SUCCESSFUL TEACHER PRACTICES FOR REDUCING MATHEMATICS ANXIETY IN SECONDARY STUDENTS

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ABSTRACT

The purpose of this qualitative study was to find what teacher best practices are being implemented to reduce the effects of mathematics anxiety on secondary students in grades 6 through 12. Semi-structured interviews were set up to gather data from 15 educators responsible for instructing mathematics in one East Tennessee school district. The findings gathered from this study developed a list of implemented teacher best practices for the environment, instruction, and student growth areas of mathematics education. Environmental best practices included strategies focused on giving praise, creating a safe atmosphere, talking to students, offering friends for assistance, building relationships, modeling expected behavior, and adding humor to the classroom. Instructional best practices included creating a daily routine of structure, providing teacher and student assistance, adding games and activities to lessons, and teaching self-regulating of stress techniques. Student growth and reflection best practices included addressing internal obstacles like no motivation or little confidence, addressing academic obstacles like previous bad experiences and learning gaps, modifying assignments, reviewing previously learned topics, giving time for peer interaction, and allowing time for individualized meetings with students on their progress. The researcher found that when used in conjunction, these best practices help in the alleviation of mathematics anxiety.
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TABLE OF CONTENTS

TITLE ......................................................................................................................... i
COPYRIGHT ............................................................................................................. ii
RESEARCH COMMITTEE ................................................................................... iii
PERMISSION STATEMENT .............................................................................. iv
ABSTRACT .............................................................................................................. v
ACKNOWLEDGEMENTS .................................................................................... vi
LIST OF TABLES AND FIGURES ...................................................................... x

CHAPTER 1 INTRODUCTION ............................................................................... 1
  Introduction of Problem .................................................................................. 1
  Background of Problem ............................................................................... 4
  Theoretical Framework .................................................................................. 4
    Classroom Environment .............................................................................. 5
    Instructional Styles ..................................................................................... 5
    Growth and Reflection Elements ................................................................... 7
  Conceptual Framework .................................................................................. 8
    Changing the Environment .......................................................................... 8
    Changing Instructional Strategies .............................................................. 9
    Giving Time for Growth and Reflection ..................................................... 10
  Research Problem ......................................................................................... 10
  Rationale for the Study .................................................................................. 11
  Purpose of the Study ...................................................................................... 12
  Research Questions ....................................................................................... 12
  Definition of Terms ....................................................................................... 13
  Limitations and Delimitations ..................................................................... 14
  Background and Relationship to Researcher ............................................... 14
  Organization of the Document ..................................................................... 17
  Summary ......................................................................................................... 17

CHAPTER 2 REVIEW OF LITERATURE ............................................................. 18
  Modern History of Mathematics Education ............................................... 19
    The 1950s ....................................................................................................... 19
    The 1960s and 1970s ................................................................................... 19
    The 1980s ...................................................................................................... 20
    The 1990s ...................................................................................................... 21
    The 2000s ...................................................................................................... 22
  An Existence of Mathematics Anxiety ......................................................... 24
    Mathematics Anxiety Defined ................................................................. 24
    Symptoms of Mathematics Anxiety .......................................................... 25
    Misconceptions about Mathematics Anxiety .......................................... 27
    Causes of Mathematics Anxiety ................................................................. 29
      Stress ........................................................................................................ 29
      Instructional Strategies ............................................................................ 29
      Abstract Mathematics Ideas .................................................................... 30
      Teacher Ability and Confidence .............................................................. 30
Presentation of Results: Research Question 2 ..................................................... 88
Describe a Daily Routine ..................................................................................... 88
What Instructional Strategies Do You Use on Anxious Students? .......... 91
How Does Group Work Impact Your Anxious Students? ...................... 94
How Do Your Students Know Your Expectations? .................................... 97
What Self-Regulating Strategies for Anxieties Do You Teach
Students? .............................................................................................................. 100
Presentation of Results: Research Question 3 .............................................. 103
Why Do Some Students Have Anxiety Over Others? .......................... 104
How Do You Help Anxious Students Reduce Anxiety and Improve
Achievement? .................................................................................................... 107
What Do You Do to Help Students Maintain Academic Progress? .... 110
How Do Anxious Students Respond to Strategies Used to Maintain
Academic Progress? .............................................................................................. 113
What Do You Do to Gain Student Feedback From Your Class? .......... 116
Presentation of Findings: Observation and Data Collection of Teacher A .... 120
Successful Best Practices ................................................................................. 120
Behaviors Observed ......................................................................................... 121
Data Collection ..................................................................................................... 121
Presentation of Findings: Observation and Data Collection of Teacher C ..... 122
Successful Best Practices ................................................................................. 122
Behaviors Observed ......................................................................................... 123
Data Collection ..................................................................................................... 124
Presentation of Findings: Observation and Data Collection of Teacher L ..... 125
Successful Best Practices ................................................................................. 125
Behaviors Observed ......................................................................................... 126
Data Collection ..................................................................................................... 127
Discussion ............................................................................................................ 128
Summary ................................................................................................................ 129

CHAPTER 5 CONCLUSIONS .............................................................................. 130
Summary of the Study .......................................................................................... 130
Findings ................................................................................................................ 131
Research Question 1 .............................................................................................. 131
Addressing Student Anxiety .............................................................................. 132
Addressing Student Ability ................................................................................. 132
Building Relationships ...................................................................................... 133
Maintaining an Effective and Consistent Classroom .................................. 133
Adding an Element of Humor ............................................................................ 134
Research Question 2 .............................................................................................. 134
Daily Routine ....................................................................................................... 135
Teacher and Student Provided Assistance ...................................................... 136
Lesson Additions ................................................................................................. 136
Self-Regulating Strategies ................................................................................. 137
Research Question 3 .............................................................................................. 138
Addressing Internal and Academic Obstacles .............................................. 139
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giving Academic Modifications</td>
<td>139</td>
</tr>
<tr>
<td>Giving time for Peer Interaction</td>
<td>140</td>
</tr>
<tr>
<td>Giving Time for Teacher-Student Interactions</td>
<td>141</td>
</tr>
<tr>
<td>Best Practices in Action</td>
<td>142</td>
</tr>
<tr>
<td>Teacher A</td>
<td>143</td>
</tr>
<tr>
<td>Teacher C</td>
<td>143</td>
</tr>
<tr>
<td>Teacher L</td>
<td>144</td>
</tr>
<tr>
<td>Conclusions</td>
<td>145</td>
</tr>
<tr>
<td>Environmental Best Strategies</td>
<td>146</td>
</tr>
<tr>
<td>Instructional Best Practices</td>
<td>147</td>
</tr>
<tr>
<td>Time for Reflection and Growth</td>
<td>148</td>
</tr>
<tr>
<td>Limitations</td>
<td>149</td>
</tr>
<tr>
<td>Recommendations for Future Research</td>
<td>150</td>
</tr>
<tr>
<td>Summary</td>
<td>151</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>153</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>161</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>162</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>164</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>166</td>
</tr>
<tr>
<td>APPENDIX D</td>
<td>168</td>
</tr>
</tbody>
</table>
# LIST OF TABLES AND FIGURES

<table>
<thead>
<tr>
<th>Title</th>
<th>Page number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 4.1 Demographics of Teacher Interviews</td>
<td>69</td>
</tr>
<tr>
<td>Figure 4.1 Characteristics That Describe Mathematics Anxiety</td>
<td>70</td>
</tr>
<tr>
<td>Table 4.2 Specific Teachers’ Characteristics of Mathematics Anxiety</td>
<td>71</td>
</tr>
<tr>
<td>Figure 4.2 How Do You Address Visible Anxiety</td>
<td>74</td>
</tr>
<tr>
<td>Table 4.3 Specific Teachers’ Strategies to Address Students and Their Anxieties</td>
<td>75</td>
</tr>
<tr>
<td>Figure 4.3 What Stresses Students in Mathematics Class</td>
<td>77</td>
</tr>
<tr>
<td>Table 4.4 Specific Teachers’ List of Mathematics Classroom Stressors</td>
<td>78</td>
</tr>
<tr>
<td>Figure 4.4 Classroom Elements That Relieve Anxiety</td>
<td>80</td>
</tr>
<tr>
<td>Table 4.5 Specific Teachers’ Classroom Elements That Relive Anxiety</td>
<td>81</td>
</tr>
<tr>
<td>Figure 4.5 Classroom Humor Examples That Relieve Anxiety</td>
<td>83</td>
</tr>
<tr>
<td>Table 4.6 Specific Teachers’ Strategies to Incorporate Humor to Relieve Anxiety</td>
<td>85</td>
</tr>
<tr>
<td>Figure 4.6 What Elements Appear in a Daily Mathematics Routine</td>
<td>87</td>
</tr>
<tr>
<td>Table 4.7 Specific Teachers’ Characteristics of a Daily Mathematics Routine</td>
<td>88</td>
</tr>
<tr>
<td>Figure 4.7 What Instructional Strategies Do You Use to Reduce Anxiety</td>
<td>90</td>
</tr>
<tr>
<td>Table 4.8 Specific Teachers’ Instructional Strategies to Reduce Anxiety</td>
<td>91</td>
</tr>
<tr>
<td>Figure 4.8 Effects of Group Work on Anxious Students</td>
<td>93</td>
</tr>
<tr>
<td>Table 4.9 Specific Teachers’ Impact of Group Work on Anxious Students</td>
<td>94</td>
</tr>
<tr>
<td>Figure 4.9 How Do Students Know the Expectations of the Teacher</td>
<td>96</td>
</tr>
<tr>
<td>Table 4.10 Specific Teachers’ List of Ways to Make Students Aware of Teacher Expectations</td>
<td>97</td>
</tr>
<tr>
<td>Figure 4.10 Student Self-Regulating Techniques for Anxiety</td>
<td>99</td>
</tr>
</tbody>
</table>
Table 4.11 Specific Teachers’ Self-Regulating Anxiety Techniques for Students 100
Figure 4.11 Why Do Some Students Stress More than Others in Mathematics 103
Table 4.12 Specific Teachers’ List of Why Some Students Stress More Than Others 104
Figure 4.12 How Teachers Reduce Anxiety While Raising Achievement 106
Table 4.13 Specific Teachers’ Strategies for Relieving Anxiety and Raising Achievement 107
Figure 4.13 Strategies to Maintain Academic Progress 109
Table 4.14 Specific Teachers’ Strategies to Maintain Academic Progress 110
Figure 4.14 Student Results after Using Academic Progress Strategies 112
Table 4.15 Specific Teachers’ Students Results of Academic Progress Strategies 113
Figure 4.15 How Do Students Give Feedback 115
Table 4.16 Specific Teachers’ Strategies Allowing Students to Give Feedback 116
CHAPTER 1

INTRODUCTION

“Good mathematics is not about how many answers you know. It’s how you behave when you don’t know.”

— Author unknown

Introduction of Problem

The problem 45/125 loomed on the board in front of the class. Fractions had never been a strength for Sarah and, by the amount of sweat on her brow, Sarah knew what was coming next. “Sarah, I would like you to come to the board and simplify this problem to two decimal places,” asked Ms. Euclid. Sarah knew the steps, the procedures, and the why, but the thought of being asked to demonstrate her knowledge in front of her classmates and friends made her mind go blank. Her heart raced and, as she made her way up to the board, she could not help but think how stupid she must look in front of everybody. Why is Ms. Euclid trying to embarrass me? I know how to do it. I know I do. Sarah, so concerned about not making a mistake and how she appears to her classmates, does not have enough space in her brain to solve the problem. Sarah’s dilemma echoes what May (2009) described as negative thoughts consuming space in the memory reserved for working out problems resulting in a smaller amount of memory available for completing mathematical tasks. For students like Sarah, this interference may hinder their ability to solve problems accurately and efficiently.

Mathematics anxieties, according to Blazer (2011), form from a combination of an individual’s personality, intellect, and the environment in which they are working. Individuals can produce cognitive anxiety symptoms, such as feelings of low self-esteem, excess worrying, inability to concentrate, confusion, or the use of negative self-talk. Affective anxiety symptoms
may present as nervous sweating on the forehead or in the palms, surging adrenaline, needing to go to the bathroom constantly, experiencing an increase in blood pressure or heart rate, or needing to go to the water fountain because of a dry mouth (Alexander, 2010). Being able to recognize these visible and hidden symptoms of mathematics anxiety will help teachers implement strategies to ameliorate the adverse effects mathematics anxiety can have on student success. Beilock and Willingham (2014) stress the importance of teacher training by administrators to ensure teachers are confident in preparing lesson plans for the accurate instructing of mathematics. Further, Blazer (2011) found that the number of students with mathematics anxiety increases when mathematics teachers show little enthusiasm for what is being taught, are deficient in the required knowledge to explain concepts with the proper amount of depth, and lack the patience needed to answer questions or re-do examples without making comments that might intimidate students from asking questions.

