling (Mirriam, 2009). Qualitative methods ease the collection of data when measures do not exist and provide a depth of understanding of concepts.

Mixed Methods Approach

For this research study, a mixed methods design was defined as a methodology for conducting research that involves collecting, analyzing, and integrating quantitative and qualitative research data in a single study (Mirriam, 2002). There are five reasons for using mixed-method designs:

"Triangulation of evaluation findings: enhancing the validity or credibility of evaluation findings by comparing information obtained from different methods of data collection (for example comparing responses to survey questions with what the interviewer observes directly). When estimates from different sources converge and agree this increases the validity and credibility of findings or interpretations

Development: using results of one method to help develop the sample or instrumentation for another.

Complementarity: extending the comprehensiveness of evaluation findings through results from different methods that broaden and deepen the understanding reached.

Initiation: generating new insights into evaluation findings through results from the different methods that diverge and thus call for reconciliation through further analysis, reframing or a shift in perspective.

Value diversity: incorporating a wider diversity of values through the use of different methods that themselves advance difference values. This encourages greater consciousness about the value dimensions of the evaluation." (Greene, 2005, p 255-56)

The most common approach to mixed method research is triangulation design. The purpose is to include different but complimentary data on similar topics to better understand the research topic, with the intent of bringing together the strengths of quantitative design methods with those of qualitative (Morse, 1991). This research design involved a separate collection of quantitative data (surveys) to identify a smaller, subgroup of students to collect qualitative data (interviews/observations) in order to bring separate results together to better understand the research problem. A convergence model of triangulating data assisted in collection and analysis of quantitative and qualitative data on a similar phenomenon to compare and contrast findings with current research on the topic.

The convergence model of triangulation, in this research study, allowed the researcher to collect quantitative data to sort participants according to their varying levels of self-efficacy and math anxiety, as well as use qualitative data to gain a comprehensive description of the participants' perceptions and characteristics (Merriam, 2009). This method draws on the strengths of each approach, allowing the researcher to frame the study within the theoretical constructs of Bandura's Social Cognitive Theory, Bem's Self Perception Theory, and Social Learning Theory. The intention was to discover answers that might directly make a positive difference in the lives of students who have experienced continued struggles in mathematics at the elementary level and assist educators with meeting the needs of students who exhibited both low and high levels of self-efficacy in mathematics.

Benefits of Mixed Methodology

Using a mixed methods research design allows researchers to rely on more than one data source (Creswell, 2009). The benefits of using a quantitative approach are described by Creswell (2009) as providing numeric descriptions of the "trends, attitudes, or opinions of a population by studying a sample of that population" (p. 12), and using descriptive words to recount how participants of the representative sample make sense of the world and their experiences (Mirriam, 2009). Qualitative data allows for the inductive interpretation of the data that builds on the concepts that quantitative data does not describe (Merriam, 2009). Conversely, quantitative methods bring objective data to the study that can minimize the biases of the qualitative methods in the study. Using mixed methods is a practical means for gathering data to answer the research questions thoroughly. This research approach offers the freedom to use all methods possible to seek multiple perspectives.

Participants, Demographics, and Instrumentation

Participants

The participants of this study resided in a suburban district in North Carolina, near an urban center. The school was located in a low to middle income neighborhoods, with 78% of participants receiving free and/or reduced lunch. Participants came from three separate mathematics classrooms. Because academic achievement is linked to socio-economic status and race, there was a strong likelihood that many of the students in this study within the failure categories were economically disadvantaged students.

Participant inclusion for this study was based on six criteria. Students could only be included if: they were considered by the school district to be a fluent English speaker, their gender and ethnicity were available through the district database, their North Carolina End of Grade Test for Mathematics scores for the 2015-2016 academic year was available through the district database, they were instructed in a regular mathematics classroom 80% of the day in the 2016-17 academic year, consent and assent forms were completed, and all portions of SEQ-C and MARS-E were completed. Applying these criteria resulted in a final sample of 30 students.

Demographics

The participants in this quantitative portion of the study included approximately 55 fifth graders who attended elementary school in the North Carolina school district during the 2016-17 academic years. The mean classroom size ranged from 21 to 28 students per teacher. The majority of the sample consisted of African American (35%), and Caucasian (37%) students and other ethnic groups included Latino/a (22%), Asian (2%), and American Indian or Alaska Native (2%). In the 2016-17 academic year, all of participants were in 5th grade. Finally, 51% (n = 28) of the sample were males and 49% (n = 26) were females.

The participants in the qualitative portion of this study included 12 fifth graders who attended elementary school in the North Carolina school district during the 2016-17 academic years. The majority of the sample consisted of African American (42%), and Caucasian (33%) students, and other ethnic groups included Latino/a (25%). In the 2016-17 academic year, all of participants were in 5th grade. Finally, 67% (n = 8) of the sample were males and 33% (n = 4) were females.

Instrumentation

Surveys. A group of 38 students, with signed consent and assent forms were administered the Math Anxiety Rating Scale-Elementary (MARS-E) and the Self-Efficacy Questionnaire-Children (SEQ-C) by the regular mathematics classroom teacher during three separate class periods in September of 2016. The mathematics teacher was instructed not to lead students on any of the questions and given ample time for all students to complete each survey. All data was analyzed off-site and recorded by the researcher.

Math Anxiety Rating Scale for Children. Students were administered the Math Anxiety Rating Scale for Elementary (MARS-E) on the first day of the study, during a regular mathematics class, administered by the regular mathematics teacher. In order to assess the mathematics anxiety levels of elementary school students, an elementary form of the MARS (MARS-E) was developed by Suinn et al. (1988) as an abbreviated version of a previous Math Anxiety Rating Scale (MARS) that was developed with Richardson (1972). The instructions of the MARS-E asked students to "circle among the items listed that may bother them or cause them to be nervous or anxious or tense when they have to do them." With the assumption that the students in the intended age group had very little experience in responding to such an instrument, the instrument helped students go through two examples before they started responding to the items. The Suinn MARS-E is a 26-item Likert scale, comprised of items that assess the degree to which students experience anxiety in specific life situations. This scale is appropriate for elementary school children in content difficulty and reading comprehension. For each item, students were asked to circle the rating, which represented how much anxiety they would experience in facing mathematical situations. The MARS-E for elementary students was used to determine the correlation between self-efficacy and anxiety.

Self-Efficacy Questionnaire for Children. To investigate elementary school students' perceptions of their mathematical self-efficacy behaviors, an existing survey was used to collect quantitative data on math self-efficacy. Due to a large number of students, the regular education mathematics teacher administered the Self-Efficacy Questionnaire for Children on the second day of the study. The Self-Efficacy Questionnaire for Children (SEQ-C) was the tool used to evaluate student self-efficacy in the mathematics classroom. Muris (2001) published the first study of the SEQ-C. The SEQ-C is a 24-item scale designed to assess three main areas of self-efficacy: social self-efficacy that pertains to children's capability to deal with social challenges, academic self-efficacy that refers to children's perceived capability to master academic affairs, and self-regulatory efficacy that has to do with children's capability to resist peer pressure to engage in high risk activities. Each item was scored on a 5-point scale with 1= not at all and 5 = very well. The scale has a good internal consistency with Cronbach's alpha for total score at 0.88 and the subscale scores ranging from .85 to .88. Sample items from the SEQ-C included "how well can you get teachers to help you when you get stuck on school work?" and "How well do you succeed at passing a test?" The SEQ-C measure was used to determine the correlation between self-efficacy and academic achievement.

Mathematics Achievement Measure

Several mathematics concepts are included in the North Carolina Standard Course of Study and are typically taught and assessed in fifth-grade classrooms, including number and operations, measurement, geometry, data analysis and probability, and algebraic thinking. Students are administered an assessment of these skills through the North Carolina End of Grade Mathematics Assessment. With this state assessment, students have up to 180 minutes to complete 54 multiple choice and open response questions that are aligned to state standards. Questions go through a multi-step process from initial draft to the item bank. Further, forms of the tests are equated based on standard psychometric processes. These mathematics concepts are considered an indicator of general knowledge about mathematics as well as an indicator of numerical reasoning. This assessment was administered during the Spring of the 2015-16 school year. To determine proficiency, students in grades 3-8 are awarded an achievement level ranging from 1 to 5 on the NC EOG, as well as a scale score.

Developmental Scale Scores from the North Carolina End of Grade test scale score are determined from the number of questions correct. The developmental scale score allows for the comparison of the student's end-of-grade scores by subject from one grade to the next. This scale score measures growth in reading and mathematics from year to year and a student's score in reading and mathematics are expected to increase each year. The scale scores for mathematics range from 218 to 295.

The NC EOG achievement levels indicate knowledge and mastery of mathematics proficiency standards, as well as college and career readiness standards. The following chart illustrates the five levels:

Table 3

Achievement level for the NC End of Grade Assessment in Mathematics

Level	Description	Meets On-Grade-Level Proficiency Standard	Meets College-and- Career Readiness Standard
5	Denotes Superior Command of knowledge and skills	Yes	Yes

4	Denotes Solid Command of knowledge and skills	Yes	Yes
3	Denotes Sufficient Command of knowledge and skills	Yes	No
2	Denotes Partial Command of knowledge and skills	No	No
1	Denotes Limited Command of knowledge and skills	No	No

Observation Protocol

Observation data was collected in November of 2016. Observations occurred in the regular mathematics classroom over three class periods. Students in each observation were identified from their scores on the MARS-E and the SEQ-C. Students with combined Total SEQ-C and MARS-E scores that deviated 25 or more points from the combined mean scores on the survey measures were chosen to participate in the observation and interview portion of this study. These twelve students were placed in a separate and small group within their regular classroom. These observations were conducted by the researcher, while students completed the fifth grade Common Core mathematics task. Each group was videotaped while completing the task and field notes were taken. Students were encouraged to think aloud and discuss their thinking while working with their group.

The mathematical task was projected on the smartboard device for all students to read, either aloud or individually, in each group. Students were instructed to begin working as soon as the task was visible. The researcher was standing in proximity to the small group identified by the surveys to record behaviors exhibited during the performance of the task. A protocol was used (see Appendix B) during the review of the videotaped sessions. Audio tapes of the observations were transcribed and analyzed by the researcher.

The researcher developed the observation protocol to fit the needs of this study. This protocol included a chart to document behaviors/episodes during the mathematical task. Each behavior/characteristic was hand coded and notes written for each episode. Coding examples included “+” for on task behavior, “-” for off task behaviors, and “X” for no interactions. On-task behavior could include discussing the problem or a strategy with another student, while an off-task behavior might include discussing a topic other than the math task or drawing on the paper as opposed to working on the task. A comment section was included to document behaviors that might be considered significant to the researcher, not covered by the codes listed on the protocol, but considered significant and needed for analysis later. A comment might be recorded if a student assisted another student or completed the work for another student. This would not have been recordable by simply using the codes provided, thus a comment on the episode would be needed. Each episode was analyzed and recorded on the chart to identify patterns and themes. An episode, in this study, was defined as a characteristic or behavior exhibited by a student during the completion of the math task.

Interview Protocol

Interviews were scheduled on the same day as the observations, in November of 2016. In an effort not to affect each student's core academic instruction, the interview sessions were established during their mathematics block while engaged in normal classroom activities. Normal classroom activities included complex mathematical tasks developed by the North Carolina Department of Public Instruction that correlate with the

Common Core State Standards. The interviews were recorded digitally and later transcribed and interpreted by the researcher. Interview participants were the same students involved in the observation. These students were individually interviewed in a separate office inside the regular mathematics classroom.