Painful years of negative mathematics experiences and mathematics teachers are often responsible for creating mathematics anxiety in students. While 93% of Americans indicated they experienced some level of mathematics anxiety, fourth grade tends to be the year where mathematics anxiety most likely begins, peaking somewhere in the middle grades, around seventh grade (Blazer, 2011). Between fourth and eighth grade, those students who claimed to like mathematics fell 13 points from 69% to 56%, and those students who thought that all people can do mathematics fell 16 points from 89% to 73% (Martinez & Martinez, 2003). The formation of mathematics anxiety begins around the grade levels when mathematics becomes more abstract (White, 1997). This coincides with the time students begin developing their own attitudes and emotions toward their mathematic learning, somewhere between the ages of 9 and 11. Once these negative attitudes are formed, anxiety may remain with a child until they reach
adulthood (Newstead, 1998) and, as White (1997) pointed out, is not limited to unsuccessful people. Because the negative reaction never goes away completely, someone suffering with mathematics anxiety needs to find a way to manage the symptoms. How a person handles frustration with mathematics can be the difference between struggling with anxiety and handling anxiety. If students lack confidence in their ability to do mathematics problems or tasks, a reasonable conclusion is that those students have a lack of confidence in their own gut reactions to do mathematics (Clute, 1984). Ma (1999) found those with high levels of mathematics anxiety had lower mathematics achievement levels; moreover, those with low mathematics anxiety levels had higher mathematics achievement levels. The way mathematics instruction is conveyed to students and the depth of content in the mathematics lesson are two areas in mathematics classrooms that have a direct influence on mathematics learning (Martinez & Martinez, 2003).

With the increase in the number of students who dislike mathematics, it is extremely vital for practitioners to know who to look for, what to do for those students, when to intervene, where the problems lie, and why certain strategies will work. Mathematics has always been an important subject, but with the increase in technology needs for current and future jobs, teacher best practices in the classroom must be examined and teachers must determine if their instructional practices and quality of teaching are the direct cause of mathematics anxiety in their classrooms. One approach, centered on more personal methods emphasizing understanding, can reduce anxiety (Newstead, 1998). With increasing state standards and new testing policies, students are required to have a deeper understanding of given topics thus making it important for teachers to know what strategies to use in order to create more mathematics-friendly classrooms.
Background of Problem

Mathematics anxieties are not new in the educational system and have been studied for many decades. Callahan (1971) cited Wilber H. Dutton’s 1956 article *Attitudes of Junior High School Pupils Toward Arithmetic* that related the importance of how students feel and how this impacted the work they did, the effort they exhibited, and their reactions to the expectations for the class. To measure students’ levels of mathematics anxiety, Richardson and Suinn (1972) developed 98-item Mathematics Anxiety Rating Scale (MARS), which correlated levels of mathematics anxiety with mathematics achievement. Similarly, Sandman (1980) developed the Mathematics Attitude Inventory (MAI), which measured secondary students’ attitudes towards mathematics on the following six scales: student views on the mathematics teacher, student feelings about mathematics, student beliefs in the value of mathematics in the world, student beliefs on how well they do in mathematics, student views on the fun in mathematics, and student views on the level of motivation in the mathematics classroom. More recently, Godbey (1997) developed a 10 question Likert-type survey, called the Mathematics Anxiety Scale (MAS) with positively and negatively worded questions used primarily at the secondary and college levels to determine students’ anxiety levels. While many scales are available for educators to determine to what degree a student has anxiety in mathematics, the problem remains that little has been done to reduce the anxieties of mathematics students (Godbey, 1997).

Theoretical Framework

To find positive learning experiences that increase student achievement and decrease mathematics anxiety, this study used a theoretical framework focused on three main aspects: classroom environment, instruction, and student growth and reflection.
**Classroom Environment**

Hodges (1983) discussed how environmental elements within the classroom may affect student learning, so changing the classroom environment can create positive learning experiences, which will work to teachers’ advantages. Students thrive in environments that foster learning that are characterized by attitudes that are light and respectful, yet structured. Teachers who introduce humor into the classroom have the opportunity to increase the learning of mathematics for all students (Godbey, 1997). This allows teachers to let their students see the lighter side of themselves and ultimately the lighter side of mathematics. Similarly, Godbey (1997) stressed the importance of aesthetics stating how teachers need to be aware of the physical aspects within their classrooms that can hinder student success and comfort. It is not uncommon for students to complain of the bright lights, unequal distribution of air flow in the room, or distractions around the room from things such as movement from other students and colorful décor. Consequently, a teacher must be aware of all aspects of the environment and how student learning is affected.

**Instructional Styles**

Once a mathematics friendly atmosphere has been established, teachers can begin to look at their instructional styles to see how they impact various learning styles. Blazer (2011) found students are better able to overcome mathematics anxiety when teachers accommodate the many types of learners within their classroom and modify their instruction accordingly, which will to allow all students to be successful in mathematics. Alexander (2010) found that constructivist instruction coupled with cooperative group work not only emphasized student involvement, but active learning as well. Simply putting students into groups will not ensure that all students are cooperating and actively participating in the learning process. Students must take responsibility
within their groups and have assigned jobs to ensure all group members are actively involved in
the process. Whether the teacher assigns a recorder, time keeper, errand monitor, or leader, each
student must be given opportunities to experience different roles. According to Meyer, Turner,
and Spencer (1997), teachers who used project-based learning had the best chances of reaching
students academically due to the real-world aspect of the project, which allows students to see
mathematics in a different way while involving them in the investigation of real problems
through the creation of memorable artifacts. Blazer (2011) furthered this notion and indicated
that the use of manipulatives in mathematics helps students in elementary school more because
those students are able to take a greater interest in what is being taught. This study intended to
allow teachers and avenue to share which teaching strategies have been shown to be effective in
helping students increase their learning and reduce their anxieties toward mathematics.

There are many teaching strategies available characterized by many different aspects of
teacher best practices. There is more to instructing than simply lecturing, assigning “drill and
kill” worksheets, and reviewing those worksheets the following day. Students need to be the
primary focus of the learning in the classroom. This study sought to find which teacher best
practices were most effective in reducing students’ mathematics anxiety while increasing
achievement or understanding. In a publication designed to help teachers understand what best
practices look like in the classroom, the Public Schools of North Carolina Department of Public
Instruction published “Best Practices: A Resource for Teachers” (n.d.), which included the
following list of things that are characteristics of classrooms in which teachers are using best
practices:

- Project materials and books are numerous.
- Students are engaged and focused on their work.
- Teachers often use collaborative and/or authentic tasks that place students at the center of the learning process.
- Seating arrangements are clustered, varied and functional with multi-instructional areas.
- Classrooms are activity-based spaces as opposed to places to “sit and get” lectures.
- Teachers are actively engaged with different groups and students are anxious to enlist visitors in their various tasks or assignments.
- There is a joyful feeling of purposeful movement, industrious thinking and a vital and vibrant atmosphere and environment.

**Growth and Reflection Elements**

Once teachers have aligned their environment and instruction practices to benefit their students, students must be given a time for personal reflection and growth. Students need to see where their successes and failures lie. Quander (2013) found that students felt safer to share their frustrations with mathematics through journal writing because teachers were able to give private feedback without the fear of embarrassment; however, this type of reflection can only work if teachers take the time to respond to student entries while offering words of encouragement. Quander also discovered that when teachers conducted conferences with students individually about how their test performance includes information about their areas of strengths or weaknesses, students were then able to develop a plan for themselves on how they would improve. Just reflecting on the past is not enough; teachers must be able to push students further. These conferences will help the students create choices about what needs to happen next in the learning process.

Blazer (2011) encourages teachers to present mathematics as a decision-making tool with the use of critical thinking skills. Research has shown that when a teacher focuses on
memorization teaching strategies instead of showing students the meaning behind the mathematics, students’ mathematics anxiety levels were likely to increase (Blazer, 2011). Almost all teachers employ repetition and memorization techniques to teach multiplication because these facts are the basics of almost all mathematics that appears in middle school and high school; however, students who do not learn their multiplication facts by the fifth or sixth grade will continue to struggle as a result of not being taught the facts properly. It is possible those students were not able to see the relevance of memorizing the facts or they missed being able to sit down with their teachers and discuss why they were struggling. Allowing students to take part in their own learning can help head off potential problems they will face in the future.

**Conceptual Framework**

Teachers’ best practices were studied to discover the degree to which mathematics anxieties can be reduced as a result of teachers making positive classroom changes which will facilitate students’ abilities to learn mathematics in a stress-free environment and become confident as mathematics students. Three main ideas—changing the environment, changing instruction strategies, and giving students time for growth and reflection—emerged as the target practices for study.

**Changing the Environment**

The first theme to emerge dealt with changing the environment to meet the specific requirements of all students. Using an environmental theory presented by Hodges (1983), teachers who changed the lighting, temperature, and seating arrangements to accommodate different learners saw an improvement in their students' attitudes about mathematics. Likewise, teachers who used mathematics humor that contained memorable events in the minds of the students saw an improvement in students’ mathematics attitudes in the classroom and a reduction
in mathematics anxiety in students. When conducting the study, Hodges (1983) asked teachers which of these methods, used separately or together, showed positive changes in the anxiety level of their students. Specific strategies the researcher was seeking to identify included: lighting, temperature, seating arrangements, classroom breaks, use of humor, and any other environmental changes that would help students overcome their anxieties.

**Changing Instructional Strategies**

Focusing on which instructional strategies teachers can incorporate to meet individual student needs and to lessen mathematics anxiety was the second theme to emerge. Capitalizing on the work of Blazer (2011), this study intended to further the notion that, to alleviate the threat of mathematics anxiety, teachers must keep in mind that visual learners need pictures, auditory learners need discussions, and kinesthetic learners need to put their hands on things and play. Unlike the lecture method, interactive and individualized methods of instruction have more influence on students’ achievement in mathematics (Adedayo, 1998). Using the constructivist approach, teachers who use cooperative group work as an integral part of instruction find that cultivating a non-threatening atmosphere will help students feel more comfortable. Working in groups helps students see the vast array of solutions that can be achieved and allows students a chance to give a little bit of themselves to the process (Quander, 2013). The concept of project-based learning, as described by Meyer and colleagues (1997), was also used to see if teachers were using projects to show the importance of mathematics in society. Through the use of these concepts, teachers will find their students not only understand mathematics more deeply, but they will also feel more comfortable contributing to their learning and discuss mathematics with others. To allay psychological stress, Butte (1993) suggested teachers do the following: provide cognitive information in a new way; break tasks into smaller units; model appropriate attitudes,
values, and emotions; provide positive reinforcement; relate success to effort; and, set goals with
students. Teachers were asked to look at their instructional strategies to see if their strategies
aligned with the research of this study.

**Giving Time for Growth and Reflection**

The last theme focused on determining if allowing students time for reflection and
growth benefitted how students viewed their own learning and were able to follow through with
journaling coupled with private conferences with their teachers afterwards to discuss their
recordings, students are able to track their feelings, successes, and failures and ultimately shape
their self-esteem, confidence, and attitude. Additionally, Blazer's (2011) ideas on mathematical
discourse in the classroom were used to facilitate students’ deeper understanding of the material.
Mathematics should have high interest appeal as it offers learners a challenge, the opportunity to
choose strategies, pose questions, use logic, and interpret conclusions. When problems are worth
solving, students’ efforts increase (Chapline & Newman, 1984). Additionally, environments that
foster dialogue, struggle, risk taking, critical thinking, and the sharing of ideas have been shown
to help students become more comfortable with challenge (O'Donnell, 2009). These strategies
have been found to help students take an interest in their learning and become motivated to
accomplish more, set goals, and move past previous failures. This study asked teachers which
strategies they have used with students who ultimately helped those students work past their
anxieties.

**Research Problem**

Mathematics anxiety affects almost every person in the educational system. Whether it is
a student suffering from poor instruction, a lack of self-confidence, or a teacher who remembers
the horrors of his or her own mathematics experiences, mathematics anxiety is a serious issue in schools. Whether students are subjected to poor instruction, humiliation, or a lack of instruction from teachers with little mathematics content knowledge, mathematics anxiety travels with them into their adulthood. If teachers are unprepared with how to handle students’ mathematics anxiety issues, they will be responsible for creating more citizens with mathematics anxiety. With mathematics becoming more important in the growing technological world, teachers need to focus on how to create school environments that are more mathematics friendly.