The interview protocol used in this study was an adaptation of an interview protocol designed by Ellen Usher (2009). Dr. Usher's work was originally adapted from Zeldin and Pajares (2000) to accurately retrieve information regarding the four sources of self-efficacy. The interview protocol was organized into categories anticipatory of conversational flow and comprehensively address all sources of self-efficacy, the last question directly related to these sources of self-efficacy (i.e., "What could make you feel more confident about yourself in Mathematics?"). Once each small group completed the mathematical task, students were individually interviewed in an office within the classroom to discuss these questions. Audio tapes of the observations were transcribed and analyzed by the researcher. The interview protocol can be found in Appendix B.

Mathematical Tasks

Mathematical tasks aligned to the North Carolina Common Core State Standards in Mathematics are designed to be used as a formative assessment in the regular classrooms to guide instruction. The mathematical task chosen for the purpose of this research was taken from standard 5.OA.3: Analyze patterns and relationships. The concept presented in this task has been previously taught so students will be able to complete in a group setting.

5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. *For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so"*.

In each task, groups of students were expected to evaluate a mathematical equation and defend their answers. More specifically, these student groups were expected to use the eight mathematical standards, found in table 5, to create an acceptable answer. Further explanation of the achievement levels for fifth grade students in North Carolina can be found in Appendix C, D, and E, as well as a copy of the task in Appendix A.

Table 4

Rubric for student task

Rubric		
Level I	Level II	Level III
Limited Performance ● Student cannot complete task without assistance.	Not Yet Proficient ● Student correctly calculates how long it will take Dan to save for his bicycle for all the different saving plans. ● Student had some difficulty or inaccuracies in generating their table and/or graph. ● Student's discussion about whether the graph will help Dan make his decision lacks mathematical reasoning.	Proficient in Performance ● Student calculates that if Dan saves his entire allowance it will take him 11 weeks to save for the bicycle. If he saves $10 a week, it will take him 17 weeks. If he only saves $5 a week, it will take him 33 weeks. ● Student generates a table to show how much money Dan will save each week for the various amounts of saving. ● Student generates a graph to show the 3 situations. ● Student engages in a mathematical discussion about whether the graph is an effective way to look at this problem.

Common Core State Standards for North Carolina Public Schools

Table 5

Standards for Mathematical Practices

Standards for Mathematical Practice
1. Makes sense and perseveres in solving problems.
2. Reasons abstractly and quantitatively.
3. Constructs viable arguments and critiques the reasoning of others.
4. Models with mathematics.
5. Uses appropriate tools strategically.
6. Attends to precision.
7. Looks for and makes use of structure.
8. Looks for and expresses regularity in repeated reasoning.

Common Core State Standards for Mathematics, North Carolina Public Schools

Procedures

This mixed methods research study used quantitative and qualitative data collection and analysis to investigate the relationship among mathematics anxiety, academic performance, and self-efficacy of elementary mathematics students, as well as identification of perceptions and characteristics exhibited by students with varying levels of self-efficacy. Quantitative data included scores from the state achievement test in mathematics and two surveys obtained from a purposeful sample of 30 upper elementary students. In addition, qualitative data from a purposeful sample of 12 students was collected through interviews and class observations in order to support and extend the quantitative evidence.

The school chosen for this study was in a suburban area near an urban center of the southeastern United States. In this case, the school system involved had given the researcher permission to conduct the study in any school in their districts, at the discretion of the principal of the individual school. This particular school was chosen through the direct contact of the investigator with the principal of the school. The author, through university associates, called upon the principal, who had been cooperative with university teacher-training programs. It was decided to begin with 5th-graders because students develop separate verbal and math self-concepts by the 5th grade due to their growing ability to differentiate their competence on different academic tasks (Marsh, 1986).

The participants were purposefully selected from three (3) elementary classrooms in this Title I school in the Southeast. Prior to conducting the study, permission and a letter of support were obtained from the county assistant superintendent, the school administration, and the university's Institutional Review Board (IRB). The initial 55 students and the students' legal guardians were given the option to sign a consent form prior to data collection. Each participant was informed that data would be collected on classroom activities, observations, interviews, as well as access to educational records. Participants were also informed that they could retain the right to withdraw permission at any time, including after data collection.

Upon university approval, 38 of the original 55 students enrolled in the regular education classroom in grades five returned the consent and assent forms. These students were administered the Math Anxiety Rating Scale for Elementary (MARS-E) and the Self-Efficacy Questionnaire for Children (SEQ-C) by the regular classroom teacher to determine separate self-efficacy ratings and math anxiety ratings for each child. The surveys used Likert-type questions that were ranked in order of strength. Each response to the Likert survey was hand scored using an ordinal system and documented in a computer program for record keeping purposes. Of the 38 students that responded to the surveys, eight did not complete all the required sections and their scores could not be used. Therefore, a final sample of 30 students were used to participate in the observation portion of the study.

The purposeful sample, whose survey scores indicate varying levels of self-efficacy and math anxiety, were selected for this study through a qualitative analysis of scores from the SEQ-C and the MARS-E. Once the sample size was analyzed quantitatively, twelve students were chosen based on the following criteria: (a) students had to have completed both surveys in their entirety, (b) students had to fall outside of the mean score of the surveys by at least 25 points combined, (c) students had to have taken the NCEOG in May of 2016, and (d) students had to be present on the day of the interviews and observations. The observations were conducted in the regular education classroom, during the students' regular mathematics block. These observation sessions were audiotaped and videotaped for no more than the 45-minutes mathematics class period. An observation protocol was used during each session to document behaviors and conversations. The observation protocol was transcribed by the researcher, allowing for an identification of codes and themes. The purpose of the classroom observation protocol was to document the students' interactions, conversations, and management of the mathematical tasks. The field notes for the protocol were recorded to document the evidence that was seen and heard in the classroom setting. The interviews, observations, and field notes served to triangulate the data. It was the hope of the researcher that a story emerged to give deeper insight into student self-efficacy and mathematical performance.

The observations focused on a small group of students who were identified by the previous criteria and were working in close proximity to the researcher. Field notes and observations were collected to examine evidence of Bandura's (1997) academic self-efficacy constructs described in the theoretical framework. As stated previously, these constructs include: (a) performance accomplishments or experience, (b) vicarious experience or modeling, (c) social persuasions, and (d) physiological and emotional states. Informal interview questions during the observation were necessary and occurred during the last five minutes of observation period. Any informal interview questions asked were noted, student responses recorded, and responses numbered. Any observation and interview protocols, including informal interview questions and an episode-recording sheet, can be found in Appendix B.

Data Collection Methods

Data collection included videotaped observations, audiotaped interviews, anecdotal notes from interviews and observations, interview and observation protocol codes, and surveys completed by individual students. Each collection method was conducted by the researcher with the exception of the MARS-E and SEQ-C surveys. Surveys were administered by the regular classroom teacher during a regular education mathematics class. Only those students who had signed consent and assent forms completed the two surveys as well as participated in the interviews and observations. Students who did not completed the consent and assent forms were working on regular classroom materials at a separate table.

The Mars-E and SEQ-C were administered on two consecutive days in the first week of October 2016. Students were read directions aloud only and instructed to answer as honestly as possible. No survey questions were read aloud to the students or any clarification given. At the end of the class period, the regular classroom teacher collected each survey and placed each in a separate envelope to give to the researcher. The survey results were calculated using an ordinal system to score the Likert scale responses. The sum of responses to both surveys were added to a computer spreadsheet for ease of analysis. Students were placed into categories, based on their survey results, to determine their self-efficacy and math anxiety self-ratings. These ratings determined which students were involved in the interview and observation sample group. Students who fell 25 points or more above or below the mean were identified and chosen to participate in observations and interviews.

Observation data was collected based on the results of the survey data. Each observation was conducted in the regular mathematics classroom for no more than 15 minutes. During the videotaped observations, students were working in small groups on the mathematics task developed by the North Carolina Department of Public Instruction based on the standard course of study for the beginning of fifth grade curriculum. Small groups of students were spread across the room to ensure that no students were videotaped without permission. Students were chosen based on the above criteria for the observation portion of the study. Twelve students met the criteria and were placed at a table separate from the other students during the mathematical task. The students were instructed to work as a group or individually, as needed, and could begin as soon as the task was seen on the smartboard. A video camera was set up in a corner of the classroom to capture the conversations and interactions of the focus group only. No assistance or clarification was given to any group during the task. The observation protocol was used to document certain behaviors that occurred during the task. The observation protocol listed all students in the group being observed. In columns to the right of each student, numbers were assigned for behaviors. These numbers are included in the observation protocol in Appendix B. These numbers were to indicate certain behaviors for the researcher. They included: 1 - actively listening, 2 - on task 90 +%, 3- contributing to conversation, 4 - attentive (posture), 5 – other. A negative/minus sign was placed in front of the numeral indicating behaviors that were deemed negative in nature. For example, if a student was not contributing to the conversation, a -3 was placed beside the name of that student, while a student contributing would have a 3 in a similar column. A final column was included to make any notes that the researcher felt would assist in analysis.

Interviews were conducted immediately after the completion of the mathematical task. Students chosen for the observation were taken, individually, to an office within the regular classroom and interviewed by the researcher. Students were audiotaped during the interviews to ensure data would not be lost. Once the students completed the interview questions, they were released back to the classroom to ensure little instructional time was lost. Students were asked questions about their self-efficacy and anxiety in mathematics in a semi-structured interview session with the researcher. Interviews were conducted by the researcher on an individual basis for no more than 10 minutes. All interviews were audiotaped to prevent loss of information and transcribed within one week of data collection. Interview questions can be found in Appendix B.

Data Analysis

This study sought to identify verbal and nonverbal characteristics that facilitate self-efficacy in elementary students in a regular mathematics classroom as well as correlations between self-efficacy, anxiety, and performance in mathematics classes. Table 6 illustrates the research question, data source, and data analysis process.

Table 6

Research Methodology

Research Questions	Data Source	Data Analysis Process
What is the correlation between self-efficacy and math anxiety?	SEQ-C, MARS-E	● Classroom teacher administered. ● Computer analysis and hand calculated results. ● Each response on the surveys were given a numerical value to assess self-efficacy and math anxiety.
What is the correlation between math performance vs. self-efficacy ?	NCEOG, SEQ-C	● EOG scores obtained from testing coordinator. ● Computer analysis of EOG scores correlated with SEQ-C scores.
What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?	Interview Protocol responses	● Interview of students completing a North Carolina Common Core aligned mathematical task. ● Identify patterns. ● Data coded and sorted into thematically related sets.
What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?	Observation Protocol	● Observation of students completing a North Carolina Common Core aligned mathematical task. ● Identify patterns of communication events. ● Data coded and sorted into thematically related sets.

Quantitative Data Analysis

The self-efficacy questionnaire is divided into three sections that address academic self-efficacy, social self-efficacy, and emotional self-efficacy. These sections are combined to receive the total self-efficacy score for the questionnaire. SEQ-C scores were hand calculated by the researcher within two weeks of receiving the surveys. Each question was rated on a Likert scale of 1-5, with a 1 being “not at all” and a 5 as “very well.” Each response was given a numerical value of 1-5 respectively. A total self-efficacy score was obtained by summing across all items and labeled TotalSEQ-C for data identification purposes. An additional score was tallied for responses to questions 1 4, 7, 10, 13, 16, 19, and 22. These questions addressed the SEQ-C scores for academic self-efficacy and are labeled SEQ-C for the purpose of data identification purposes.

The MARS-E was also hand scored within two weeks of receiving the survey. Each question was rated on a scale of 0-4, with 0 being “not at all nervous” to a 4 being “very, very nervous.” Each response was given a numerical value of 0-4 respectively and hand scored by the researcher. A total math anxiety rating score was obtained by summing all responses.