**Rationale for the Study**

While most studies focus on specific strategies and programs that work best for students, few studies focus on use of several classroom strategies working in conjunction with one another to alleviate students’ mathematics anxiety. This study seeks to extend the literature through the examination of the efficacy for the use of employing multiple strategies in tandem in an effort to alleviate mathematics anxieties among students. Future research is needed due to the greater number of students who are developing a disdain for mathematics. As a result of an increase in high stakes testing, changing standards, unsupportive classroom environments characterized by teachers who use intimidating language or sarcasm, are not respectful, or make themselves the center of the class, students have little motivation to excel in mathematics (Alexander, 2010). If teachers can find a combination of strategies to use in the classroom that will meet the needs of all students, alleviate fears and anxieties, and create mathematics relevant materials, students will see the importance and joy in mathematics. This study will aid teachers in this endeavor by giving them a list of strategies approved by teachers.
Purpose of the Study

Stodolsky, Salk, and Glaessner (1991) found particularly compelling the idea that the combination of how a lesson is taught, what goals and expectations are given, and the content presented worked together, to a degree, to shape student views and attitudes about mathematics. The purpose of this study was to survey teachers about the specific strategies they employed and how they implemented those strategies to create communities of learners within their classrooms by alleviating any mathematics fears and anxieties that may be present. Classrooms need to allow students to make guesses, invent new procedures, and build confidence through the use of problem solving (Stuart, 2000). Historically, shifts in instructional changes have included the use of more hands on materials, increased awareness the role multiple representations plays in student learning, and an emphasis on the role of the student as an active learner in the mathematics classroom to create environments where students are less anxious about mathematics (Taylor, 2006).

This study sought to discover which teacher best practices have been successful in the reduction of mathematics anxiety. Encompassing a variety of facets from a variety of strategies, the researcher hopes the resulting list of positive changes to reduce mathematics anxieties in students will be beneficial to many teachers. The goal of this study was to see which changes, modifications, or implementation strategies work in conjunction to reduce mathematics anxiety in secondary students.

Research Questions

Many topics, questions, and concerns fueled this study. Broad topics were narrowed down to the types of modifications teachers implement that positively affect student behavior and learning. More specifically, which strategies are able to reduce the already present
mathematics anxiety in students when they enter into a classroom? The goal of this qualitative study focused on the following research questions:

1. What best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
2. What best practices, concerning classroom instruction, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
3. What best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety?

**Definition of Terms**

The following terms are used throughout this qualitative study concerning teacher best practices for reducing mathematics anxiety.

1. *Mathematics Anxiety.* Richardson and Suinn (1972) define mathematics anxiety as “feelings of tensions and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (p. 2).

2. *Secondary Students.* According to the Tennessee Department of Education (2016), a teacher with a secondary license teaches in grades 7 through 12. Sixth grade was included in this study since this grade band is closely correlated to seventh and eighth grade standards.

3. *Teacher Best Practices.* Instructional strategies that include balancing the curriculum with differentiation across subject levels, teaching an integrated curriculum, differentiating instruction to varied levels of learners, and providing active instruction to students (North Carolina, n.d.).
Limitations and Delimitations

Data for this study were limited to 15 mathematics teachers in grades six through 12 in one East Tennessee school district. Consequently, the small sample size limited the number of responses obtained from the interview questions. Since the study had a narrow focus on which strategies reduce the most anxiety, the potential sample size was limited to the teachers’ students who exhibit mathematics anxiety and were taught using the best practices. Additionally, winter weather and subsequent snow days during the time of interviews, in conjunction with a lack of technology, inhibited some teachers from participating in video interviews. Lastly, the intended use of TCAP scores as a standardized measure of academic performance was ultimately replaced by students’ grades in mathematics due to the unforeseen lack of TCAP testing for the 2015-2016 school year.

Delimitations of the study include, but are not limited to, the sample of the study. The sample was limited to sixth through twelfth grade teachers across 11 schools in one school district. Other school districts were not chosen due to their distance from the researcher. Additionally, the researcher limited the sample to teachers of secondary students due to the researcher’s interest in learning about this particular population of students.

Background and Relationship to Researcher

While mathematics anxiety affects almost the entire population, individuals with varying degrees of anxiety have developed different strategies to handle their anxiety. As a public school student, the researcher was exposed to many teachers who were able to positively or negatively influence learning within their classrooms. The researcher was a good mathematics student but did not enjoy mathematics or find it interesting. Upon entering seventh grade, the researcher was introduced to a truly influential teacher. While the researcher did not suffer from mathematics
anxiety, this teacher showed what real instruction involved and instilled values the researcher
continues to use in the classroom today. The researcher became fascinated in mathematics
through the many real-world applications that were taking place within the classroom, as well as
the advanced tutoring in algebra in preparation for high school.

While in ninth grade, the researcher ran into a teacher who wanted things her way, and
even though the researcher fully understood the content, the researcher began to struggle when
the researcher did not work the problems out the teacher’s specific way, resulting in the teacher
marking the correct answers wrong. When frustration and dread started to enter the researcher’s
thoughts, the teacher from seventh grade came back to the researcher. After discussions with the
teacher about the frustrations, the researcher explained how to do the problems a way different
than the teacher’s that made sense to the researcher. The teacher was not happy that the
researcher wanted to work the problems out differently, but the researcher asked, “Does it matter
how I get the answer, as long as I get it right?” Ultimately, correct answers no longer became
subject to being marked as incorrect, regardless of the method used to find the solution.

Not long after this conversation when the researcher began making better grades, fellow
classmates began showing similar signs of frustration and anxiety. After overhearing the
conversations shared by peers, the researcher offered help. New methods were taught, questions
iterated, and processes were re-explained. It did not take long for the researcher’s classmates to
understand what was being said and show improvement in their work. The researcher then
realized the importance of helping other struggling students because the researcher ultimately
wanted them to understand and appreciate mathematics.

Many years later, as a first year secondary teacher at a small country high school, the
researcher soon realized mathematics students were separated into two categories: those on the
college path and those on the technical path. Unfortunately, these divisions brought about four specific categories of students:

1. When college path students liked mathematics, they would do any amount of work to make an A.
2. When college path students could do mathematics but did not like it, they did enough to get by.
3. When technical path students were okay with mathematics, they tried their best with the work.
4. When technical path students hated mathematics, they did not care if they did anything.

Consequently, this resulted in varying degrees of behavior problems, primarily among those students in the technical path. The researcher, however, tended to enjoy these classes the most because the students needed more encouragement and help than those students on the college path. Signs of anxiety such as behavior problems, anger, crying, constant negative talk, and skipping class were prevalent among those students on the technical path. The most hurtful behavior witnessed was the lack of motivation and the yearning to give up due to their hatred of mathematics. Many conversations with students led the researcher to see that this hatred of mathematics started in the middle grades.

After three years in high school, a move down to middle school was needed to find an answer to the question, “Why do students hate mathematics in elementary school?” Five years of teaching mathematics to seventh grade students has given the researcher an opportunity to learn about these fears, witness why and when they take place, and implement strategies to see which student anxieties improve or worsen. The journey has brought the researcher to this point
in time to see which teaching practices teachers believe help reduce anxiety students have at the secondary level, more specifically, in the middle grades.

**Organization of the Document**

The study contains five chapters. Chapter 1 details the problem, background of the problem, theoretical and conceptual frameworks of the study, research problem, rationale and purpose of the study, research questions, key terms, limitations and delimitations, how the problem relates to the researcher, and a summary. Chapter 2 contains a literature review on the importance of studying the effects of mathematics anxiety. Chapter 3 discusses the methodology from the study used to analyze teacher best practices for reducing mathematics anxiety in secondary students. Chapter 4 outlines the data collection process and presents the findings of this study. Lastly, Chapter 5 gives a conclusion to the study with an application for future research related to mathematics anxiety.

**Summary**

Mathematics anxiety in today’s classrooms is a real issue. While students are told how a little stress and anxiety is a good motivating factor, many students do not know how to properly regulate their anxieties. Furthermore, teachers who possess any anxiety with regards to teaching mathematics must first find a way to combat their own anxieties before expecting students to handle theirs. Teachers need to know what strategies are most beneficial in the reduction of mathematics anxieties. The following study examined teacher beliefs with respect to which best practices helped in the reduction of mathematics anxiety for secondary students in grades six through 12.
CHAPTER 2

REVIEW OF THE LITERATURE

The importance of mathematics competence has not changed much over the last few decades. Educators, administrators, and the public realize the importance of mathematics in education. The Education Committee (1953) of the Industrial Mathematics Society in Detroit, Michigan stated the importance of mathematics applies to more individuals than just mathematics teachers and specialists. Mathematics is necessary for all citizens in order to remain competent in everyday experiences. In 1953, these committee members realized the need for the educational system to move towards developing more training in technology and mathematics or it would continue creating citizens who were unprepared for the future.

Sixty-one years later, Felton (2014) furthered this notion with the following three assertions as to why students should study mathematics:

1. Students should study mathematics to learn about and appreciate diversity in human thinking and accomplishments throughout history and around the world.

2. Students should study mathematics to see the role of mathematics in their daily lives, their community practices, and their cultural backgrounds.

3. Students should study mathematics to understand, analyze, critique, and take action regarding important social and political issues in our world, especially issues of injustices. (para. 5)

The reasons behind the importance of mathematics may change with the way the world thinks, but the overall appreciation of mathematics comes from the idea that people need to be competent in the knowledge of mathematics to survive. One is not sure what the future holds, but a push should be made for individuals to be mathematics able without the use of calculators,
cash registers, or cell phones. This competence will be hindered with the growing reports of mathematics anxieties present in today’s schools and society. Blazer (2011) reported that nearly 93% of Americans indicated the presence of mathematics anxiety in their daily lives. This inclination should inform educators, administrators, and the public to take a serious stance on the reduction, or possibly elimination, of mathematics anxiety.

**Modern History of Mathematics Education**

**The 1950s**

Mathematical education changed significantly in 1957 with the launching of Sputnik I by the Soviet Union, inciting what would be known as the space race between themselves and the United States. Consequently, the United States realized just how lacking the educational system was in the learning of mathematics and science courses in comparison to other countries around the world (Burris, 2014). Herrera and Owens (2001) noted that after World War II, the public, as well as educators, realized that more technology was being used in the world and students needed better preparation in mathematics. The resulting public sentiment was to do whatever was necessary to start the momentous task of moving in the right direction for mathematics in the school system. This, whatever was necessary stance, began a long spiral of mathematical movements, going from one extreme to another, trying to find a means of mathematically preparing students for an ever-changing world.

**The 1960s and 1970s**

After Sputnik was launched, a new reform movement was introduced in the United States. This “New Mathematics” of the 1960s and 1970s brought about a different mathematical language in textbooks, new rules and procedures for solving mathematics problems, and more abstract mathematics concepts (Burris, 2014). Herrera and Owens (2001) found that the only
changes made to the elementary school mathematics programs were the addition of new properties to the mathematics textbooks and generalizations of place value beyond base ten; unfortunately, these changes were not enough to bring about improved student understanding or achievement in mathematics. Instead of increasing the United States’ standing in the mathematical world, the idea of “New Mathematics” was ultimately rejected when the changes created misunderstanding of perceptions and meanings among educators (Burris, 2014). Subsequently, this “New Mathematics” program seemed to fail due to inconsistencies among educators in changing the way mathematics was taught.

**The 1980s**

In the later part of the 1970s and early into the 1980s, a new focus was given to the basic mathematical skills of memorization and simple computation. This “Back to the Basics” movement (Burris, 2014), as described by Hunsaker (1979), was an ambiguous means of making students proficient in reading, writing, and mathematics that assigned the least possible level of quality to students in an effort to make sure they were able to graduate. The ambiguity came from the fact that educators were not in agreement on what the “basics” included. When teachers were polled on what they deemed to be the “basics,” the top five responses were reading, arithmetic, spelling, grammar, and government. Even then, teachers could not come to terms with what should be taught. The mathematics curriculum was given new objectives with more measurable outcomes (Herrera & Owens, 2001).

Once educators realized they were not getting any closer to meeting the same standards that were commensurate with other countries in mathematics, another shift in the educational system changed the focus from the “basics” to more critical thinking skills. The National Council of Teachers of Mathematics (NCTM) Standards were released in 1989 as a means of
showing students how to problem solve through mathematics, communicate using mathematical language with other students, make connections between other academic subjects, and learn how to reason through processes (Burris, 2014). Frye (1989) explained how these standards came about after the public demanded tougher mathematics programs for students, which would ensure that students were prepared for the workforce and growing technological needs. Further defined by educator beliefs in the value of mathematics, these standards described a top notch program in mathematics that stressed the necessity for students to learn mathematics from teachers using the best practices and assessments possible. Not simply a list of procedures and expectations, the NCTM Standards set up stimulating and achievable skills for students.

The 1990s

Along with the release of a new set of learning standards, the NCTM also released a set of teaching standards that outlined what the expected teaching strategies should look like for teachers. This helped teachers understand and teach the new goals of the NCTM Standards. These expectations, termed the NCTM Professional Standards for Teaching Mathematics, allowed teachers to design new ways of assessing student performance, which was the desired purpose of the NCTM (Burris, 2014). Aiding in the release of the NCTM Standards and NCTM Professional Standards for Teaching Mathematics, new strategies were suggested for helping students learn the standards more effectively. States helped teachers find more hands-on activities and real-world applications resulting in the development of manipulatives for every area of mathematics and new technological devices in the mathematics classroom (Burris, 2014).

With the NCTM Standards becoming so popular with educators, states wanted to see where they stood with one another. Thus, proficiency testing was became a popular tool to assess how well students were performing in mathematics in comparison to their peers.
nationally. Categorizing students in one of four levels, advanced, proficient, basic, and below basic (Burris, 2014), these tests made it possible for teachers to gauge how students were achieving when compared to other students in their class, grade level, or even between other students in other schools in the county, state, or nation.

The 2000s

The turn of the millennium brought about many educational shifts within the mathematical community. When educators believed the standards were working and would stay in place for a while, the NCTM divided the standards into six main parts for grades three through twelve: number and operations, algebra, geometry, measurement, and data analysis and probability (Burris, 2014). In 2001, accountability became the word of choice for administrators and the government. The No Child Left Behind Act of 2002 required school systems, educators, and schools be held accountable for the learning of every child. The process involved schools and districts increase the number of students who scored proficient or above in both mathematics and reading each year by a particular increase in percentage, only determined by the percentage received that year (Burris, 2014).

Koretz (2009) cited several reasons for the failure of NCLB with the first being score inflation. Score inflation, according to Koretz (2009), occurs when a large rise in test scores is suspected, but the actual measurement of student learning does not compare to that suspected. Second, NCLB forced teachers to focus instructional time solely on teaching to a test. Because of the pressure of having to increase the percentage of proficient students, other, possibly more important, content will be left out because it is not a standard. Third, this mandate forced teachers to focus on the students who were labeled as threshold students, or those who scored just below proficient and could possibly score proficient on the upcoming end of year test. This
type of focus left the teachers giving less attention to those students who were labeled as clearly being proficient or those who clearly would not be proficient because the teacher’s accountability score would not rely heavily on these students. The greatest problem with NCLB, according to Koretz (2009), was the lack of proof that this program was actually beneficial as a means of increasing student learning.

According to the Common Core State Standards Initiative (n.d.), in 2009, the 48 contiguous states, the District of Columbia, and two nationally owned territories led the journey of the Common Core State Standards (CCSS). The CCSS were influenced by educator experiences under NCLBL, public feedback on student academic performance, and current standards used in the states, with the primary reason for the execution of these new standards being the lack of consistency over the meaning of proficient. If each state had a particular proficiency percentage goal, there needed to be a consistent means of identifying the academic division of scores. By 2015, only 42 states and three U.S. territories adopted the standards for educational use, but that number dwindled to only 21 states by 2016 (Common Core State Standards Initiative, n.d.).

Even with the significant changes to mathematics education programs over the last sixty years, students still continue to struggle in mathematics. Harris (2016) identified five reasons why students struggle or fail in mathematics. First, students do not readily seek help. When a student struggles with retaining mathematics facts, they often shy away from asking for help. Students need to be given opportunities for clarification when the teacher’s instruction is not enough. Second, students lack patience. Not all mathematics can be done in seconds and students are required to put in extra effort when problems take longer amounts of time. Students need to be reminded that mathematics learning takes time. Third, students struggle when they
lack prior knowledge, which can lead students to feel behind in their current class. Fourth, when students are not asking questions, they must have a reason for doing so. Whether it is due to intimidation, shyness, or just being uncomfortable in class, not asking questions hinders students from completely understanding mathematics concepts. Lastly, struggles seemed to occur as a result of students not paying attention. Whether this distraction is due to a diagnosed attention disorder or just trouble paying attention, distracted students often miss steps, tire easily, and lose their place when working through mathematics problems. These struggles then lead to the presence of mathematics anxiety, a term defined specifically by its effect on an individuals’ ability to work through mathematics situations.

**An Existence of Mathematics Anxiety**

**Mathematics Anxiety Defined**

With nearly 93% of Americans reporting some form of mathematics anxiety in their day to day lives (Blazer, 2011), defining the term mathematics anxiety is important for individuals other than educators. Richardson and Suinn (1972) defined mathematics anxiety as “feelings of tension and anxiety that interfere with manipulation of numbers and solving of mathematical problems with a wide variety of ordinary live and academic situations” (p. 551), while Ma (1999) defined it as “a disturbance of the recall of prior mathematics knowledge and experience” (p. 522). Both definitions include an interference that does not allow information to come to the forefront when entering into a certain situation.

Blazer (2011) and Godbey (1997) explained that mathematics anxiety takes place in a complex fashion, resulting from a combination of personal, intellectual, and environmental factors stemming from many years of negative experiences. Personal factors present as low self-esteem, frustration not easily handled, and various levels of shyness, while intellectual factors
include a student’s lack of ability to understand how to handle mathematics concepts.

Environmental factors, according to Blazer (2011) stem from various home, classroom, and social situations, such as demanding or undemanding parents, negative school experiences, over emphasis on memorization and repetitive worksheets, poorly trained teachers, poorly written textbooks, peer pressure, and excessive school absences. Each of these factors can cause various levels of anxiety for students. Fiore (1999) agreed with Blazer (2001) and Godbey (1997) that multiple factors influenced mathematics anxiety. Attitudes and opinions of teachers, parents, and peers, along with self-esteem, how mathematics is taught, and the ability to handle frustration, Fiore (1999) observed, changed the level of mathematics anxiety present in students. The problem for educators then becomes identifying which factors cause the highest levels of anxiety and what these anxieties look like in the classroom.

**Symptoms of Mathematics Anxiety**

Alexander (2010) found mathematics anxieties could present in the form of cognitive, affective, or behavioral anxiety. When a student experiences cognitive anxiety, they begin to develop negative thoughts about themselves succeeding in mathematics, express high negative emotions, show signs of worry, poor concentration, and confusion during class time, and often express to others how badly they perform in mathematics. While this anxiety often has negative effects on mathematics success and achievement, a small amount of worry or concern can actually motivate students to try harder. Affective anxiety, however, attacks the student in other manners that do not revolve around the ability to perform mathematics. Students with these symptoms developed nervous tendencies and high levels of tensions, especially in mathematics testing conditions. Other reactions include uncontrollable sweating, surging of energy, urinating constantly, increasing of blood pressure and heart rate, and displaying a need to drink lots of
water due to a dry mouth (Alexander, 2010). Further, Godbey (1997) explained that mathematics anxiety can bring about the following symptoms: feelings of nausea; feelings of skin tingling; nervousness; ears pounding where students cannot hear the teacher; concentration issues; stomachaches; and, sweaty palms. Ho and colleagues (2010) found that affective consequences of mathematics anxiety affected student perspectives of their abilities and performance levels, causing students to overestimate or underestimate their abilities due to mathematical anxiety.

Hilton (1980) contended the existence of mathematics avoidance as an important problem facing the people of the country because mathematics will continue to be an important element of the educational system. Students need to be prepared for mathematics in their everyday lives, what jobs will require certain levels of mathematics, and how the world around them uses mathematics. Alexander (2010) found that when a person developed mathematics avoidance, that individual limited their choices for professions and careers. Blazer (2011) explained behavioral anxieties as the cause of avoiding mathematics classes in higher education, procrastinating with homework, and putting off studying regularly. Behavioral anxieties have a means of making students perform poorly on mathematics tests, even when the students have a full understanding of how to solve the problems presented.

Mathematics phobia is a created symptom, not an inborn tendency, resulting from environmental, social, or emotional factors. People are not born bad at mathematics. Mathematics phobias can develop when teachers put too much emphasis on the memorization and application of formulas and step-by-step procedures, do not make connections between how students perform and their self-esteem in mathematics, or when individual learning needs are not considered (Dodd, 1992). Just because students have mathematics anxiety, this is not an
indication of low mathematical ability. A very competent student who experiences mathematics anxiety struggles due to the fact that their “ability is hidden by anxiety” (Fiore, 1999).

Once mathematical anxiety symptoms have been identified, educators and parents must find ways to eliminate mathematical myths and misconceptions about the learning of mathematics. It would seem these misconceptions will eventually die out with the increase of new mathematical jobs, a growing technological world, and a new generation of learners; however, common misconceptions continue to guide students down educational paths unintended to hinder their potential. These misconceptions must be addressed.

**Misconceptions about Mathematics Anxiety**

Misconceptions about mathematics abilities and stereotypes need to be dispelled to students to ensure mathematics anxieties and mathematics avoidance does not creep into a student’s life (Blazer, 2011). The first misconception is that males are better mathematicians than females. When males and females are treated differently with respect to ability and stereotyping, levels of anxiety and achievement are affected. Brownridge (1996) found that females reported to have higher levels of mathematics anxiety than males because of the way they were treated in mathematics class. This myth can be discarded with careful attention being paid to the language used in mathematics classrooms.

The second misconception is that individuals are born good at mathematics. Parents preserving the notion that mathematical ability is inborn or inherited may also be a contributing factor to mathematics anxiety. When parents feel their child receives bad grades in mathematics because the child simply does not have a mathematics mind and blame a child’s poor performance on their inability to do mathematics, this can be detrimental to a child’s success in mathematics (Godbey, 1997). Likewise, teachers play an important role in ridding this
misconception in the classroom.

Blazer (2011) believes that only thinking there is one way to solve a mathematics problem is the third misconception. For example, when students are told one year that all fractions are written with the biggest number on bottom and then told the next year that the biggest number can be on the top, a student’s mathematical world may crumble. Having have been told two conflicting rules about fractions, students must now take their current teacher’s word on which is the correct procedure. A teacher showing multiple representations of problems, solutions, and explanations can stop students from believing in only one way to do mathematics (Blazer, 2011).

The fourth misconception is that all mathematicians can solve problems quickly in their heads. Teachers and parents need to dispel this “mathematics mind” myth (Morris, 1981) because being able to do mathematics on paper or in one’s head is irrelevant when compared to whether or not the student knows how to do the mathematics. Proving oneself by doing all mathematics quickly in one’s head does not make that individual more intelligent than someone who completes the work on paper.

When these misconceptions are not addressed, students’ mathematical anxiety begins to take form. A simple idea that a student will never be able to do mathematics because of their gender or parents’ attitudes often keeps students from attempting higher levels of mathematics. Consequently, other, more serious symptoms will continue to emerge from students, creating a student who is anxious about mathematics. Teachers must be aware of the many factors leading to a student’s development of mathematics anxiety. Those factors, ranging from personal, environmental, or social factors, often work together to wear a student down.
Causes of Mathematics Anxiety

**Stress.** Students have many areas in their lives that serve as stressors to their everyday frame of mind. Categories of stressors include the amount and challenge of school assignments, relationships with teachers and peers, family issues pouring over into the school environment, physical injury, emotional well-being, amount of discipline at home and school (Butte, 1993), and more with the growing fad of social media. Martinez and Martinez (2003) claimed that stress is not necessarily a negative part of life and it can actually help the mind and body function more efficiently. To cope with stress, Butte (1993) suggests distracting students from their stressors, taking direct action on what is causing the stress, giving social support through peer, teacher, and guidance support, suggesting the use of relaxation techniques, and even finding ways of getting the stress out through the process of writing down what is going on to purge the negative feelings.

**Instructional strategies.** Fiore (1999) found that mathematics anxiety begins to take form with the methods teachers use to instruct mathematics. Preparation and thought must be taken into account when planning how lessons are delivered and how students will feel during each lesson. When planning, teachers must be able to answer the following questions: (1) what questions will students have; (2) what struggles will students encounter; and (3) how will student react when they do not understand (Fiore, 1999). Regardless of the grade level of students, the way the instructor teaches mathematics has a great impact on the level of mathematics anxiety in students (Alexander, 2010). Martinez and Martinez (2003) listed several teacher-initiated instructional strategies that help in the reduction of mathematics anxiety. One important aspect, they stated, was teaching students to keep fighting instead of taking the flight response to difficult mathematics problem solving. The second most important strategy listed was taking
learning out of the mathematics textbooks and putting it back into the context of real-world applications so that students could really grasp the practicality of learning the material.

**Abstract mathematics ideas.** Between the ages of 9 and 11, attitudes and emotions towards mathematics learning begins to develop (Newstead, 1998). This corresponds with findings that mathematics anxiety begins around the 4th grade and peaks somewhere in middle school around 7th grade (Blazer, 2011). The reason mathematics anxiety and mathematics avoidance begin to increase after the fourth grade and the positive attitudes that children previously had concerning mathematics begin to decline is because mathematics concepts change from the world of the concrete (shapes and block) to the world of the abstract (variables, numbers, and operations) (Martinez & Martinez, 2003; White, 1997).

**Teacher ability and confidence.** When teachers cannot explain a mathematics concept in depth, lack the patience necessary to teach varying degrees of student performance levels, have little to no joy for teaching the subject, and frighten their students into submission behaviorally, they are often responsible for creating students with the highest degrees of mathematics anxiety (Blazer, 2011). Teachers need to feel confident in their abilities to plan, teach, and answer questions about various mathematics lessons. Fiore (1999) found mathematically confident teachers showed compassion for their students, cared whether or not learning was taking place, and motivated students to work harder to learn. The power that teachers possess over student successes and failures was also responsible for affecting self-esteem. Chapline and Newman (1984) contended that teachers need to be responsible by increasing their mathematics content knowledge, developing their confidence in teaching mathematics, and finding ways to show how mathematics can be useful by providing appropriate tools for students to use in the real world. Additionally, increased reliance on state testing has
been responsible for the high negative emotions that students and teachers have towards mathematics, thus increasing the prevalence of students with mathematics anxiety (Blazer, 2011).