NC EOG scores were calculated by the state and scores reported to the regular classroom teacher alphabetically. These scores were obtained from the school testing coordinator and entered into the university’s statistical program along with the TotalSEQ-C, SEQ-C, and MARS-E scores. The statistical program was used to calculate Cronbach’s alpha for reliability and validity purposes, a paired sample t-test for correlations, and an item analysis of the survey questions.

Qualitative Data Analysis

Qualitative data in this study utilized observations of a purposeful sample of twelve students performing a North Carolina math task created by the North Carolina Department of Public Instruction. These students were chosen base on their survey scores’ deviation from the MARS-E and TotalSEQ-C mean score. In other words, each student’s combined SEQ-C and MARS-E score was at least 25 points from the mean survey score of the entire sample to be admitted into the observation and interview group. During the observation, the researcher was taking notes with the observation protocol and coding behaviors. The videotape was also viewed within the following two weeks to note any additional codes and/or comments that were missed in the original observation. Once the codes were written, the researcher identified common elements in varying levels of self-efficacy and math anxiety. Elements are defined as the characteristics students exhibited as well as the codes from the observation protocol. These elements were then documented under the category of either High SEQ/Low MARS or Low SEQ/High MARS. Based on the information from the categories, themes on the level of self-efficacy, math anxiety, and academic achievement were created. These themes are discussed in chapter 4.

Once the sub group of twelve students were observed completing the mathematics task, the researcher allowed the regular education teacher to begin instruction. The researcher called students into the adjoining office to conduct the interviews individually. Interviews were audiotaped for accuracy in transcription. The transcriptions were completed by the researcher within two weeks of the interviews. Each transcription was typed in a word processing program, printed and cut apart for each participant. Themes were identified based on common responses to questions. These themes are discussed in chapter 4.

Limitations

This study can be limited in that the participants were purposefully selected rather than randomly selected. With "purposeful selection" of participants, there is always the chance that the participants may not reflect the opinions and views of the greater population. The study can be considered limited because the participants were chosen from a very small group of students. This study may also be limited by researcher-bias.

Because this researcher has some strong opinions about this topic, it was difficult to obscure certain biases and opinions about this subject. As a public school teacher, the researcher is familiar with research and the topic and discussions with the regular education mathematics teacher assisted in eliminating personal opinions and biases. Therefore, as a way of controlling for limitations, this study was open to outside scrutiny to avoid any subjectivity.

In addition, the presence of a researcher observing a classroom can affect the behavior of the students. It was possible that the participants would deviate from his/her normal approach with tasks and become self-conscious and/or behave in a manner that is not typical of their ordinary style. Observations were made over a two-week period to reduce the observation effect and in essence to make the cameras and researcher a part of the classroom environment. In addition, since the participants were not aware of the actual purpose of the study during data collection, this should have reduced the possibility of behaving or responding in a manner that would “please” the researcher. The regular classroom teacher was involved in the process from the inception of this study and discussions about the students chosen and the results that occurred throughout the process of data collection. She reviewed the data that was collected and verified that the behaviors and characteristics of the students observed were consistent with how each normally behaved. Therefore, these behaviors were consistent with the characteristics they normally display within the classroom.

De-limitations

This study was delimited to student outcomes on standardized achievement tests. Conclusions are not to be extended beyond student achievement and self-efficacy. To ensure the protection of the participants in this study, the researcher carefully followed the guidelines as outlined by the Institutional Review Board (IRB). The first consideration involved collecting signed informed consent statements from all participants. The following safeguards have been outlined in the informed consent statement:

- Participants' real names were not used in the data collection or in the written report. Instead, pseudonyms were assigned to all participants in all verbal and written records and reports.
- All materials were locked in file cabinet to safeguard confidentiality. No audiotapes, transcription notes, field notes, or observation notes were used for any purpose other than for the purpose of this study. When this study is completed, all related materials will be destroyed.
- Participation in this study was strictly on a voluntary basis. No children were spoken to, or questioned without written consent from legal guardians. Participants had the right to withdraw from this study at any time without penalty.

Along with the above listed safeguards, proper permission was secured from the data collection sites giving permission to do the study in the school. In addition, a timeline was provided indicating the projected times when each phase of this study would take place. Therefore, it is hoped that the information gained from this study would be helpful in learning more about the phenomenon, and its findings beneficial to the education process of all students.

Summary

Studying self-efficacy is a complex process that has traditionally been evaluated using quantitative techniques. This study sought to explore the self-efficacy beliefs of students by employing the qualitative tool of semi-structured interviews, observations, and surveys. Through the voices of students that have experienced success or failure in mathematics, the researcher aimed to examine the characteristics exhibited during a mathematical task and how they were influenced by the mediating variable of achievement. This task presented challenges, as qualitative data can be cumbersome to collect, organize, code, and interpret. The researcher addressed these validity and reliability challenges by planning a triangulation strategy that encouraged further accuracy, through cross checking, during the interpretation of data.

CHAPTER 4

RESULTS

Introduction

In this section, the quantitative and qualitative results of the study are reported. Quantitative data includes computer generated and hand calculated results from the Math Anxiety Rating Scale for Elementary students and the Self-Efficacy Questionnaire for Children. Qualitative data includes interviews and observations of twelve students from different mathematics classes. Qualitative data was evaluated by the researcher and themes identified. These themes are discussed below.

Missing Data

A total of 38 students responded to the SEQ-C and MARS-E surveys. After analyzing the data more closely, eight of the respondents were missing one or more pieces of data, which led to their elimination from further data analyses. Even though the sample size was already small, it was appropriate to eliminate those additional eight participants from the overall analysis, reducing the sample size to 30 participants.

Demographics

The 30 fifth grade students in the study were categorized by the following demographics:

31% female, 69% male, 38.5% African American, 41% Caucasian, 20.5% Hispanic.

Review of Data Collection Methods

Thirty (30) students in a suburban public school mathematics classroom were administered the Math Anxiety Rating Scale for Elementary children (MARS-E) and the Self-Efficacy Questionnaire (SEQ-C) in the fall of 2016. Surveys were administered by the regular education mathematics teacher on two consecutive days. Surveys were collected by the researcher for analysis. Once the surveys were calculated and criteria met, twelve students were identified to participate in the interview and observation portion of the study. Inclusion criteria included: (a) a combined MARS-E and SEQ-C score that deviated 25 or more points from the mean score of each measure, (b) present the day of qualitative data collection, (c) score for North Carolina End Of Grade test (EOG) available to the researcher.

Observational and interview data was collected one month after administration of the surveys. Observations occurred in the regular mathematics classroom while students were completing a mathematical task created by the North Carolina Department of Public Instruction. Students had not been exposed to the task before the study but students had completed other tasks created by the same organization in the past. Students were instructed to work individually or in small groups to solve the task. A video camera was set up in front of each group being observed. While students were being observed, an observation protocol was used to code behaviors of the students. Once the students had completed the math task, the regular mathematics teacher began her lesson and students were individually interviewed by the researcher.

Interviews followed a semi-structured, open ended format that yielded student self-reports about their sense of mathematics self-efficacy and the sources that influenced it; however, the questions did not limit or lead the students' answers in any way. The questions focused on students' math backgrounds, experiences with math and people, and efficacy in mathematics. The interviews elicited responses regarding experiences in the class that influenced students' sense of efficacy. Students were reassured that the interviews were in no way associated with their performance in the class and that their responses would remain confidential. Students were encouraged to give descriptive responses and that there were no wrong answers. The students were interviewed independently in a private office in their classroom. Interview times in minutes averaged 5:58 with the longest interview lasting 10:02 and the shortest 4:12.

The purpose of the interview and observation data was to gain more insight into each student's perceived self-efficacy and math anxiety as measured by the SEQ-C and MARS-E, respectively, as well as document behaviors exhibited by students with varying levels of self-efficacy. A previously created interview protocol was used by the researcher. The observation protocol was created for the purposes of this study. Both protocols enabled the researcher to document verbal responses and record behavioral episodes with ease and speed. The students were also audio/video taped for the same reason. A copy of the interview and observation protocol is included in Appendix B.

Research Questions

The following describes how the data was collected and addressed each of the research questions posed. The first explores the SEQ-C and MARS-E data and is later augmented with data drawn from interviews, observations, and classroom tasks.

Question 1: What is the correlation between self-efficacy and math anxiety?

In order to assess the mathematics anxiety levels of elementary school students, an elementary form of the MARS (MARS-E) was developed by Suinn et al. (1988). The instructions of the MARS-E ask students to “place a (✓) in the circle that shows how nervous you would feel.” The survey assumes that the students in the intended age group having very little experience in responding to such an instrument, and helps students go through two examples before they begin responding to each item. The survey includes 26 5-point Likert type items, such as “being given a set of division problems to solve on paper” (item 20), that measure computational anxiety; “when counting how much change you should get back after buying something, how nervous do you feel?” (item 6) that measure anxiety in using mathematics in real life situations; “starting to read a hard new chapter for your math homework” (item 11) that measure mathematics course anxiety; “being asked by your teacher to tell how you got your answer to a math problem” (item 12) that measure mathematics teacher anxiety; and “taking a big test in your math class” (item 13) that measure mathematics exam anxiety. For example, in the MARS- E, students are asked to rate their level of nervousness from “not nervous at all,” which would be scored as a zero, to “very, very nervous” which would be scored as a 4. When the score from each item is computed, a total scale score is obtained which may range from zero and 130; higher scores indicated higher levels of mathematics anxiety.

The Self-Efficacy Questionnaire for Children (SEQ-C) (Muris, 2001*)* assesses general self-efficacy across three domains: academic, social, and emotional situations. There are no instructions on the survey itself but students are to color in the bubble which indicates their level of efficacy. The survey includes 26 5-point Likert type items, such as “How well do you succeed in understanding all subjects in school” (item 16) and “How well can you study a chapter for a test" (item 7), that measures general academic self-efficacy; "How well do you succeed in cheering yourself up when an unpleasant event has happened" (item 3) that measures emotional self-efficacy; and "How well can you work in harmony with your classmates" (item 11) that measures social self-efficacy. Each item is rated on a five point Likert scale with 1 being "not at all" and 5 being "very well." Therefore, the higher the sum of the responses is, the higher the self-efficacy. The scale has been shown to demonstrate good construct validity with a Cronbach's alpha of .90. Suldo and Huebner (2005) found internal consistency for the SEQ-C to be 0.82, 0.78, and 0.76 for the academic, emotional, and social subscales, respectively.

Table 7 reports Pearson's r statistic for the relationship between Total SEQ-C, Academic Achievement, and MARS-E. The correlation for this group of students is negative, the Sig. (2-Tailed) value in the sample was 0.025. This value is less than .05. Because of this, it was concluded that there was a statistically significant correlation between the level of math anxiety and self-efficacy in the participants of this study. In this data set, the correlative relationship should be negative because the mean score results on each measure are typically inverted according to the literature. If SEQ-C is high, MARS-E is typically low (and vice versa), so there would be an expected negative association. Therefore, this study supports the literature regarding the correlation between math anxiety and self-efficacy. In other words, according to the results of this study, students with high self-efficacy tend to exhibit lower levels of math anxiety and vice versa.

Table 7

Correlation of MARSE, TotalSEQ-C, Academic Achievement

		TotalSEQ	MARSE
TotalSEQ	Pearson Correlation	1	-0.409
	Sig (2 tailed)		0.025
	N	30	30
MARSE	Pearson Correlation	-0.409	1
	Sig (2 tailed)	0.025	
	N	30	30

Note. Correlation is significant at the 0.05 level (2-tailed).