According to Beilock and Willingham (2014), targeting pre-service teachers with specific training on mathematics concepts and how to address them will help reduce mathematics anxieties in these instructors. Additionally, Blazer (2011) suggested that teacher training should focus on shaping positive teacher attitudes towards mathematical concepts and skills. This could be accomplished through the teaching of teacher best practices and workshops centered on informing teachers about how mathematics anxiety can affect achievement. If mathematics instructors have mathematics anxiety, the consequences could be catastrophic for students and their mathematics achievement. College students in teacher preparation programs typically have few mathematics requirements, which would assume that more mathematics training is necessary for educators to reduce their own anxieties (Beilock, Gunderson, Ramirez, Levine, & Smith, 2010). Training needs to take place because once mathematics anxiety has taken root within a person, those negative attitudes become difficult to change, allowing that negativity to continue into adulthood (Newstead, 1998).

**Individual’s confidence.** Stuart (2000) compared the learning of mathematics to playing a sport. Mathematics is 90% mental, or how the student perceives their own confidence, and only 10% physical, which is how the student perceives their own competency level while performing mathematics. Teachers need to find methods of increasing students’ confidence to ensure they are able to experience success. When a person has low or no self-confidence in their own beliefs, an obstacle to learning takes place due to the idea that “beliefs govern action” (Dodd, 1992). Fincham, Hokoda, and Sanders (1989) defined learned helplessness as the ability
to not place blame of failures on the amount of effort that students put into their work, but rather place blame on the teachers, parents, lack of time, extracurricular activities, and other factors that begin to develop around the middle school years when students become better acquainted with who they are.

When students have strong, positive motives to achieve, situations will be approached with a better attitude and by more creative means; however, when students carry negative feelings into the mathematics classroom, situations will be approached with thoughts of failure or humiliation (Green, 1990). High levels of mathematics anxiety negatively impact the part of the brain responsible for reasoning and emotional regulation causing it to slow down and ultimately hinder student success (Young, 2013).

Students’ beliefs and attitudes towards mathematics can be shaped from the beliefs held by their teachers. Interactions between students and teachers greatly influence a student’s abilities, weaknesses, strengths, and mathematical journey (Forgasz, 1995). When educators are able to change mathematics anxiety into mathematical confidence, students receive not only an emotional boost to their self-esteem, but teachers are able to make major professional gains by finding a way to bridge the gap between academic achievement and mathematics anxiety (Ma, 1999). Mathematics self-efficacy, as described by May (2009), is a student’s feelings about how well they do in mathematics as mathematics self-efficacy. Further, their self-efficacy is closely tied to motivation, previous successes or failures in mathematics, and the type of mathematics problems they are confronted with. Consequently, students consistently estimate their abilities inaccurately. While some overestimation in abilities is needed to keep students persevering in mathematics, these overestimations, or even underestimations, can be detrimental to achievement. In a study conducted by May (2009), 57% of students were found to have
overestimated what they were able to do mathematically and 20% underestimated just how much mathematics content they could actually master.

There are many factors which contribute to mathematics anxiety, which have led researchers to develop several different tests designed to measure the level of mathematics anxieties in students and adults. Over the past sixty years, these tests have been adapted for different audiences in order to look for gender, socioeconomic status, and academic variables in an effort to predict which students at-risk for developing mathematics anxiety; however, the overall goal of these measures was to look at how mathematics anxiety affects mathematical achievement (Wu, Barth, Amin, Malcarne, & Menon, 2012). The following section will outline these different tests and describe the intended audience.

**Measuring Mathematics Anxiety**

In his 1956 article for the *School Review*, Dutton was the first to discuss finding possible reasons why students develop negative feelings and attitudes toward mathematics. Even though the term mathematics anxiety was not used, Dutton (1956) argued that the way students felt about mathematics affected the amount of work they did both in and out of class, the effort given to assigned tasks, and the level of understanding they showed for individual mathematics concepts. Dutton’s work influenced the development of many tests in an effort to help educators identify students showing negative signs toward mathematics.

The Mathematics Anxiety Rating Scale (MARS), was developed by Richardson and Suinn in 1972. This widely used rate scale for mathematics anxiety correlates mathematics anxiety with achievement with the use of a 98-item scale that has been found to be both reliable and valid in determining levels of anxieties in individuals (Baloğlu & Balgalmış, 2010). The MARS has been adjusted several times to differentiate between specific populations taking the
test. For example, the elementary form of the test, the MARS-E, asks students to circle responses instead of rating situations from 1-5. Similarly, a shorter version of the test with only 30 questions, the MARS-30, was developed to ensure that individuals taking the test did not tire from the long 98-item test of the original (Baloglu & Balgalmış, 2010). The Fennema-Sherman Mathematics Attitudes Scale (MAS; 1976) measured confidence, teacher perceptions of mathematics, the usefulness of mathematics, and the perception that mathematics is a male domain (Wigfield & Meece, 1988). Subsequent measures of mathematics anxiety include the Mathematics Attitude Inventory (MAI) and the Anxiety toward Mathematics Scale, designed by Sandman (1980), which measures the attitudes of mathematics that secondary students’ exhibited. Wigfield and Meece (1988) developed the Mathematics Anxiety Questionnaire that focused on six domains of negatively toward mathematics, especially during mathematics testing. Those six domains included dislike, lack of confidence, discomfort, worry, fear and dread, and confusion and frustration. Godbey’s Mathematics Anxiety Scale (MAS; 1997) is a 10-question Likert-type survey that uses both positively and negatively phrased situations for individuals to rate and is mainly used with secondary and college level students.

Whether students are learning to handle their own anxieties or teachers are learning how to identify mathematics anxiety symptoms, educators need to ensure they are not adding to a child’s anxiety level. Teachers are true artists, holding many instructional strategies at their fingertips with the Internet, technology, gadgets for students to play with, endless numbers of games and activities found on sites like Pinterest, and a growing field of highly qualified educators. Teachers must be aware of the many types of learners in the classroom in order to create lessons that all students can learn from. Gill (2013) found the following five instructional methods to be the most used by teachers: lecture style; coaching style; activity style; group style;
blended style. While all instructional methods have pros and cons, teachers must make sure the students are engaged in the learning taking place. The following descriptions outline several of the most widely used instructional strategies for teachers.

**Teacher Instructional Strategies**

The way a teacher instructs mathematics lessons and the depth of content in the lessons are aspects that directly affect mathematics learning and teaching (Martinez & Martinez, 2003). Teacher practices need to be examined to be determined if the causes of mathematics anxiety rest in the instructional strategies and quality of instruction (Newstead, 1998). Appropriate classroom instruction can cause the number of students with mathematics anxiety to decline or even be eliminated (Stuart, 2000). While numerous instructional strategies available, teachers usually stick with what works best for them or what is easiest to implement; however, the easiest methods or what has always worked is not necessary the best instructional strategy. When teachers use ineffective instructional strategies, their students can fall behind academically (Scarpello, 2007). Detailed below are just a few instructional strategies teachers use in the classroom.

**Lectures**

Most mathematics lectures involve asking students to remember learned steps or procedures the teacher has already thought about, planned for, and then worked out for the students, concerning the problem. The problem with this strategy poses the question, “Why does the student not have the chance to reason out the problem?” While students are frequently able to learn formulas and vocabulary through memorization, they are often unable to generalize their knowledge as a result of being provided limited examples by their teacher. For the lecture method to work, teachers should allow students time and opportunities to reason through the
mathematics themselves while facilitating a discussion about the given material (Whitney, 1987). Likewise, Adedayo (1998) claimed the problem with teachers consistently using lecturing in mathematics class is that instructors jump into definitions, procedures, and proofs without taking into consideration where the student was academically or if the students understood what was being said.

With increased technology, more gadgets and the Internet with an endless supply of manipulatives, worksheets, and activities, teachers who stick to lecturing do so for the following two reasons: they were taught with this method when they were students and they believe that this method is effective since it was effective for them in their learning (Adedayo, 1998). Many teachers have this fixed mindset because it is the most familiar to them; however, the lecture method does not take into account how students of this generation learn. If teachers want to influence student achievement, they need to use more interactive and individualized methods instead of relying solely on the lecture method (Adedayo, 1998).

**Interactive and Individualized Methods**

Rather than the teacher being the focus of the lesson as is the case for teachers using the traditional lecture style of instructing, interactive and individualized methods of instruction take a more student-centered approach to the instruction of mathematics. In a study conducted by Newstead (1998), two types of mathematical approaches that teachers used were compared. When teachers used the traditional lecture approach, they began with simple paper and pencil computation, moved to the teacher modeling problems on the board, and ended with students practicing on their own. On the other hand, when teachers used an alternative approach, they started with a problem on the board or laid out in group settings, offered manipulatives or hands-on approaches to solving the problem, asked for students to talk about what strategies they would
use and to defend those strategies, and summed up the lesson with students applying those strategies to other real-world applications. This alternative instructional approach utilized both interactive and individualized methods of instruction. The interactive approach was applied to a group setting while the individualized method was used with individualized students and would ask students to work at their own pace, advancing as needed. Students taught under the traditional approach reported higher levels of anxiety when compared with those students taught using the alternative approach.

In a similar study, Clute (1984) explored the discovery and expository methods of instruction. Teachers using the discovery method, would ask beginner level questions, followed by questions that would lead students in the right direction if they were to come up with incorrect answers. Teachers would also ask that students share what they have found and work together to build on their discoveries while also asking questions to ensure that explanations accompanied their answers. Teachers who utilized the expository method of instruction, began with an introduction that summarized the previous lesson, built on lessons previously taught, presented the lesson in a basic format, did multiple examples to ensure understanding, reviewed the procedures and steps again, practiced the lesson in groups and individually, explained what the students would be doing as an assignment, and showed how to organize the problem with various methods.

Results of the study confirmed that some learners learned better using the discovery method while other students were more successful taught with the expository method. Clute (1984) found that the students with the lowest mathematics anxiety levels responded very positively to the discovery method; however, the expository method seemed to work better for those students with higher levels of mathematics anxiety. May (2009) agreed 25 years later, also
finding highly anxious students scored higher on tests when they were exposed to the expository mathematics treatment and those students with lower levels of anxiety scored better when they were taught using the discovery method.

**Homework**

While homework may not necessarily be seen as an instructional method as much as a means of content practice, homework has many positive and negative effects. One such negative effect is when educators use homework as a means of busy work, taking it up, throwing it away, or simply just marking right and wrong answers. Homework must be used as a means of constant feedback between students and teachers. In their 2006 synthesis of research on the efficacy of homework and its ability to improve academic achievement, Cooper, Robinson, and Patall classified the positive effects of homework into four categories: immediate achievement and learning, long term academic, non-academic, and parental/family assignments. Immediate achievement and learning assignments have been shown to help students retain factual information such as definitions, procedures, and basic skills while helping the students use critical thinking skills to better understand the work done in the classroom. Long term academic assignments improved student feelings about school in general, created better study habits in students, and helped increase academic skills in other areas. Non-academic assignments provided time for better organization, a place to be curious, and better discipline. Parental/family assignments provided many opportunities for parents to become involved in their child’s schoolwork and helped improve parental awareness of what was happening between the school and home. When used correctly, Cooper and colleagues found that homework can serve as the thoroughfare between knowledge and understanding (2006).

Conversely, Cooper, Robinson, and Patall’s synthesis of the research highlighted certain
negative effects of homework as detrimental to a student’s performance, behavior, and emotional stress (2006). Students lost interest in their school work because the homework was not interesting and the time it took to complete the work made the students fatigued, both physically and emotionally. The amount of homework given caused students to feel that they were denied time to have fun and relax when at home. Parental pressures also negatively impacted students. Whether the parents were confusing the students with different instructional techniques or just pressuring the students to finish the work, students noted these pressures as negative interferences. When students are hit with a large amount of work to complete in such a short amount of time, students often resorted to cheating.

No matter the instructional strategy, learning takes place in conjunction with quality instruction. Students can learn from the lecture, interactive, individualized, or homework methods of instruction. While each method has its positives and negatives, best practices must be considered when preparing instruction for students. Teachers must be willing to develop their practices and discover which practices are most influential in increasing mathematics achievement and decreasing mathematics anxiety. Best practices change from student to student, class to class, and year to year. Gill (2013) asserted that each teacher has abilities unique to only him or herself and, while no two students are alike, teachers should not expect to be like another teacher. Best practices will emerge through experience and experimentation. The following best practices were found to be most beneficial in the reduction of mathematics anxiety.

Best Practices in the Reduction of Mathematics Anxieties

The frame of mind that students have can affect their effort, processing speeds and skills, memory capacity, and creative ability. Bryan, Mathsur, and Sullivan (1996) described two different frames of mind. With a frame of mind in the negative direction, students do not put
forth all of their effort and the speed with which they process information slows down. With a positive frame of mind, the amount of information that can be stored in memory is increased, and students are more likely to use creativity to solve problems. Godbey (1997) wrote that teachers need to be mindful of the level of material they are presenting to the students, as well as the frame of mind of students. This mindset could prevent the teacher from overestimating a student’s ability and then blaming them for not performing well. This also connects to teachers being aware of student feelings about mathematics. By finding creative means of delivering useful lessons in mathematics, student anxieties could be lightened and invite students to want to do mathematics willingly. Any attempts in implementing more rigorous mathematics programs or curriculums would ultimately lead to increased mathematics anxiety and avoidance if not balanced with positive teacher practices aimed at helping students improve their attitude and confidence levels. These strategies could be beneficial in finding methods that positively influence student performance and emotion well-being (Martinez & Martinez, 2003). The following best practices encompass three different areas of student interaction with mathematics. First, the way mathematics is taught severely affects how well they understanding the concepts and apply it to their everyday lives. Second, the environment in which a student learns mathematics is critical. The environmental factors include the basic atmospheric properties of the classroom, the language used in the classroom, and the amount of support given to students by the teacher and their peers. The third aspect of best practices involves the opportunities given to students to monitor their own growth, which includes writing about their feelings, tracking their successes and failures, setting goals, and talking about their concerns. Through these best practices, teachers can help students monitor and reduce their own mathematics anxieties.


**Instructional Strategies**

If teachers want students to perceive mathematics as useful and apply it to their everyday lives, teachers need to consider taking a step back and analyzing how they are presenting mathematics to their students. Even with more rigorous standards revolving around problem solving, investigations and inquiry, and higher levels of mathematics discourse between students, Stodolsky, Salk, and Glaessner (1991) found that generally teachers’ instructional focus continued to be on computation and procedures, which has been shown to increase the number of students exhibiting symptoms of mathematics anxiety. There are many approaches teachers can use to decrease the levels of mathematics anxiety while increasing the levels of achievement. The following instructional strategies will give examples of how these best practices work.

**Constructivist approach.** Stuart (2000) asserted that “classrooms should be mathematics communities that thrive on conjecturing, inventing, and problem solving that build mathematical confidence in students” (p. 334). This parallels the definition of constructivist instruction, which stresses the importance of keeping students active in their own learning by involving them in every aspect of the learning. Cooperative grouping is an important aspect of constructivist teaching, focusing on teaching for understanding instead of sticking to procedures (Alexander, 2010).

Mathematics should be presented as a means of allowing students to think critically, make decisions, explore new possible solutions, practice different techniques, and use the knowledge they have (Blazer, 2011). Encouraging students to work with peers in small cooperative groups may have important affective consequences, including a reduction in anxiety (Newstead, 1998). When students are grouped with different types of students, opportunities are
then provided for students to talk through their ideas freely, ask questions for clarification, compare their justifications to others, and critique the ideas of others (Blazer, 2011).

Hodges (1983) discussed several sociological elements cooperative groups have to help with anxiety. Working together gives students a chance to work with their peers in a whole class setting, in a pair, in a team used in a competitive nature, or with the teacher in a one-on-one sitting. When students work with different types of students on a regular basis, the social aspect of learning is triggered. People learn best from other people, their beliefs, their ideas, and their perspectives. According to Hodges (1983), only a few students reported never liking the group setting to do work. Conversely, Stuart (2000) discussed some of the negative aspects of working with groups, including the concern that one person would be doing all the work, group members not getting along, and the fear that team members might laugh at others. In order to tackle these negative aspects, teachers should ensure students know the role they hold while working in groups and give all students the same level of responsibility and accountability. If students know their role and they are being graded on their part, their participation will increase because they know no one will step up to do their part without getting the credit for the work.

**Individualized instruction.** All students learn in different manners, at different rates, and under different circumstances. While it may seem difficult for teachers to have different concepts or different variations of concepts spread among a classroom of students, setting up individualized lessons is most beneficial for student learning. The needs of all students are most met when a routine is set up for how those students are to advance in their learning. Rodriguez (2012) discussed six needs of all learners at the core of student willingness and acceptance to learn. Those six needs are as follows:

1. Concept of the Learner
2. Role of the Learner’s Experience
3. Readiness to Learn
4. Orientation to Learning
5. Motivation
6. Need to Know Why (p.30)

Not all learners realize these needs at the same time in life. As students move up through elementary to middle to high school, their needs will become more prominent to themselves.

**Types of learners.** Being aware of the different learning needs of students in the classroom continues to be the essential element of successful classrooms. Educators should align student learning with the learning style of the student (Blazer, 2011). Printed or copied pictures, colorful diagrams, and short classroom videos can aid visual learners (Blazer, 2011; Muro, 2006), while auditory learners respond more favorably to teacher lectures, working in groups, and sharing their finds with the class. Hands-on learners, however, seek to explore through the process by getting up, moving around, and touching things (Blazer, 2011). Successful teachers do not use each type of learning every day, but use as many strategies as possible whenever to increase the chances of reaching as many students as possible.

Some students just need to know that mathematics can be difficult and it takes a while for some to understand the processes and procedures. Stuart (2000) outlined a variety of practices that a teacher must incorporate to truly embrace their instructional strategies as a means of reducing mathematics anxiety for those who struggle with mathematics. One such practice, Stuart (2000) noted, was to accommodate different learning styles. Students need to see that it is all right to learn differently from others. Additionally, the instructor should create a variety of environments that put students into different social situations. Whether working in pairs, groups,
whole class, or individually, a student must be able to transition within these different environments comfortably. Sometimes students just want to know that their hard work is being noticed so teachers need to make sure that students are remaining positive about their situation. When a teacher emphasizes that no one is perfect and makes mistakes at one time or another (Blazer, 2011; Stuart, 2000), students learn to work through their mistakes. Other practices that successful educators were noted to incorporate in their lessons were helping students see the relevance of mathematics, encouraging students to critique others and have an opinion, and allowing students to socialize while learning (Stuart, 2000).

**Active learning.** One pattern of effective teaching behavior, termed direct instruction, requires that a large amount of class time be dedicated to active instruction, where the teacher interacts with students to help them learn and develop their skills (Clute, 1984). An active approach requires a more personal instructional style that focuses on student understanding, instead of repetition and endless worksheets (Newstead, 1998). Incorporating manipulatives allows hands on learners to take abstract ideas and represent them in an easier to see fashion (Blazer, 2011). Expecting students to be passive in their learning by listening to lectures and reading a textbook is ineffective and ill advised. Students need to be active in their learning to allowing them to make connections to other aspects of their lives (Muro, 2006).

**Proper assessment practices.** A critical component of effective instruction includes personal reflection of assessment practices and overall beliefs in the classroom. If different instructional methods yield various levels of understanding and anxiety, it only makes sense to assume that a variety of assessments will do the same thing. Blazer (2011) found that a variety of assessments to evaluate students aided students with a variety of learning styles. Oral questioning could be beneficial for those learners that have trouble reading or putting their
thoughts on paper while observations and demonstrations work best for those students who put forth their best work on hands-on projects and activities. When a teacher is not sure why a student is working in such a manner, discussions serve as a means of bridging the gap between what the student knows and what the student understands. Allowing students to re-test has been shown to be very beneficial for those students with test anxiety because it gives the students time to reflect and show again what they knew (Blazer, 2011). When students are simply asked to recall facts, state vocabulary, explain concepts, and identify answers, the teacher is keeping students in the lower levels of learning. In order to have students achieve and understand, the higher levels of Bloom’s Taxonomy need to be used in the classroom (Muro, 2006).

Higher levels of Bloom’s Taxonomy involve asking students to apply what they have learned, analyze trends, evaluate strategies of others, and create a product based on what they learned (Vanderbilt University, 2016). Silbey (2013) listed the following questions for teachers to use in order to go beyond the basic yes or no type questions that keep students from thinking deeper: What do you need to know? Which strategy did you chose and why? What will you do first in order to solve this problem? How can you determine that your answer makes sense or is right? What other real-world problems involve the same procedures you used? Seeking assessments outside of the usual unit test can allow students to see the true purpose behind their learning. When teachers teach to a test, a student learns to pass a test. When teachers teach for application, a student learns to survive in the world.

**Real-world application.** Mathematics anxiety takes place when students see “mathematics as a collection of disconnected rules” (Muro, 2006, p.1). Unfortunately, this behavior causes students to turn to memorization as an outlet for getting the answers at that moment, instead of understanding the mathematics concept and what the concept truly means.
Mathematics should constantly be connected to real-world applications, such as going to the grocery store and finding the better buy or counting back correct change (Blazer, 2011). When students see how the mathematics concepts apply to things they encounter or will encounter in their lives, they can then practice those skills and apply them to future situations and problems they encounter.

**Offer challenges.** Chapline and Newman (1984) reported that mathematics should have high interest appeal with problems offering learners the challenge and opportunity to choose strategies, pose questions, use logic, and interpret or question conclusions. Students' efforts are enhanced when they feel the problems they are working on and the questions they are answering are worthy of their efforts. A key step instructors can take to promote positive student attitudes is to design opportunities for students to cooperate on tasks. Working in sub-groups during a class session make it possible to accommodate students who are at different points in concept mastery and who have different learning rates and styles. Cooperation, not competition, fosters a student's sense of being part of a mutual support system that can encourage curiosity, experimentation, and intuitive thinking (Chapline & Newman, 1984). Meyer, Turner, and Spencer (1997) reported working in groups allows teachers to give challenging questions to different groups who do not need as much instruction. Challenging students gives them the intrinsic rewards associated with setting goals and working strategically to attain them. It builds a bridge to higher knowledge, providing students with opportunities for developing self-monitoring and self-regulating strategies. Confronting challenges is at the juncture of cognitive, conative (motivational and volitional), and affective growth; however, challenges that do not steadily build on previous knowledge may result in frustration and repeated failure.

Additionally, Meyer, Turner, and Spencer (1997) discussed three theoretical frameworks
on motivation that emphasized the important role of providing students with a challenge: academic risk taking, achievement goals, and self-efficacy. Academic risk takers have a preference for difficult tasks, a tolerance for failure, and a tendency to use strategies flexibly in the face of error. They also tolerate uncertainty, error, and confusion because, even if risk takers are confused, they keep in mind the larger goal of understanding. When properly motivated, students can take on challenges and persevere in solving the problem.

The type of instruction used by teachers is the most influential aspect of the level of anxiety a student produces in the mathematics classroom. The teacher can adapt instructional strategies for individuals, groups, or the whole class. Fortunately, other factors, besides the way a lesson is taught, can positively affect the level of mathematics anxiety in students. The following section explains how other factors, such as the classroom environment, can reduce a student’s anxiety.

Environmental Changes

Supportive teachers who provide mathematics learning environments where investigative skills are emphasized and where students are active participants are more likely to have male and female students with more functional beliefs about mathematics and about themselves as learners of the subject (Forgasz, 1995). Hodges (1983) listed four emotional elements of learning style: motivation, persistence, responsibility, and structure. Motivation is needed so teachers need to develop an interest inventory of real life examples and let students make some choices so that they can be in control of part of their education. Persistence is needed to show students that failure is not an option because it is a roadblock to a future success. Teachers should praise and show positive reinforcement for partial work and good tries. Students must be given responsibility in the classroom. Giving students a job they alone are responsible for gives them
something non-mathematics related to take part in every day. Structure in the classroom means

clear and concise objectives, rules, consequences, and procedures.

Jackson and Leffingwell (1999) stated that teachers who took the most active role in

reducing mathematical anxiety were able to increase students’ enjoyment of mathematics and

facilitate true mathematical learning. There were several strategies that teachers used to make

classrooms safer for student experimentation and creativity, which included disclosing how the

teacher overcame anxiety, projecting why the teacher finds enjoyment and interest in

mathematics, offering additional time to master skills inside and outside of class time, giving

specific written and verbal feedback, and offering opportunities for re-testing. Chapline and

Newman (1984) found that positive attitudes were formed by students when opportunities were

made for the students to work cooperatively. Keeping in mind that students did not work at a

single, constant pace, working in groups helped accommodate those students working at different

rates and with different styles. Working with peers in small groups or in pairs satisfies students’

need and desire for social interaction while requiring them to be active learners (Dodd, 1992).

Teachers need to be aware of the negative components in the classroom environment that cause

the most upset in a safe classroom, therefore causing the most anxiety; however, there are many

elements that teachers must consider that are important to a student’s learning process.

Considerations other than just in lesson planning must be taken to ensure that all students are

placed in the safest and most learning-centered environments.

Suffering in silence. Loneliness is another barrier to learning. Students often believe

they are the only ones who do not understand what is being explained which cause them to suffer

in silence rather than risk looking stupid by asking a question. For this reason, collaborative and

cooperative learning activities should be part of every mathematics classroom (Dodd, 1992).
Small group settings allow those students who struggle with speaking out in class a chance to share their ideas in a smaller group environment (Chapline & Newman, 1984). Groups help students see that problems can be solved in a variety of ways and that each student contributes something to the processing. As a result of placing students in groups, students will more willing to take risks with sharing their ideas (Quander, 2013).