Table 8 reports the 30 students' total mean score and standard deviation for the 26 item anxiety scale of the MARS-E, the 24-item self-efficacy scale of the TotalSEQ-C and the NCEOG. The TotalSEQ-C score includes all three domains of the self-efficacy survey while the SEQ-C information only includes data from the items on the instrument that assess academic self-efficacy. These mean scores were used to create a baseline for selection of the subgroup of students for the interviews and observations, but they also provide a snapshot of the general levels of math anxiety and self-efficacy in this particular group of students. As compared to the mean scores in table 8, students whose sum of TotalSEQ-C and MARS-E scores were greater than 25 were chosen for the subgroup. Twelve students were identified.

Table 8

Mean and Standard Deviation

Measure	Mean	SD
MARS-E	26.3	16.20377
EOG	54.1957	20.97752
Total SEQ-C	84.2333	19.59536

Question 2: What is the correlation between math performance vs. self-efficacy?

The mean total scores for the 30 students on the SEQ-C, the SEQ-C for academic self-efficacy, and the NCEOG scale scores are displayed in table 9. These mean scores were used to determine which of the 30 students varied 25 or more points on the combined survey scores. Those that were 25 or more points from the mean scores shown below were chosen for the interview portion of the study.

Table 9

Standard Deviation and Mean Scores

	TotalSEQ-C	SEC-Q	NCEOG
Mean	84.2333	29.2647	54.1957
SD	19.5953	7.25847	20.97752

The correlation between math performance and self-efficacy is reported in Table 10. The Pearson r was used to find the correlation between self-efficacy and academic performance on the North Carolina End of Grade Test. The test revealed a Pearson r of 0.111. Therefore, there is very modest positive relationship, but no statistically significant correlation between self-efficacy and mathematics performance.

Table 10

Correlation of TotalSEQ-C, Academic Achievement

		TotalSEQ	EOG
TotalSEQ	Pearson Correlation	1	0.111
	Sig (2-tailed)		0.558
	N	30	30
EOG	Pearson Correlation	0.111	1
	Sig (2-tailed)	0.558	
	N	30	30

Note. Correlation is significant at the 0.05 level (2-tailed).

Students' MARS-E, EOG, and TotalSEQ-C were evaluated and compared to the mean score of each measure. Students scoring higher than the mean were considered high scorers in that measure, while students scoring below the mean were considered low. A comparison of this performance in the self-efficacy, math anxiety, and achievement measures yielded the following results in Table 11.

Table 11

High Achievement, Self-Efficacy, Math Anxiety Comparison

Student	EOG High Achievers	TotalSEQ-C	MARS-E
1	High	Low	High
2	High	Low	High
3	High	Low	High
4	High	High	Low
6	High	High	Low
7	High	High	Low
8	High	High	Low
9	High	High	Low
10	High	High	Low
13	High	Low	High
14	High	High	Low
15	High	Low	Low
17	High	Low	High
21	High	High	Low
22	High	Low	Low
23	High	Low	High
24	High	High	Low
26	High	Low	High
28	High	High	Low
30	High	High	High

Low Achievement, Self-Efficacy, Math Anxiety Comparison

Student	EOG Low Achievers	TotalSEQ-C	MARS-E
5	Low	Low	Low
11	Low	Low	Low
12	Low	Low	High
16	Low	High	Low
18	Low	High	High
10	Low	Low	High
20	Low	High	High
25	Low	High	High
27	Low	High	Low
29	Low	High	Low

Previous research literature would predict a high math anxiety, low self-efficacy result for lower exam scores and conversely, low math anxiety coupled with high self-efficacy result in higher exam scores. A number of students in this study do not support those results. Of the 30 students, 60% indicate results that are not consistent with the literature. These anomalies are addressed in the discussion in chapter 5. Table 12 displays the pattern of the 60% of students showing the anomaly.

Table 12

Anomalies of High Student Achievement, Self-Efficacy, Math Anxiety Comparison

Student	High Achievers	TotalSEQ-C	MARS-E
1	High	Low	High
2	High	Low	High
3	High	Low	High
13	High	Low	High
15	High	Low	Low
17	High	Low	High
22	High	Low	Low
23	High	Low	High
26	High	Low	High
30	High	High	High

Anomalies of Low Student Achievement, Self-Efficacy, Math Anxiety Comparison

	Low Achievers		
5	Low	Low	Low
11	Low	Low	Low
16	Low	High	Low
18	Low	High	High
20	Low	High	High
25	Low	High	High
27	Low	High	Low
29	Low	High	Low

Questions 3: What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?

Students were interviewed privately and individually in an office within the regular mathematics classroom. During the interview sessions, responses were recorded and transcribed within two weeks of completing all interviews. The interviews were transcribed by the researcher, typed onto a Word document and then sorted by respondent. Multiple readings were needed to find commonalities in the interviewee's responses. The themes identified through analysis were: how others see them as mathematicians, reported self-efficacy when compared to survey results, what they thought helped them in mathematics class, and self-reported mathematical ability.

Of the twelve student responses, 67% of the students were able to respond and give examples of what their peers, teachers, and/or parents thought about their mathematics ability. Of the students identified as low SEQ and high MARS, 100% felt that their peers felt they were good mathematicians, but only 50% self-reported in the interview that they felt confident in their mathematical ability. Additionally, 75% felt their self-efficacy was low. The differences in the responses to the levels of self-efficacy can lead one to believe that this concept of self-efficacy may have been confusing for this group of students.

Conversely, students considered high SEQ and low MARS exhibited a 57% confidence level in their ability and 100% with high self-efficacy. This is consistent with their reported efficacy scores on the SEQ-C. This group of students appeared to be more aware of their ability and was more confident in this ability.

Students were also assessed on their responses on how they felt they performed as math student. Of the twelve respondents in the sub group, 43% of the students scored themselves between a five and a six on a scale of one to ten - with ten being they felt they were a very capable math student. The average rating for the eleven students was 7.36. This indicates that 57% of the students felt they were capable math students, but were self-aware of their own deficiencies. Students responded with, “um I’m struggling with division” and claimed they always “do terrible with division problems.” Max, a high self-efficacy student claimed “I’m not the best and the brightest on division but I’m good at multiplication.”

When asked what they felt would increase or decrease their performance in mathematics, 73% of the student responses dealt more with self-confidence in math. Jasmine, a low self-efficacy student replied, “Something giant could give me courage...uh failing a test”. Taylor, a high self-efficacy student understood the importance of studying in relation to her performance in math and answered, “studying harder” to this question. Overall, the majority of the students could not explain beyond learning their mathematical facts and “getting better” at their multiplication and division as factors that would increase their performance.

Students evaluated how assignments and assessments affected their self-efficacy in a mathematics class. Questions from this section included “When you are given a math test, how does that make you feel?” and “How do you feel when you are given a math assignment?”. Of the seven students with high self-efficacy and low anxiety, 71% reported they felt confident when given a classroom assignment, while 86% felt confident when given a mathematics test. Of the 5 students identified as low self-efficacy and high anxiety, only 50% felt confident in taking a test but 100% felt confident when given an assignment. Overall, students, regardless of their SEQ-C and MARS-E score, indicated they felt confident in their ability to solve the problems similar to the task that was completed for this study. One student explained, “Nervous. Really nervous because I usually don’t get a lot of practice at home and I usually don’t like math but I have to do it so I get nervous because I don’t know if we have learned it or not sometimes in multiplication I don’t know all my multiplications.” This student was the only one who rated their self-efficacy below a nine. This self-efficacy was also reflected in her responses on the SEQ-C and the MARS-E. The differences in scores and responses on the SEQ-C and MARS-E would indicate a misunderstanding of the question or that students were not fully aware of their anxieties and confidence levels when not immediately presented with a mathematical task.

Question 4: What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?

The purpose of the qualitative data in this study was to identify students with high self-efficacy and low anxiety as well as students with low self-efficacy and high math anxiety and observe characteristics exhibited while performing a mathematics task. Those identified were interviewed and observed during their regular mathematics class, completing a North Carolina Department of Education Mathematics task. The following Mathematical task was used:

Domain	Operations and Algebra
Cluster	Analyze patterns and relationships
Standard(s)	5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane.
Materials	Paper and pencil, graph paper
Task	Dan is saving money to buy a bicycle. The bicycle costs $165. Dan earns $15 in allowance each week. If he saves his whole allowance, how many weeks will pass before Dan has enough money for his bicycle? Create a table to show how long it will take and how much money Dan will have each week. Dan decides that he wants to spend a little bit of his allowance each week instead of saving it all. If he saves $10 a week, how long will it take him to save up for the bicycle? Add a column to your table showing this data. What if he only saves $5 a week? Add another column to your table showing how long it will take Dan to save enough for his bicycle. Use graph paper to show how long it will take Dan to save enough money for his bicycle using each of the three situations above. Would having this graph help Dan make a decision about how much he should save each week? Why or why not?

Figure 1. North Carolina Common Core Mathematical Task.

Students were placed in groups and instructed to read the task and complete it as a group. The students who were chosen from the quantitative data sat together as one group to ensure only students who signed the assent and consent forms were videoed.

The purpose of the observations was to determine physical characteristics students may exhibit while completing a mathematics task with their peers. An observation protocol was developed by the researcher, based on previous experience with students in mathematics classes and common behaviors observed in the past. This observation protocol was developed in order to document behaviors with ease and speed. The students were also videotaped for the same reason. A copy of the observation protocol is included in Appendix B. The students were videotaped in three different groups at three different times with an average taping of eight minutes and thirteen seconds. The longest taping was 11:29 and the shortest 4:22. The differences in time are related to mathematics performance, confidence, and self-efficacy and are explained in the results section.

Observational data indicates that 64% of the students exhibited higher self-efficacy and were more eager to begin working on the problem and organize a strategy to solve it. These students also discussed the problem, defended their thinking, and were more eager to take risks in problem solving. Higher self-efficacy and low math anxiety students were confident in their choice of strategy and did not look to the teacher for instructions or additional assistance. They were also more cognizant of other students and their performance on the problem - asking at one point “Do you know what to do?” and “Do you need help getting started?”. One student with high self-efficacy and low math anxiety helped one child work out the entire problem, explaining each step in detail.

In each group, 36% of the students who exhibited lower self-efficacy and higher math anxiety did not immediately begin working and waited for other students to begin working - indicating a lack of confidence in their ability. None of the students with low self-efficacy and high math anxiety asked questions of the other students or teacher, disturbed the group, or indicated they did not understand the problem. They waited for the students with higher self-efficacy to ask them if they needed assistance and sat passively while they were helped. Each of these low self-efficacy and high math anxiety students were passive observers during the entire exercise.

Physical characteristics of students with high self-efficacy and low math anxiety included good posture - sitting up straight, holding their pencil to the paper, and leaning forward, ready to discuss the problem with another student. These students physically showed an eagerness to work on the problem through their postures. They nodded their heads to others comments and responded in a polite manner. They tended to use their hands to gesture to prove a point and organized their thoughts on paper before discussing with their classmates. These students were also eager to show their work to other students to defend their thinking.

Students with low self-efficacy and high math anxiety had poor posture - slumping in their seat, hands off the desks, and made little or no eye contact with other students or the teacher. They were very watchful of what other students were writing on their papers but did not engage any other students in conversation or ask questions. One student constantly bounced his leg during the entire observation, indicating a nervous habit. Other observed physical characteristics of students with high math anxiety and low self-efficacy included watching the rest of the room. These students were very aware of what other students outside of their group were involved in and tended to look outside of their group to observe other behaviors.