**Verbal and non-verbal communication.** Teachers describing their experiences with mathematics makes the subject less rigid, formal, and imposing, and if instead parents provide encouragement and support, along with a quiet, uninterrupted time for mathematics homework, their child will be more likely to respond to mathematics with greater self-confidence and more positive feelings (Morris, 1981). The way a teacher communicates with students happens in apparent and elusive ways. Whether teachers cross their arms when they talk, scrunch up their face when being spoken to directly, or use positive or demeaning language, teachers need to make sure their verbal language and non-verbal body language are not taken incorrectly (Chapline & Newman, 1984). One such phrase, pointed out by Chapline and Newman (1984), was overused by teachers and misinterpreted the most by students. The phrase, “it’s easy” was used by teachers to help students see that the work was not that strenuous or difficult. Instead, the phrase made students feel that they were dumb for not knowing how to do such an easy task. This judgment, researchers found, caused students to blame themselves for not knowing how to do the work.

**Outside environment factors.** Some environmental factors are not controlled in the classroom. Parental involvement reduces mathematics anxiety and is positively correlated with mathematics achievement, while the converse is true for mathematics anxiety, which has been negatively correlated with mathematics achievement. Consequently, high levels of parental
involvement have been shown to be negatively associated with mathematics anxiety (Roberts & Vukovic, 2011). Scarpello (2007) discovered parental encouragement affected student learning and attitudes toward mathematics. Teachers can teach strategies to students to help them control their anxieties with outside factors. Techniques include taking deep breaths, visualizing what needs to be done, taking a break from the problem to relax, and giving positive messages of inspiration to oneself (Blazer, 2011).

**Classroom characteristics.** Morris (1981) observed classrooms and labeled classrooms as positive and supportive when they implemented the following strategies: listening intently when students asked questions; displaying an inclination to answer questions in various forms; exerting consistent positive reinforcement; assigning real-world application problems over memorization tactics; finishing one concept completely before beginning new concepts; and providing positive feedback on tests. In a similar study, Alexander (2010) observed eight classrooms and found three types of classroom environments: supportive, ambiguous, and unsupportive. Teachers in the supportive classrooms had several characteristics in common. First, these teachers were respectful to all students, enthusiastic about the instruction of mathematics, and humorous. Second, supportive teachers saw and taught mathematics as valuable and worthwhile of learning. Third, teachers held high expectations for all students, were caring and helpful in the line of confusion and frustration, and they constantly encouraged students to work collaboratively. Ambiguous classrooms, Alexander (2010) noted, typically started out correctly at the beginning of the year, academically supported and learning centered; however, the teachers frequently miss-estimated student development. Teachers in these classrooms never connected personally to their students, which caused the students to not trust
the teachers. The failing in these classrooms came due to inconsistent procedures and few attempts to motivate students (Alexander, 2010).

Alexander (2010) found that unsupportive classrooms had many failures. First, teachers did not support their students academically or personally. In order to get the students to do what they wanted, teachers turned repeatedly to extrinsic types of motivations such as extra recess, extra credit, stickers, and classroom jobs, such as line leader. Second, teachers placed themselves at the center of the classroom, using an authoritarian discipline style to make students fearful and anxious. This style of classroom management often involved teachers using sarcasm and being disrespectful to the students. Third, teachers taught their lessons with the idea that the students would not find the lesson or activities fun, they were just teaching by going through the motions. Classroom environments should foster dialogue, risk taking, struggling, critical thinking, and sharing of ideas so that students become comfortable with challenge. Students need to be encouraged to rely on their own thinking so that they will be able to go on to ever higher levels of reasoning (O'Donnell, 2009).

A supportive classroom fosters these beliefs and will place less emphasis on correct answers and computational speed. Rather, focus should be placed more on the computational process and less on the result. When grading tests and quizzes, teachers should check the procedure instead of only the final answer to gain a better understanding of where students need help (Blazer, 2011). A lesson should be centered on the use of games and manipulatives, which allows students to move around among stations or centers increasing the chances of fun and socialization. A positive, supportive classroom atmosphere must be established early in the year and carefully monitored (Morris, 1981).
Certain physical elements need to be present in the mathematics classroom to create positive learning experiences. First, games and manipulatives allow students to practice skills and concepts through the use of fun cooperation. Second, allowing students to move increases the heart rate, increases brain activity, and decreases boredom. Third, students often try to sneak candy and gum into the classroom because it gives them something to do that reminds them of being at home in their physical, comfortable environment. Allowing students to have a snack while working helped students have more positive experiences while working and creates a more comfortable environment (Hodges, 1983). Muro (2006) found when teachers expressed their expectations and procedures at the beginning of the year, the environment continued to stay light and positive throughout the year. These types of environments involved enthusiasm, beliefs in student success, and an increase in interest appeal.

**Breaks and Movement.** Introducing humor into the classroom setting can be advantageous in the learning of mathematics. Mathematics cartoons, jokes, puns, riddles, stories, and even certain spontaneous behaviors that contain unexpected or out of context elements become memorable events in the minds of students. Humorous examples or other breaks during instruction can promote comprehension and serve as cues for recalling information for test, as well as for long term retention. Instructors who are enthusiastic about the subject and really try to make mathematics fun will have more success with student comprehension. Students will also find themselves looking forward to mathematics class rather than dreading a dull presentation of mathematics facts (Godbey, 1997).

Games can generate both excitement among students and motivate them to participate in mathematics. Although games have been used primarily to review mathematical concepts at the middle school level, games should and often do, have other instructional purposes. Games
should be grounded in mathematics, self-directed and engaging, appropriate and challenging (Jackson, Taylor, & Buchheister, 2013). Lotta (2015) researched scientifically based reasons why students' movement in the classroom will increase their learning. Movement provides circulation, which in turn helps the brain to focus better. The negative effects of sitting for long periods on the physical body include stress on lower back nerves and the reduction of circulation. When the body experiences these negative effects, so will the mental self.

While most people think of environment as where the student sits and what the temperature is like in the room, there are other environmental factors that increase or decrease a student’s anxiety level. The attitude of the teacher’s is critical to maintaining a positive learning environment. When the teacher has built positive relationships with the students, the students then begin to believe the teacher holds their best interest to heart. This step is critical when helping students track their progress in class. Students who trust their teachers will work with the teacher to better themselves. The following will outline other factors that contribute to the reduction of mathematics anxiety, outside of instructional and environmental changes.

**Growth and Reflection**

Having the best interests of all students at all times is the definition of a diligent educator (Callahan, 1971). Unlike instructional strategies and environmental factors, opportunities to track growth and reflection take special consideration. These factors can be motivational or disastrous for student learning. When students are kept in the dark about their performance and progression, they do not understand why they are failing or falling behind. Tests only come around once every couple of weeks or months, but a lot of learning takes place in between that time. Students need to take part in recording their progress in journals, methods of tracking, and means of setting goals.
**Journaling.** Sometimes students need to express their fears, anxieties, and concerns about what they are learning or how they are progressing in the class. Beilock and Willingham (2014) found when students wrote what they were experiencing before a mathematics test, the achievement gap between those with high anxiety and those with low anxiety was reduced. In order to properly help students see their growths and falls, some sort of academic log or journal should be kept and constantly updated. While recording their day to day feelings, successes, and failures, students typically can see what has caused some of their negative feelings. Once students see a pattern with their feelings, in connection to their successes and failures, they can then find ways to self-correct their learning. Positive attitudes will develop when the negative behaviors begin to change to positive behaviors (Chapline & Newman, 1984). Quander (2013) found frustrations with mathematics learning became safer to share when students discussed these feelings in mathematics journals. Muro (2006) found positive success strategies in having students write about their feelings in mathematics class to reduce anxiety. When the negative feelings were left on the page, students had a clear mind to create more positive experiences.

**Goals and expectations.** Students need to be aware of the progress they are making in class. Meeting with students individually to discuss test results, places where the student is proficient or lacking, and how that student can move forward will allow students to make goals and find a means of correcting their current actions (Stuart, 2000). Goals teachers set for students are typically classified as either learning or performance based. Learning goals have a desired result of not just completing the task but gaining some type of understanding as well. Performance goals, however, lead a student to be concerned only with the outcome of the task. If students do not perceive the outcome of the task to be valuable, then they are not likely to attempt the task in the first place (May, 2009).
Ryan, Ryan, Arbuthnot, and Samuels (2007) categorized goals students set for themselves into four branches. Mastery approach goals are characterized by a focus on mastering a task, striving to accomplish something challenging, and promoting success on the task, often in reference to one's previous achievement. Mastery avoid goals are distinguished by a focus on avoiding any misunderstanding or errors and preventing a negative outcome on a task, specifically in reference to one's previous achievement. Performance approach goals concern a focus on demonstrating high ability and looking smart. Performance avoid goals concern a focus on avoiding negative judgements of one's ability and avoiding looking dumb. Whatever the goal, teachers must hold high expectations, allow time to think, and encourage students to use their own thinking (O'Donnell, 2009).

Expectations can take on another form in the mathematics classroom. Teacher feedback on tests, quizzes, homework, or classroom was most responsible for changing the course of student performance. Green (1990) found feedback to be an important element in student improvement; however, specific feedback allowed students to correct their work and motivated students to try again and achieve. Teacher feedback was found to be both beneficial and detrimental to students, depending on how the feedback was used. Muro (2006) discussed how students cannot learn from their mistakes if teachers simply mark questions wrong, proper feedback must be provided to allow students to understand their mistakes and see common mistakes they were making from one assignment to another, eventually learning to correct their own mistakes. In order to ensure students correct their mistakes, students must first learn the procedure of turning corrected work back in. This allows teachers to see if students are taking the time to fix their mistakes or simply just writing something down to make it seem as though they were trying. Communication must be a two-way street in the course of feedback.
Conclusion

Creating an anxiety-free learning environment may sound like a daunting task, but the task can be done with just a few changes to a teacher's already long list of instructional techniques, resources, games, expectations, and procedures. Using the characteristics found to be common among effective mathematics teachers, O'Donnell (2009) highlighted the following ten strategies to reduce mathematics anxiety in the classroom:

1. Teachers should invite cooperative groups to clarify their ideas and share their failures as well as successes.
2. When students have difficulty finding the answer, a teacher should prod students by asking questions, allowing students to go in depth.
3. Students should re-voice, restate, and reapply their reasoning to compare to the reasoning of others.
4. Students should be prompted to further their reasoning.
5. Teachers should give an appropriate wait time in between responses to allow students time to think.
6. Students should be introduced to terminology that connects students to previous conclusions, and teachers should rephrase student questions and comments to allow others to understand the question.
7. Teachers should identify and challenge students' unclear ideas.
8. Counterproductive behavior and work should be managed to ensure students are aware of appropriate classroom etiquette.
9. When the discussion falls flat, teachers should change the discussion direction to seek new paths of thinking.
10. When one method does not work, teachers should offer new representation.

Educators are charged with more than just instructing students for one year and passing them on to their next teacher. It is every teacher’s responsibility to teach students how to become lifelong learners so their mathematical learnings can help them in furthering their education or picking an occupation or career (Quander, 2013). If teachers can squash the mathematics anxiety bug, they can prevent students from losing interest in mathematics.
CHAPTER 3

METHODOLOGY

The leading force behind this study was to better understand the existence of mathematics anxiety in order to identify the best practices teachers can use to alleviate mathematics anxiety in secondary school students. Consequently, the purpose of the study was to investigate the relationship between environmental factors, instructional strategies, and the types of student reflection techniques used in classrooms and how they can affect mathematics anxiety levels in students. This chapter will outline the research methodology guiding the study, which includes the research questions, and descriptions of the participants, research design, data collection procedures, and steps in the data analysis process. With an increase in students reporting anxiety related to mathematics, there is a definite need to find what teacher practices are effective for reducing or eliminating mathematics anxieties among students in grades six through 12.

Many topics, questions, and concerns fueled this study. Broad topics were narrowed down to the types of modifications teachers implement that positively affect student behavior and learning. More specifically, which strategies were the most effective in reducing the already present mathematics anxiety in students when they enter into a classroom? The goal of this qualitative study focused on the following research questions:

1. What best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
2. What best practices, concerning classroom instruction, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
3. What best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
Description of Qualitative Research

A qualitative research design was selected in order to identify teacher best practices from a sample of secondary mathematics teachers within the target population. Ary and colleagues (2014) describe qualitative research as a form of inquiry “that focuses on understanding social phenomena from the perspective of human participants in natural settings” (p. 24) resulting in “a narrative report so rich and comprehensive that you can understand the social reality experienced by the participants” (p. 25). Because qualitative researchers see individuals as interconnected with the world in which they live, researchers seek to develop explanations as to why groups behave the way they do within certain circumstances. In this case, research was conducted using semi-structured interviews to identify the teacher best practices that were most effective in reducing mathematics anxiety.