Overall, students in the sixth year and third month of the school year exhibit characteristics consistent with other findings of low performing students. This indicates that low performing students at this age are very aware of their performance and their ability to complete an assigned mathematical task. These students are reluctant to begin the task, and ask less questions, and do not engage other students in conversation. Students with higher self-efficacy tend to more readily engage in conversation, ask leading questions, ask questions to further understanding, and are eager to share their strategies/answers. More information on this is included in the interview protocol.

Summary

Research data from this study indicates that the students with high self-efficacy and low math anxiety were more apt to engage in mathematical conversations, have a posture that indicates readiness to learn (sitting up, leaning toward others, hands ready to work), and ask questions to reinforce learning or clarify. These students were confident in their answers to interview questions and could answer without hesitation or much clarification. They were very aware of their performance as it relates to other student and teacher beliefs. However, their reports of self-efficacy were not always directly related to their performance on the EOG standardized test.

Students with high math anxiety and low self-efficacy were reluctant to engage in conversations with other students, had posture which indicated shyness (slouching, hands in lap, heads turned toward the desk), and did not ask questions or for assistance. They would readily listen when another student asks to help them and watch passively, only writing down what the student instructed.

There were some students who did not follow the pattern of high self-efficacy, low math anxiety, and high achievement on the EOG. These students had increased performance scores but indicated in their self-reports that they had a higher level of math anxiety coupled with reports of high self-efficacy. These students were hyper aware of their performance and how their performance was affected by their capabilities. Conversely, there were students who also had low EOG performance, but demonstrated high self-efficacy and low math anxiety on the SEQ-C and MARS respectively. These students had the most trouble with the interview questions and did not discuss how mathematics capability influenced performance. As noted, these latter incidences among students represent some significant anomalies from what the mathematics education research literature would predict. The results for this particular group of students raised several questions that need addressing. These are taken up in Chapter 5 where, among other things, they are discussed regarding what might be learned from the data and what implications they might hold.

CHAPTER 5

DISCUSSION, RECOMMENDATIONS, and CONCLUSION

Methods and Procedures

Varying levels of self-efficacy and math anxiety persist in the educational setting. Recent accountability measures developed by federal and state legislators have increased the possibility for additional stressors for children as young as ten years of age. Using the theoretical framework of Bandura's Social Cognitive Theory (1977), Daryl Bem's Self Perception Theory (1967), as well as Social Learning Theory, the impact of success and failure in Mathematics achievement and its relationship to self-efficacy and math anxiety was explored using a mixed methods approach. This study utilized quantitative methods that examined the results from the Self-Efficacy Questionnaire for Children and the Math Anxiety Rating Scale for Children to identify students with a combined score that indicated varying levels of each. Data from these instruments were analyzed by the researcher using computerized software, and a purposeful sample of twelve children in the fifth grade were chosen to conduct interviews and observations during a Common Core State mathematics task on number analysis and patterns. Qualitative data included interviews and observations of the twelve students from different mathematics classes. Each interview and observation was coded, and characteristics exhibited by each student were recorded and patterns identified.

A total of 38 students responded to the quantitative surveys. Of the 38 student responses, eight of the participants submitted incomplete surveys. Therefore, it was appropriate to eliminate those additional eight participants from the overall analysis; thus, reducing the sample size to 30 participants. The 30 fifth grade students in the study are categorized by the following demographics: 31% female, 69% male, 38.5% African American, 33% Caucasian, 23.5% Hispanic, and 5% were listed as American Indian/Other.

Research Questions and Summary of Findings

The purpose of the study was to utilize a mixed methods approach to develop a study that included self-efficacy perceptions and physical characteristics exhibited by fifth grade students that have experienced either success or failure on a high stakes assessment in Mathematics, as well as identify correlations between math anxiety, self-efficacy, and performance. Analysis of surveys, observations of small groups, and semi-structured interviews of individual children provided opportunities for the researcher to identify characteristics the participants have in common in order to answer the following research questions:

1. What is the correlation between self-efficacy and math anxiety?
2. What is the correlation between math performance vs. self-efficacy?
3. What are the perceptions of fifth grade students regarding how self-efficacy influences their academic achievement in mathematics?
4. What characteristics do fifth grade students exhibit that contribute to positive or negative self-efficacy in learning mathematics?

The observation and interview questionnaire examined four areas of student self-efficacy and math anxiety levels. These areas included: the individual as they see themselves as a math student, how others view them as mathematicians, affective and physiological responses to mathematics, and self-efficacy in mathematics. The common themes for the interview include: evaluation of how students' peers see them as mathematicians, how students gauge their ability in mathematics classes, what they thought helped them in mathematics class, and confidence in mathematics as compared to their survey results.

Re-occurring responses to interview questions about how others see them as mathematicians indicated that peer and teacher input had very little influence on how well students felt about their success or failure in mathematics - more emphasis was placed on state testing results and grade reporting procedures. Other influences that students identified as factors in their achievement levels that were mentioned, but not significant, were making mistakes on assignments and individual performance on isolated skills.

Many of the students in this study indicated that their ability was based on different factors. One common element in half of the respondents involved low self-esteem and/or high anxiety. Despite the different reasons for evaluation of their mathematics ability, 75% of the students' ratings of their math ability were similar to their academic achievement scores. This could indicate that the students in this study could possibly be more aware of their ability based on their NCEOG scores, even though eleven of the twelve did not mention this as a factor.

Students in this study were asked to identify factors that contributed to success or failure in mathematics classroom. The majority of the students listed noise levels in the classroom were the biggest factor in success or failure in their mathematics classroom. Only 25% of the students listed specific skills that would possibly cause them to fail, as opposed to 67% who listed success attributed to other factors unrelated to the noise level in the classroom. These factors of success included being able to use the standard algorithm, being able to set and work toward a goal, and difficulty level of a problem.

Students were asked to report a self-efficacy rating on a scale of one to ten during the interview portion of this study. Their answers from the interview portion of this study correlated with their SEQ-C survey scores. This could indicate that the students in this study are aware of their self-efficacy when asked about specific mathematical situations as well as self-efficacy after the completion of a grade level mathematical task.

During the interview sessions, students with high self-efficacy and low anxiety were eager to discuss and discussed at length their ability and mathematics. Their interview times exceeded those of students with low self-efficacy and high anxiety. The students asked for clarification, seemed comfortable discussing schoolwork with a stranger, and confidently evaluated their performance in mathematics. Students with low self-efficacy and higher anxiety levels were more hesitant to answer questions, were less likely to ask for clarification of questions, and had difficulty evaluating performance.

The results of this study did confirm the correlation between math anxiety and self-efficacy, but not self-efficacy and academic performance. Students who self-evaluated as high self-efficacy and low math anxiety proved capable and confident when solving mathematical tasks. These students also performed well on state standardized tests in mathematics. Students that are more efficacious were actively engaged in conversations with other students about the mathematical task and were eager to explore options for solving it. Conversely, students with low self-efficacy and high math anxiety were less eager to begin working on a mathematical task and scored in the bottom 50th percentile on the state assessment in mathematics. These students were also not as confident when discussing mathematics with their peers and tended to wait for additional assistance or allowed another student to do the work for them. Little to no eye contact was made and their bodies were not in a “ready” position - hands on desk, pencil gripped, leaning forward, and actively engaged in conversation. Low self-efficacy students with low academic performance self-reported low levels of self-efficacy on the SEQ-C but high levels of mathematical ability in the interview sessions.

Discussion

Overall Findings

Recent research in mathematics and academic achievement has indicated that self-efficacy is a predictor of academic achievement that influences motivation, self-regulation, self-perception, expectancy of results, and the choices and interests of students. Unless a student believes they can produce desired results or attain a set goal, there is little incentive to act. This belief can impact academic motivation, interest level in mathematics, and academic achievement (Bandura, Barbaranelli, Capara, & Pastorelli, 1996). Self-efficacy can influence the choice of a student’s behavior, but through expectations of success, can affect their efforts. Interview and observation data in this study indicated that the students surveyed with high self-efficacy and low math achievement were more willing to engage in conversations with others students, assist struggling students, and ask questions of the teacher or other adult in the room. Additionally, students in this study with lower self-efficacy and higher math anxiety were more withdrawn and waited for others to assist them or complete the problem presented to the group.

Zimmerman and Martinez-Pons (1990) developed a model to explain self-regulated learning based on Bandura's theory of social cognition. Their work on the three classes of determinants - personal processes, environment, and behavior - highlight student's self-efficacy perceptions as related to self-monitoring, academic motivation, and academic achievement. Similar to the students in this study, the students in the Zimmerman and Martinez-Pons study used strategies associated with self-perceptions of mathematics to regulate learning. The findings of this research study indicate that students with higher mathematical proficiency displayed higher levels of self-efficacy and made greater use of learning strategies designed to regulate personal, environmental, and behavioral factors. During the classroom observations, high self-efficacy students were immediately engaged and developing a strategy to solve the problem. These students were observed discussing multiple strategies with the other high self-efficacy students. These students were aware of the students that were not confident in their abilities and did not engage them in the strategy discussion but once a strategy was agreed upon, high self-efficacy students explored the needs of the low self-efficacy students.

The implications of this study were similar to Zimmerman and Martinez-Pons (1990). In the results from the observational data, students who were more self-efficacious were more eager to begin their work on the mathematical task while those whose experiences in mathematics were less successful found the problem difficult and were reluctant to begin their work. Students in this study with low self-efficacy and high anxiety were extremely aware of those in their group who were successful in math and using this vicarious experience, were able to gain assistance in solving their problems. These students sat passively and allowed others to do the work for them. This is consistent with Bandura’s work on self-efficacy and his Social Cognitive Theory. Bandura’s theory states that students will not engage in a task unless they see the reward or feel that success is evident. Low self-efficacy students in this study were extremely reluctant to discuss their behaviors and were, in most cases, unable to answer the interview questions as opposed to the high self-efficacy students. Answers from these low self-efficacy students were not answered confidently or dismissed altogether as a misunderstanding. Even after explaining further from the researcher, these students were not able to expand or completely answer the interview questions.

Prior achievement has some bearing on student self-efficacy and math anxiety in mathematics classrooms (Basque & Buchannon, 2013). Student intelligence, aptitude, and motivation affect classroom performance. This was not evident in this research study. Students with low self-efficacy, high math anxiety, and low performance were unable to complete the task when administered in small groups. Lower performing students were content to wait for someone to notice their reluctance and offer assistance. They were extremely passive and quiet. Students with higher scores on the North Carolina End of Grade assessment used this information as well as the information from their report cards to explain their level of performance during the interviews. Conversely, there were anomalies to the data that included students with high self-efficacy, differing levels of math anxiety and low achievement scores. This is discussed in the next section.

Anomalies

The data from chapter four regarding the academic, anxiety, and self-efficacy levels are listed in table 13.

Table 13

Anomalies of Student Achievement, Self-Efficacy, Math Anxiety Comparison

Student	Achievement	TotalSEQ-C	MARS-E
1	High	Low	High
2	High	Low	High
3	High	Low	High
5	Low	Low	Low
11	Low	Low	Low
13	High	Low	High
15	High	Low	Low
16	Low	High	Low
17	High	Low	High
18	Low	High	High
20	Low	High	High
22	High	Low	Low
23	High	Low	High
25	Low	High	High
26	High	Low	High
27	Low	High	Low
29	Low	High	Low
30	High	High	High

Anomalies of Student Achievement, Self-Efficacy, Math Anxiety Comparison

Support of Literature of Student Achievement, Self-Efficacy, Math Anxiety Comparison			
Student	Achievement	TotalSEQ-C	MARS-E
4	High	High	Low
6	High	High	Low
7	High	High	Low
8	High	High	Low
9	High	High	Low
10	High	High	Low
12	Low	Low	High
14	High	High	Low
19	Low	Low	High
21	High	High	Low
24	High	High	Low
28	High	High	Low

In this table, 60% of the students in this study did not follow the pattern for anxiety, achievement, and self-efficacy that supports the literature. There are several reasons for this. The first reason is the time of the study and the achievement measure itself. This study was completed six months after the administration of the North Carolina End of Grade test. Therefore, the student data is considered cold. The current benchmark data or completing the survey in the same period as the NCEOG assessment could be more beneficial for further research. Additionally, the NCEOG relies heavily on adequate reading skills in grades 3-5. The assessment consists of 54 problem-solving activities that students must be able to read on their own. An assumption from this study can be made that students with levels of anxiety and self-efficacy that support literature but exhibit lower academic achievement could stem from an inability to comprehend the reading portion of the mathematics assessment. Further research in this area might be beneficial.

Secondly, some students with high academic achievement and varying levels of math anxiety and self-efficacy indicated their anxiety was not related to the work during mathematics but test anxiety. Students were asked additional questions after discussing the final section of the interview questions about what they thought they were anxious about. Of the twelve students interviewed for this study, 27% indicated that they had anxiety when taking a test. Therefore, research isolating test anxiety might be beneficial for future research.

Finally, the anxiety measure may need to be updated or the time given adjusted. Suinn et al. (1988) developed the MARS-E in the late 1970's and though reliability and validity is acceptable, an updated version may be beneficial. Additionally, the time frame the survey was given in relation to the task and NCEOG might have needed to be adjusted. Giving the survey measures closer to the administration of the NCEOG, having it read aloud, or completing a second survey after completing the math task and comparing the two sets of results may have remedied some of the anomalies.

Recommendations for Further Research

More research into the root causes and initial onset of issues with math anxiety and self-efficacy should increase. Increasing research in younger students can alleviate misconceptions and attitudes towards mathematics achievement in elementary school and possibly reduce the achievement gap. Students of color are still lagging behind their White and Asian counterparts in the area of mathematics. The most important task at hand is the reduction of math anxiety.

Math anxiety is defined as negative emotions that interfere with the solving of mathematical problems. It is often described it as “the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematics problem” (Tobias & Weissbrod, 1980). Approximately 93% of Americans indicate that they experience some level of math anxiety and it can develop at any age. For many, these negative attitudes toward math begin early in life - often before they enter kindergarten. Studies have found a negative relationship between math anxiety and math achievement across all grade levels (Legg & Locker, 2009; Scarpello, 2007; Woodard, 2004).

Students need to be given opportunities to succeed in a math task if the desired outcome is to increase students’ self-efficacy. Of the twelve (12) students in this study, only 25% reported they had received some type of award in mathematics. If the students see how they can be successful, they can believe that they can be successful again in the future. This intervention could be very useful in the classroom, perhaps in the form of gradual movement from easier material to more difficult material in math curriculum. Early support in this area can develop better work habits that can lead to more success in later math - given that they believe that success is possible. One student specifically mentioned she would do well in mathematics class if she was given something that gave her courage – for example, doing well on a test – while the majority of the students in this study could not discuss their own work habits at length.

Multiple techniques can be used by educators, stakeholders, and parents of students who exhibit lower self-efficacy and higher anxiety associated with low performance. These include, but are not limited to, developing positive attitudes towards mathematics, relate mathematics to real life experiences, encourage the process as opposed to correct answers, use cooperative learning models, manipulatives, and technology to enhance the learning process. Alternative assessment practices can also have positive effects.

Developing strong skills and a positive attitude toward math can have a lasting effect on students' mathematical performance and self-efficacy. Teachers who create positive classroom environments enable students to have the freedom to explore ideas, ask questions, and potentially cultivate academic achievement with a lifelong interest in mathematics. Standards documents in science (National Research Council, 1996) and mathematics (National Council of Teachers of Mathematics, 2008) are designed for all students. Researchers have found that teachers with math anxiety or a negative view of math contribute to the development of math anxiety in their students (Furner & Berman, 2004). Studies highlight the need for more teacher training that develops educators' math skills and positive attitudes toward math (Sparks, 2011). The students in this study repeatedly responded with specific teachers and specific ways the teachers were able to help them with mathematics. This would indicate that the students in this study felt their teachers were capable educators. One student specifically named a strategy his fourth grade teacher used that helped him maximize his learning.

Math anxiety has been linked to competition among students. Therefore, researchers recommend the use of cooperative group work. Cooperative groups provide students with opportunities to practice newly introduced skills or to review skills and concepts through read aloud, partner reading, jigsaw reading, and games. Teachers can use cooperative learning activities to help students make connections between the concrete and abstract levels of instruction through peer interactions. Cooperative learning can reduce competition and encourage student thinking and positive relationships within the mathematics classroom. The teacher in this study used cooperative group activities and all twelve (12) students were able to recount multiple strategies they had learned within their group work.

Implications for Practice

The implications in this study indicate that self-efficacy and math anxiety are related and may or may not affect academic performance of students as young as ten years of age. During repeated discussions with the regular education mathematics teacher, she indicated she knew the academic levels of her students and how to meet these needs, but was unable to address anxiety or self-efficacy issues within the classroom. Therefore, the students in this study may have benefited from the implementation of continuing education courses for experienced educators as well as a course of study for pre-service educators on the topic of self-efficacy and math anxiety at the elementary level that can increase awareness and offer strategies to improve classroom instruction to address differing levels of anxiety and self-efficacy. These strategies and classroom techniques can improve students' level of confidence in the subject of mathematics, allow students to self-regulate through vicarious experiences, and improve academic performance. These continuing education and pre-service coursework hours should include an examination of self-efficacy and math anxiety rating scales and instructions on administration in the regular classroom to ensure each student's needs are being met. Strategies and classroom techniques include instruction on the Concrete to Representational to Abstract (CRA) learning model, proper use of manipulatives in classroom settings, use of motivational techniques, cooperative learning models, and integration of technology. The regular education classroom teacher indicated if she had been knowledgeable of the prevalence of math anxiety and self-efficacy, and how it could affect each other and academic performance, she would be more prepared to combat these issues in her classroom.

During the observation portion of this study, students with high academic performance and high self-efficacy were able to discuss strategies for solving the task with their peers and the researcher. Therefore, the students in this study seemed to benefit from the strategies they had been taught previously to solve current tasks. These strategies were named and explained to other students within the groups and the students in this study could attribute their success to specific mathematics teachers form a lower grade level. This indicates that the students in this study were able to rely on past experiences in mathematics and what was successful for them.

A study is recommended to understand when students develop a higher level of mathematics anxiety as compared to the other grade levels at the elementary school level. A comparative study may involve other elementary students in the school district or the current research site to find similarities and differences among the different grade levels. A further look into instructional pedagogy at the different schools/classrooms may explain shortcomings. The study would explore the structure of the classrooms, including how students learn mathematics as a whole.

In addition, an intervention program could be developed to address students with high levels of mathematics anxiety and low self-efficacy. The program would build confidence in students' mathematical ability, reduce their low self-efficacy beliefs, and decrease math anxiety, thereby addressing the issue of negative attitudes in mathematics. The intervention program would begin with students journaling about their previous experiences of learning mathematics. Whether positive or negative, this self-evaluation of their mathematical ability would help build self-efficacy (Stevens et al., 2009), mathematics ability, and academic performance. An additional piece to journaling would include a student math questionnaire at the end of the school year to measure levels of mathematics anxiety. The information gathered would be used to place students in intervention programs for the following year.

Professional development of educators on the subject of math anxiety, self-efficacy, and its correlation to academic achievement is essential to increasing student performance. The expectation would be for classroom teachers to implement instructional strategies that are proven to reduce mathematics anxiety and increase self-efficacy with students. Research indicates that the constructivist approach to mathematical instruction improves student retention in mathematics as compared to the traditional classroom of rote-memorization and skill and drill practice.

Finally, involving parents/guardians in the identification remediation process could be beneficial for students who struggle with self-efficacy, math anxiety, and low math performance. Regular parent/guardian meetings could be offered to the families of students who have issues with self-efficacy and mathematics anxiety. The curriculum for these meetings should be similar to the professional development offered to educators but include techniques to reduce mathematics anxiety at home and suggestions on how to help their children in mathematics.

Concluding Remarks

Self-efficacy beliefs about mathematics are formed early and career choices can be affected by mathematics performance. To achieve expected student outcomes, educators must strive to understand students’ attitudes and anxieties as well as the measures that need to be taken to assist in overcoming those (Hancer et al., 2007). One of the objectives of pre-service teacher education programs can include the implementation of coursework dealing with math anxiety as it relates to self-efficacy and academic performance. Multiple factors and variables affect students’ success in mathematics. Therefore, understanding these and identifying students’ deficits can be utilized to positively develop student remediation practices and increase knowledge concerning learning difficulties about mathematics.

Previous behavioral studies focusing on individuals with poor self-efficacy have concentrated on adolescents and adults (Young & Menon, 2012), but very few studies have focused on the data acquired from the self-efficacy ratings of younger students and the relationship to standardized test performance during the elementary school years. Therefore, through a mixed methods approach, the primary purpose of this study was to investigate perceptions and descriptions of the self-efficacy beliefs of fifth grade students that have experienced either success or failure on a high stakes assessment in Mathematics, as well as identify correlations between math anxiety, self-efficacy, and performance through observations, interviews, and artifacts. Offering alternative assessments, multiple attempts on assessments, journaling opportunities, using manipulatives, and technology are all ways to increase self-efficacy, improve academic performance, and positively affect math anxiety.

REFERENCES

Ahmed, W., Minnaert, A., Kuyper, H., & Van., W. G. (June 01, 2012). Reciprocal relationships between math self-concept and math anxiety. *Learning & Individual Differences*, *22*, 3.)

Akinsola, M. K., & Olowojaiye, F. B. (2008). Teacher instructional methods and student attitudes towards mathematics. *International Electronic Journal of Mathematics Education, 3* (1), 60–73.

Alsup, J. (2004). A comparison of constructivist and traditional instruction in mathematics. *Educational Research Quarterly*, *28*(4), 3-17.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*, *80,* 260–267.

Anderson, L. W. (February 01, 2009). Upper Elementary Grades Bear the Brunt of Accountability. *Phi Delta Kappan*, *90*, 6, 413-418.

Ashcraft, M. H., & Kirk, E. P. (January 01, 2001). The relationships among working memory, math anxiety, and performance. Journal of Experimental Psychology. *General*, *130*, 2, 224-37.

Bandura, A. (January 01, 1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review, 84,* 2, 191-215.

Bandura, A. (1997). *Self-efficacy in changing societies*. Cambridge, U.K: Cambridge University Press.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (January 01, 1996).

Multifaceted impact of self-efficacy beliefs on academic functioning. *Child Development*, *67*, 3, 1206 22.

Basque, M., & Bouchamma, Y. (December 07, 2013). Academic Achievement in Effective Schools. *Alberta Journal of Educational Research, 59,* 3, 503-519.

Baxter, P., & Jack, S. (December 01, 2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *Qualitative Report, 13,* 4, 544-559.

Bem, D. J. (January 01, 1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review*, *74,* 3, 183-200.

Biller, J. (1996). Reduction of mathematics anxiety, Paper presented at the Annual National Conference on Liberal Arts and Education of Artists, New York.

Bredekamp, S., & Copple, C. (Eds.) (1997). Developmentally appropriate practice in early childhood programs (Rev. ed.). Washington, DC: National Association for the Education of Young Children.

Burchinal, M., McCartney, K., Steinberg, L., Crosnoe, R., Friedman, S. L., McLoyd, V., & Pianta, R. (January 01, 2011). Examining the Black-White Achievement Gap Among Low Income Children Using the NICHD Study of Early Child Care and Youth Development. *Child Development, 82,* 5.)

Chaiken, S., & Baldwin, M. W. (January 01, 1981). Affective-cognitive consistency and the effect of salient behavioral information on the self-perception of attitudes. *Journal of Personality and Social Psychology, 41*, 1, 1-12.

Creswell, J. W., & Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks: Sage Publications.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Boston: Pearson.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda, MD: National Institutes of Health, 4-5*

Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. New York, NY: *Harper and Row.*

Ding, C. S., & Davison, M. L. (January 01, 2005). A Longitudinal Study of Math Achievement Gains for Initially Low Achieving Students. *Contemporary Educational Psychology, 30,* 1, 81-95.

Duda, J. L., & Nicholls, J. G. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology, 84,* 290–299.

Dulaney, C., Bethune, G., & Wake County Public Schools System, Raleigh, NC. Dept. of Evaluation and Research. (1995). *Racial and Gender Gaps in Academic Achievement: An Updated Look at 1993-94 Data. Report Summary.*

Dweck, C. S. *(1986). Motivational processes affecting learning. American Psychologist, 41, 1040-1048.*

Eccles, J.S. & Gootman, J.A. (2002). *Community Programs to Promote Youth Development. Washington, DC: National* Academy Press.

Eccles, J., Wigfield, A., & Reuman, D. (1987, April). *Changes in self-perceptions and values at early adolescence*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Evans, R. (April 01, 2005). A Special Section on the Achievement Gap--Reframing the Achievement Gap. *Phi Delta Kappan*, *86*, 8, 582.

Forster, P. (2000). Katie thought she couldn't do it but now she knows she can. *Educational Studies in Mathematics, 43*, 225-242.

Fryer, R. G., & Levitt, S. D. (April 01, 2013). Testing for Racial Differences in the Mental Ability of Young Children. *American Economic Review, 103,* 2, 981-1005.

Furner, J.M., & Berman, B.T. (2003). Math Anxiety: Overcoming a Major Obstacle to the Improvement of Student Math Performance. *Childhood Education, 79*(3), 170-175.

Furner, J.M., & Berman, B.T. (2004). Confidence in Their Ability to Do Mathematics: The Need to Eradicate Math Anxiety so our Future Students Can Successfully Compete in a High Tech Globally Competitive World. *Philosophy of Mathematics Education Journal, 18*(1), 1-33.

Furner, J. M., & Duffy, M. L. (November 01, 2002). Equity for All Students in the New Millennium: Disabling Math Anxiety. *Intervention in School and Clinic, 38,* 2, 67-74.

Galla, B. M., & Wood, J. J. (January 01, 2012). Emotional self-efficacy moderates anxiety related impairments in math performance in elementary school-age youth. *Personality and Individual Differences*, *52*, 2, 118-122.

Galyon, C.E., Blondin, C.A., Yaw, J.S., Nalls, M.L., & Williams, R.L. (2012). The relationship of academic self-efficacy to class participation and exam performance. *Social Psychology of Education, 15*(2), 233-249

Garduno, E. L. H. (December 07, 2001). The Influence of Cooperative Problem Solving on Gender Differences in Achievement, Self-Efficacy, and Attitudes toward Mathematics in Gifted Students. *Gifted Child Quarterly*, *45,* 4, 268-82.

Gercek, C., Koseoglu, P., Yılmaz, M. & Soran, H. (2006). An analyses of the attitudes of teacher candidates towards computer use. *H.U Journal of Education, 30,* 130–139.

Geist, E. (2010). The Anti-Anxiety Curriculum: Combating Math Anxiety in the Classroom. *Journal of Instructional Psychology*, *37*(1).

Gresham, G. (2007). A study of mathematics anxiety in pre-service teacher. *Early Childhood Education Journal*, *35*(2), 181-188.

Hampton, N. Z., & Mason, E. (January 01, 2003). Learning Disabilities, Gender, Sources of Efficacy, Self-Efficacy Beliefs, and Academic Achievement in High School Students. *Journal of School Psychology*, *41,* 2, 101-112.

Hancer, A., Uludag, N., & Yılmaz A. (2007). The evaluation of the attitudes of science teacher candidates towards chemistry lesson, *H.U Journal of Education*, 32, 100–109

Havighurst, R. J. (1955). Community Factors in the Education of Gifted Children. *The SchoolReview, 63(6*), 324–329. Retrieved from http://www.jstor.org/stable/1083764

Hawkes, T. H. (October 01, 1973). Ideals of upper elementary school children. *Psychology in the Schools, 10*, 4, 447-457.

Haycock, K. (March 01, 2001). Closing the Achievement Gap. Educational Leadership, 58, 6, 6-11.

Helmke, A., & van, A. M. A. G. (December 01, 1995). The causal ordering of academic achievement and self-concept of ability during elementary school. *Journal of Educational Psychology, 87*, 4.)

Heuser, D. (September 01, 2000). Reworking the Workshop for Math and Science. *Educational Leadership, 58*, 1, 34-37.

Hughes, S. A. (January 01, 2003). An Early Gap in Black-White Mathematics Achievement Holding School and Home Accountable in an Affluent City School District. *Urban Review New York-, 35*, 4, 297-322.

Ignacio N. G., Nieto, L. J. B., & Barona E. G. (2006). The affective domain in mathematics learning international. *Electronic Journal of Mathematics Education, 1* (1), 16–32

Jameson, M. M., & Fusco, B. R. (November 01, 2014). Math Anxiety, Math Self-Concept, and Math Self-Efficacy in Adult Learners Compared to Traditional Undergraduate Students. *Adult Education Quarterly: a Journal of Research and Theory, 64*, 4, 306-322.

Jinks, J., & Morgan, V. (March 01, 1999). Children's Perceived Academic Self-Efficacy: An Inventory Scale. *Clearing House, 72*, 4, 224-30.

Larson, R.W. (2000, January). Toward a psychology of positive youth development. *American Psychologist, 55(1*), 170-183.

Lee, J. (September 01, 2009). Universals and Specifics of Math Self-Concept, Math Self Efficacy, and Math Anxiety across 41 PISA 2003 Participating Countries. *Learning and Individual Differences, 19*, 3, 355-365.

Legg, A.M., & Locker, L. (2009). Math Performance and its Relationship to Math Anxiety and Metacognition. *North American Journal of Psychology, 11*(3).

Lepper, M. R. (1988). Motivational considerations in the study of instruction. *Cognition and Instruction, 5*, 289–309.

Luzzo, A., Hasper, P., Albert, K., Bibby, M., & Martinelli, E. (1999). Effects of self-efficacy enhancing interventions on the math/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology, 46*(2), 233-243.

Maloney, E. A., Waechter, S., Risko, E. F., & Fugelsang, J. A. (June 01, 2012). Reducing the sex difference in math anxiety: The role of spatial processing ability. *Learning and Individual Differences*, *22*, 3, 380-384.

Maccini, P. & Gagnon, J.C., (2000). Best practices for teaching mathematics to secondary students with special needs. *Focus on Exceptional Children, 32*, 1-22.

Marsh, H. W. (October 01, 1991). Subject-Specific Components of Academic Self-Concept and Self-Efficacy. *Contemporary Educational Psychology, 16*, 4, 331-45.

Martinelli, S. C., Bartholomeu, D., Caliatto, S. G., & Sassi, A. G. (January 01, 2009). Children's Self-Efficacy Scale: Initial Psychometric Studies. *Journal of Psychoeducational Assessment*, 27, 2, 145-156.

McClelland, M. M., & Cameron, C. E. (December 07, 2011). Self-regulation and academic achievement in elementary school children. *New Directions for Child and Adolescent Development*, 2011, 133, 29-44.

Merriam, S. B. (2002). *Qualitative research in practice: Examples for discussion and analysis*. San Francisco: Jossey-Bass.

Middleton, J. A. (1995). A study of intrinsic motivation in the mathematics classroom: A personal constructs approach. *Journal for Research in Mathematics Education, 26,* 254-279.

Miller, H., & Bichsel, J. (January 01, 2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences, 37,* 3, 591-606.

Morris, D. S. (January 01, 2015). Actively Closing the Gap? Social Class, Organized Activities, and Academic Achievement in High School. *Youth and Society, 47,* 2, 267-290.

Moyer, P. S., Bolyard, J. J., & Spikell, M. A. (2002). What are virtual manipulatives? *Teaching Children Mathematics, 8*(6), 372-377.

Muris, P. (September 01, 2001). A Brief Questionnaire for Measuring Self-Efficacy in Youths. *Journal of Psychopathology and Behavioral Assessment, 23,* 3, 145-149.

NAEYC and NAECS/SDE. (2003). Early childhood curriculum, assessment, and program evaluation building an effective, accountable system in programs for children birth through age 8. Retrieved January 21, 2016, from http://www.naeyc.org/about/positions/cape.asp.

National Research Council. (1996). *National science education standards.* Washington, DC:

NCTM, R. C. (January 01, 2008). Situating Research on Curricular Change. *Journal for Research in Mathematics Education, 39,* 2, 102-112.

Norwood, K. S. (1994). The Effect of Instructional Approach on Mathematics Anxiety and Achievement. *School Science and Mathematics*, *94*(5), 248-54.

Núñez-Peña, M. I., Suárez-Pellicioni, M., & Bono, R. (January 01, 2013). Effects of math anxiety on student success in higher education. International *Journal of Educational Research, 58,* 3, 36-43.

Peker, M., Mirasyedioğlu, S. (2008). Pre-service elementary school teachers' learning styles and attitudes towards mathematics. *Eurasia Journal of Mathematics Science & TechnologyEducation, 4* (1), 21–26.

Ozyürek, R. (January 01, 2005). Informative sources of math-related self-efficacy expectations and their relationship with math-related self-efficacy, interest, and preference. *International Journal of Psychology, 40*, 3, 145-156.

Pajares, F. (March 08, 1997). Self-Efficacy Beliefs in Academic Settings. *Review of Educational Research*, 66, 4, 543-78.

Pajares, F., & Miller, M. D. (June 01, 1994). Role of Self-Efficacy and Self-Concept Beliefs in Mathematical Problem Solving: A Path Analysis. *Journal of Educational Psychology,86,*2, 193-203.

Rahmani, P. (January 01, 2011). The relationship between self-esteem, achievement goals and academic achievement among the primary school students. *Procedia - Social and Behavioral Sciences, 29*, 2, 803-808.

Rich, Y. (1993). Education and instruction in the heterogeneous class. Springfield, IL: Charles C. Thomas, Publisher.

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology*, *19*, 551-554.

Roth, J.L., & Brooks-Gunn, J. (2003). Youth development programs: Risk, prevention, and. *Journal of Adolescent Health, 32*, 170-182.

Rule, A., & Harrell, M. (2006). Symbolic drawings reveal changes in pre-service teacher mathematics attitudes after a mathematics methods course. *School Science and Mathematics Journal*, *106*(6), 241-258.

Salinas, T. (2004). Effects of reflective notebooks on perceptions of learning and mathematics anxiety. *PRIMUS*, *14*(4), 315-327.

Scarpello, G. (2007). Helping Students Get Past Math Anxiety. *Connecting Education and Careers, 82*(6), 34-35.

Schunk, D. H., & Zimmerman, B. J. (September 01, 1997). Social origins of self-regulatory competence. *Educational Psychologist*, *32*, 4, 195-208.

Shapka, J. D., Domene, J. F., & Keating, D. P. (August 01, 2006). Trajectories of Career Aspirations through Adolescence and Young Adulthood: Early Math Achievement as a Critical Filter. *Educational Research and Evaluation*, *12,* 4, 347-358.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. Review of Educational Research, 50(2), 241-271.

Slavin, R. E., Leavey, M. B., & Madden, N. A. (1984). Combining cooperative learning and individualized instruction: Effects on student mathematics achievement, attitudes, and behaviors. The Elementary School Journal, 84(4), 409422.

Sparks, S.D. (2011). Researchers Probe Causes of Math Anxiety. *Education Week, 30*(31).

Steiner, E. T., & Ashcraft, M. H. (January 01, 2012). Three brief assessments of math achievement. *Behavior Research Methods*, *44*, 4, 1101-7.

Suinn, R., Taylor, S., & Edwards, R. (1988). *Suinn Mathematics Anxiety Rating Scale for elementary school students (MARS-E): Psychometric and normative data.* Manuscript submitted for publication.

Suldo, S.M. & Huebner, E.S. (2006). Is extremely high life satisfaction during adolescence advantageous? *Social Indicators Research, 78*, 179–203.

Thyer, B., & Myers, L. (January 01, 1998). Social Learning Theory. *Journal of Human Behavior in the Social Environment*, *1*, 1, 33-52.

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: an update. *Harvard Educational Review, 50*(1), 63-70.

Townsend, M., & Wilton, K. (2003). Evaluating Change in Attitudes Towards Mathematics Using the 'Then-now' Procedure in a Cooperative Learning Program. *British Journal of Educational Psychology*, *73*, 473-487.

Troutman, K. P., & Dufur, M. J. (January 01, 2007). From High School Jocks to College Grads: Assessing the Long-Term Effects of High School Sport Participation on Females' Educational Attainment. *Youth & Society, 38*, 4, 443-462.

Usher, E., & Pajares, F. (January 01, 2008). Self-Efficacy for Self-Regulated Learning. *Educational and Psychological Measurement*, *68*, 3, 443-463.

Viadero, D. (April 16, 2008). Black-White Gap Widens Faster for High Achievers. *Education Week*, *27*, 33.)

Vanneman, A., Hamilton, L., Anderson, J. B., Rahman, T., & National Center for Education Statistics (ED). (2009). *Achievement Gaps: How Black and White*

*Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Educational Progress. Statistical Analysis Report. NCES 2009-*455. National Center for Education Statistics. Available from: ED Pubs. P.O. Box 1398, Jessup, MD 20794-1398. Tel: 877 433-7827; Web site: http://nces.ed.gov/help/orderinfo.asp.

Vinson, B. M. (2001). A comparison of pre-service teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal, 29*(2), 89–94.

Vygotsky, L. (1987) The Problem and the Method of Investigation. In Rieber, R.W. Carton, A.S. (Ed.), The Collected Works of L.S. Vygotsky. New York: Plenum Press.

Walters, K., Smith, T. M., Leinwand, S., Surr, W., Stein A. & Bailey P. (November, 2014). An Up-Close Look at Student-Centered Math Teaching. Nellie Mae Education Foundation. *American Institutes for Research,* 1-40.

Wenglinsky, H. (November 01, 2004). Closing the Racial Achievement Gap: The Role of Reforming Instructional Practices. *Education Policy Analysis Archives, 12*, 64.)

Wood, R. and Locke, E. (1987) The relation of self-efficacy and grade goals to academic performance, Educational and Psychological Measurement, 47(4), pp. 1013–1024.

Woodard, T. (2004). The Effects of Math Anxiety on Post-Secondary Development Students as Related to Achievement, Gender, and Age. *Inquiry, 9*(1).

Wu, S. S., Barth, M., Amin, H., Malcarne, V., & Menon, V. (January 01, 2012). Math anxiety in second and third graders and its relation to mathematics achievement. *Frontiers in Psychology, 3.*

Young, C. B., Wu, S. S., & Menon, V. (January 01, 2012). The neurodevelopmental basis of math anxiety. *Psychological Science, 23,* 5, 492-501.

Yusof, Y., & Tall, D. (1999). Changing Attitudes to University Mathematics Through Problem Solving. *Educational Studies in Mathematics, 37*, 67-82.

Zimmerman, B. J., & Martinez-Pons, M. (March 01, 1990). Student Differences in Self Regulated Learning: Relating Grade, Sex, and Giftedness to Self-Efficacy and Strategy Use. *Journal of Educational Psychology, 82*, 1, 51-59.

APPENDIX A: NORTH CAROLINA COMMON CORE STATE STANDRDS MATHEMATICAL TASK

1. Dan is saving money to buy a bicycle. The bicycle costs $165. Dan earns $15 in allowance each week. If he saves his whole allowance, how many weeks will pass before Dan has enough money for his bicycle? Create a table to show how long it will take and how much money Dan will have each week.

Dan decides that he wants to spend a little bit of his allowance each week instead of saving it all. If he saves $10 a week, how long will it take him to save up for the bicycle? Add a column to your table showing this data. What if he only saves $5 a week? Add another column to your table showing how long it will take Dan to save enough for his bicycle.

Use graph paper to show how long it will take Dan to save enough money for his bicycle using each of the three situations above.

Would having this graph help Dan make a decision about how much he should save each week? Why or why not?

APPENDIX B: PROTOCOLS

Interview Protocol:

Tell me about yourself as a math student.

a. What sort of work habits do you have in math?

b. Have you ever been recognized for your ability in math?

c. If you were asked to rate your ability in math on a scale of 1 (lowest) to 10 (highest), where would you be? Why?

d. Do your friends know that you are good at math? (Why or Why not?)

e. Do your classmates know that you are good at math? (Why or Why not?)

f. What do you like to do related to math outside of school?

g. What sorts of things do your teachers tell you about your performance in math?

h. Describe the best teacher you've had in math. What made her (or him) so good?

i. Under what conditions do you perform well in math? Under what conditions do you perform less well? Why?

Mathematics and others

a. What do members of your family do that involves math?

b. What do your parents tell you about math?

c. What would your parents tell your teachers about you as a math student?

d. Do you think the people you admire would be good at math? Why?

Affective and physiological response to mathematics

I want to ask you to think about how math makes you feel.

You probably haven't been asked to think about that before.

a. When you are given a math test, how does that make you feel?

b. How do you feel when you are given a math assignment?

Sources of self-efficacy in mathematics

Earlier you rated your math ability on a scale of 1 to 10.

a. How would you rate your confidence? Why?

b. What could make you feel more confident about yourself in math?

Observation Protocol:

High Self Efficacy/ Low Anxiety

Student Name						Comments

1-actively listening, 2-on task 90%+, 3-contributing to conversation, 4-posture, 5 - other

-1 – distracting, -2 - off task 25%+, -3- silent observer, -4 - fidgeting (posture), -5 - other

APPENDIX C: MATHEMATICS ACHIEVEMENT LEVEL DESCRIPTORS

Grade 5

Achievement Level 1: Students performing at this level have limited command of the knowledge and skills contained in the Common Core State Standards (CCSS) for Mathematics assessed at grade 5 and are likely to need intensive academic support to engage successfully in further studies in this content area. Level 1 students can rarely write and interpret numerical expressions or analyze patterns and relationships. They are usually not able to understand the place value system or perform operations with multi-digit whole numbers and decimals to hundredths. Students at level 1 rarely use equivalent fractions as a strategy to add and subtract fractions. They usually do not apply and extend their previous understanding of multiplication and division to multiply and divide fractions. They can rarely convert like measurement units within a given measurement system or correctly represent and interpret data. Level 1 students can rarely graph points on the coordinate plane to solve real-world and mathematical problems. They demonstrate little understanding of the concepts of volume or relating volume to multiplication and addition.

Achievement Level 2: Students performing at this level have partial command of the knowledge and skills contained in the Common Core State Standards (CCSS) for Mathematics assessed at grade 5 and are likely to need additional academic support to engage successfully in further studies in this content area. Level 2 students inconsistently write and interpret numerical expressions or analyze patterns and relationships. They sometimes understand the place value system or perform operations with multi-digit whole numbers and decimals to hundredths. Students at level 2 seldom use equivalent fractions as a strategy to add and subtract fractions. They show some evidence that they apply and extend their previous understanding of multiplication and division to multiply and divide fractions. They can sometimes convert like measurement units within a given measurement system as well as correctly represent and interpret data. Level 2 students can sometimes graph points on the coordinate plane to solve real-world and mathematical problems. They demonstrate emerging understanding of the concepts of volume and relating volume to multiplication and addition.

Achievement Level 3: Students performing at this level have a sufficient command of grade-level knowledge and skills contained in the Common Core State Standards (CCSS) for Mathematics assessed at grade 5, but they may need academic support to engage successfully in this content area in the next grade level. They are prepared for the next grade level but are not yet on track for college and-career readiness without additional academic support.

Achievement Level 4: Students performing at this level have solid command of the knowledge and skills contained in the Common Core State Standards (CCSS) for Mathematics assessed at grade 5 and are academically prepared to engage successfully in further studies in this content area. Level 4 students can typically write and interpret numerical expressions or analyze patterns and relationships. They usually understand the place value system and perform operations with multi-digit whole numbers and decimals to hundredths. Students at level 4 often use equivalent fractions as a strategy to add and subtract fractions. They show evidence that they can apply and extend their previous understanding of multiplication and division to multiply and divide fractions. They can typically convert like measurement units within a given measurement system as well as correctly represent and interpret data. Level 4 students can usually graph points on the coordinate plane to solve real-world and mathematical problems. They demonstrate a sound understanding of the concepts of volume and relating volume to multiplication and addition.

Achievement Level 5: Students performing at this level have superior command of the knowledge and skills contained in the Common Core State Standards (CCSS) for Mathematics assessed at grade 5 and are academically well-prepared to engage successfully in further studies in this content area. Level 5 students can consistently write and interpret numerical expressions or analyze patterns and relationships. They understand the place value system and perform operations with multi-digit whole numbers and decimals to hundredths. Students at level 5 consistently use equivalent fractions as a strategy to add and subtract fractions. They show strong evidence that they can apply and extend their previous understanding of multiplication and division to multiply and divide fractions. They are able to convert like measurement units within a given measurement system as well as correctly represent and interpret data. Level 5 students can consistently graph points on the coordinate plane to solve real-world and mathematical problems. They demonstrate a strong understanding of the concepts of volume and relating volume to multiplication and addition

APPENDIX D: NORTH CAROLINA STATEWIDE TESTING PROGRAM RAW SCORE BY ACHIEVEMENT LEVEL END OF GRADE MATHEMATICS GENERAL EDUCATION (EFFECTIVE 2014-15)

Grade	Achievement Level	Scale Score	Minimum Number Correct	Number of Questions	Approximate Percent Correct
3	Lowest 2 Lowest 3 Lowest 4 Lowest 5	440 448 451 460	17 to 18 25 to 26 29 to 30 38 to 39	44	39-41% 57-59% 66-68% 86-89%
4	Lowest 2 Lowest 3 Lowest 4 Lowest 5	441 449 451 460	16 24 to 25 27 37	44	36% 55-57% 61% 84%
5	Lowest 2 Lowest 3 Lowest 4 Lowest 5	441 449 451 460	15 to 16 23 to 24 25 to 26 36 to 37	44	34-36% 52-55% 57-59% 82-84%

APPENDIX E: WEIGHTED DISTRIBUTION FOR GRADES 3-5 MATHEMATICS

Domain	Grade 3	Grade 4	Grade 5
Operations and Algebraic Thinking	30–35%	12–17%	5–10%
Number and Operations in Base Ten	5–10%	22–27%	22–27%
Number and Operations—Fractions	20–25%	27–32%	47–52%
Measurement and Data	22–27%	12–17%	10–15%
Geometry	10–15%	12–17%	2–7%
Total	100%	100%	100%