In order to classify the research as qualitative, specific techniques were employed. Bogdan and Taylor (1975) listed the following requirements of qualitative research:

- Interviews ensured the data were descriptive.
- Interview questions emerged from data collected, instead of being pre-selected.
- Data were collected in classrooms, which represented a natural setting.
- Statistical measurements were not necessary since descriptive reports were used.
- The goal was to understand how individuals respond to a process and to develop insights to explain this viewpoint.

Descriptive details of teacher best practices were sought rather than ratings from other selected practices. Following the guidelines Bogdan and Taylor (1975) set forth, a set of basic interview questions were selected, each interviewee was listened to in order to see the path most needed to proceed in with questioning, and additional questions were added as a result of descriptive data
collected from the interviews. Interviews were conducted in the classrooms of participating teachers to ensure the natural setting would not be compromised. Since details were needed to explain why these best practices aided in the reduction of mathematics anxiety, no statistical measurements were needed other than listing the frequency of best practices mentioned. The overall goal was to explain why and how these set of best practices seemed to work best in reducing mathematics anxiety over other research theories of best practices.

**Description of the Specific Research Approach**

A research design based on Glasser and Strauss’s 1967 grounded theory method of research was used in order to provide an explanation for the usage of different types of teacher best practices. The study sought to generate a list of best practices that teachers can use with secondary students who exhibit mathematics anxiety; more specifically, which combination of best practices worked most effectively in unison. While mathematics anxiety appears more frequently in students with lower mathematics achievement levels, the study looked for an explanation as to why teachers use specific strategies with all levels of students.

The grounded theory has two basic characteristics involving “constant comparative analysis and theoretical sampling” (Cho & Lee, 2014, p. 4), which includes collecting and comparing data side-by-side from several individuals or groups. Ary and colleagues (2014) define theoretical sampling as “selecting a person or site that exemplifies the theoretical construct and continues to select new cases that reflect the developing theory to include as the research unfolds and the theory emerges” (p. 458). Likewise, Cho and Lee (2014) indicate that theoretical sampling is done through an initial collection of data, analysis, and subsequent data collection guided by initial findings in an effort to “explore multiple dimensions of the social process under study” (Glasser & Strauss, 1964).
Description of Study Participants and Setting

Participants included 15 teachers of mathematics serving students in grades six through 12 across nine elementary and two high schools. Convenience sampling was used to select the participating teachers from a targeted population of 25 teachers in an East Tennessee school district due to the researcher’s access to the schools and teachers within the system. The target school district served approximately 4,642 students (48.3% male, 51.7% female); AdvanceEd, 2014) across Pre-K through 12 grade spans at 11 schools. A majority (93.5%) of the students were Caucasian with 100% of the students classified as economically disadvantaged (AdvanceEd, 2014).

Data Collection Procedures

Before the collection of data, the Carson-Newman University Doctoral Committee needed to approve the proposal before proceeding with the study. Permission from Carson-Newman University Institutional Review Board (IRB) was then received in order to conduct research on human subjects. After receiving IRB approval, approval was sought and received from the Superintendent of Schools in which the target population was located. Upon approval, a pilot study was employed with a sample of elementary school mathematics teachers, outside of the target population. These teachers were interviewed to test the clarity of the questions to be included in the study survey and to anticipate the types of responses to be collected.

In order to achieve triangulation, multiple data sources were used in order to reach more trustworthy conclusions and to confirm patterns that emerged from the main source. The process began with teacher interviews in an effort to identify themes in their responses for best practices used to reduce mathematics anxiety. Using initial findings, participating teachers were observed in their classrooms using the identified best practices they claimed to be most beneficial. Student
Data in the form of gradebook scores and behavior logs were collected from observed teachers and then obtained to see if academic learning and positive behaviors had increased with those students whose mathematics anxieties were reportedly reduced.

Data were collected in each participant’s classroom to ensure the participant was interviewed and observed in their natural environments, with the exception of those participants who requested a video conference for the interview. Interviews, observations, and the collection of student data were gathered during the spring semester of the 2015-2016 school year by the researcher. To ensure all participants understood all definitions included in the study, mathematics anxiety and teacher best practices were defined.

Interviews

Interviews were scheduled through an e-mail invitation with all participating teachers at times that were convenient for the participating teacher (Appendix A). Teachers were asked to sign a consent form showing their awareness of their rights to the study and their ability to withdraw at any time without consequence (Appendix B). Teachers were asked open-ended, pre-selected questions about what instructional best practices they perceived were most beneficial in reducing mathematics anxiety among their students, including what classroom, instruction, and reflection strategies were used in the classroom. A full list of interview questions can be found in Appendix C. Interview questions focused on the areas of environmental factors, instructional strategies, and opportunities for student growth and reflection. Depending on teacher responses to the initial line of questioning, interview questions were either omitted or created in order to obtain a full understanding of the teachers’ perspective as to which best practices are the most effective in the reduction of mathematics anxiety among their students. While the interviews were responsible for gathering a list of practices used by
teachers, the interviews also allowed teachers to elaborate on how they would handle certain situations with various levels of student anxieties within the classroom.

Interview responses from the teacher best practices questions were collected via recording and handwritten notes for accuracy from the interviews and entered into a spreadsheet document that identified the teacher’s name, gender, number of years of service, and level of mathematics taught. Responses were then organized by themes that emerged from the responses. To ensure high response rates were obtained, two reminder e-mails were sent to teachers about upcoming interview dates. Video interviews were also offered to any teacher whose scheduled interview was altered due to inclement weather.

Observations

After the conclusion of each interview, the researcher noted any unique best practices used by the teacher and asked for a follow up observation to see the best practice in its natural environment. Observation times were arranged with the cooperating teacher and researcher upon completion of the teacher interview. After an analysis of the data from the teacher interviews were complete, 15 minute observations were conducted to determine which mathematics best practices those teachers claimed to be most effective in reducing mathematics anxiety were actually employed. To do this, student behaviors in response to the teacher’s use of best practices were observed. Changes in student attentiveness, student behavior, and student participation were to be observed. Each behavior was then ranked against the culmination of observable behaviors to measure how effective each teacher practice was in correlation with the desired behavior. When confronted with a student with mathematics anxiety, a student who increased their attentiveness but showed no change in participation and understanding would be ranked less effective over a student whose increased attentiveness resulted in an increase in
either participation or understanding. Teachers’ behaviors in response to intervention strategies not working as intended were also observed. This included behaviors such as how teachers handled frustration and other symptoms of mathematics anxiety. Coding was used to track various students and their behavior throughout the observation periods to see changes in behavior and level of class participation.

**Student Data**

Data were collected on students who were identified by participating teachers as showing the greatest reduction in mathematics anxiety. This data included teacher notes on changes in student behavior (i.e. demeanor, outbursts, ability to sit still, attentiveness, etc…) in the form of behavior logs and gradebook scores over the course of the school year. Data were collected for students, entered into a spreadsheet document and coded to identify trends and common themes.

**Ethical Considerations**

Once permission was obtained from the school system to continue with the research, particular attention was given to protecting the identities and statements from the teacher participants and their affiliated schools. Participating teachers and schools were given pseudonyms for their names to protect their true identities. Coding with confidential identifiers was only recognizable to the researcher. Each teacher participant was asked to sign a consent form (Appendix B), and each participant was informed that they had the right to withdraw from the study at any time. Participants were also informed that their responses to all questions would be confidential and only recognizable to the researcher. In order to ensure that all participant comment or answer was used in context as intended, each participant was given the opportunity to review his/her transcript.
Limitations to the study included the number of teacher participants accessible to the researcher and the teachers’ willingness to participate in the study. With a mere 25 teachers in the targeted population, care was taken to ensure that at least 15 teachers participated. The size of the population may impact the validity of the study since the research was only conducted in one small East Tennessee school system. This limitation was increased by the researcher’s position within the same school district as the targeted population. The researcher did not work directly with the participants; however, results from the interviews may be skewed if teachers responded how they felt the researcher anticipated. In order to decrease the possibility of bias among responses, definition of key terms were defined to reduce confusion of questions, a list of possible examples that ranged from multiple aspects of the topic, and an opportunity to pass on a question and answer at a later time, after reflection was given to the question.

Teachers were given the choice to participate in the study and were informed of their right to withdraw their participation at any time.

**Data Analysis Procedures**

Through the use of semi-structured interviews, observations, and student data, the researcher sought to compare the trends in the data to the interview data offered by the teachers to see if they were well aligned. Coding was used to track participants and best practices, as well as student data on behavior and achievement. Each response from the participants was entered into a spreadsheet document to show the distribution of participant genders, number of years of service, and level of mathematics most taught. Best practices used by teachers were coded as relating to one of the three identified themes: environmental, instructional, or growth/reflection oriented. Observations of teachers’ use of best practices were coded by effectiveness levels (*very effective, effective, somewhat effective, and not effective*). Student data collected were coded as
either positively affected or negatively affected, as a result of the best practices implemented.

Through the use of bar graphs, participant distributions in comparison with environmental, instructional, and informational data on growth and reflection in the reduction of mathematics anxiety were shown. Initial comparisons were made according to the gender of the participants with the best practices used to reduce mathematics anxiety. Subsequent comparisons with the use of best practices were made according to the number of years of service of each participant as well as the level of mathematics most taught by the participants. The resulting histograms were used to locate trends in best practices among the participants. Since semi-structured interviews were utilized, software was needed to sift through the unorganized data, in order to organize and analyze the content. NVivo and Excel software were used to help organize and analyze trends from teacher interviews. Specific trends included most widely used teacher practices that helped in reducing mathematics anxiety.

Summary

The qualitative design of the study allowed the researcher to use participating teachers’ classrooms as a means of obtaining data related to teachers’ use of best instructional practices as they occurred in their natural setting. Semi-structured interviews were arranged at times convenient to participants, and all interviews were recorded and transcribed for accuracy. After each interview, observation times were set up with those teachers expressing unique best practices techniques for reducing mathematics anxiety. Student data was collected to confirm the practices worked for reducing mathematics anxiety. All data were coded and analyzed for patterns and themes. The best practices informed the researcher in the creation of a list of teacher best practices that will aid in the reduction of mathematics anxieties in secondary
students in reference to the student’s environment, method of instruction, and methods of growth and reflection.
CHAPTER FOUR
ANALYSIS OF DATA

The purpose of this qualitative study was to discover what specific strategies teachers employ and implement to create communities of learners within their classrooms to alleviate the mathematics anxieties of students that may be present. Building on Stodolsky, Salk, and Glaessner’s (1991) compelling idea that the combination of how a lesson is taught, what goals and expectations are given, and how content is presented work together to shape students’ views and attitudes about mathematics, this study sought to discover which best practices teachers use that have been successful in the reduction of mathematics anxiety among their students. The resulting list of positive changes to reduce mathematics anxieties in students, those used separately or in conjunction with one another, will be beneficial to many teachers. Teacher input was sought to answer the following research questions:

1. What best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
2. What best practices, concerning classroom instruction, do secondary teachers believe have a positive impact on reducing mathematics anxiety?
3. What best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety?

Three major characteristics of best teacher practices were found that led to the alleviation of mathematics anxiety in students: environmental strategies, instructional strategies, and interpersonal strategies concentrating on student growth. The environmental strategies teachers used included modifying the environment and finding positive ways to alleviate anxiety. The instructional strategies identified include how the lessons were taught, what activities were used,
and how much extra practice or help was provided for those students in need. Interpersonal strategies concerning student growth focused on making and building relationships among students and between students and the teacher to increase confidence, morale, and motivation.

**Presentation of Descriptive Characteristics of Participants**

This study included the responses of 15 educators serving students in grades six through 12 attending nine elementary and two high schools within the same school district. Convenience sampling was used to select the participating teachers in the East Tennessee school district due to the limited access to and familiarity with the schools and teachers within the system. Participants included 14 classroom teachers (three male, 12 female) and one female curriculum coordinator with teaching experiences ranging from six to 41 years. Of the nine sixth, seventh, and eighth grade teachers, the majority \((n = 8)\) taught one grade level, while one taught students in both seventh and eighth grades. All the high school teachers \((n = 5)\) taught across the nine through 12 grade span.

Unique to the teachers at the two high schools, some of the classes \((n = 2)\) utilized a curriculum where classes were conducted entirely online. Those teachers were responsible for facilitating the students’ online work by getting them started on the computer program, opening online quizzes, and checking quiz grades periodically throughout the class. Therefore, many of their responses were limited because they did not teach many traditional mathematics classes. The participating elementary school teachers taught in schools serving students in kindergarten through eighth grade and were responsible for instructing multiple classes in their grade level a day. Even though the schools are elementary schools, teachers teaching sixth, seventh, and eighth grade will be referred to as secondary teachers for the purposes of this study.

Table 4.1
### Demographics of Teacher Interviews (n=15)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>Current Position</th>
<th>Experience</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>Elementary</td>
<td>6th</td>
<td>24</td>
<td>F</td>
</tr>
<tr>
<td>Teacher B</td>
<td>High</td>
<td>9th - 12th</td>
<td>9</td>
<td>M</td>
</tr>
<tr>
<td>Teacher C</td>
<td>Middle</td>
<td>8th</td>
<td>6</td>
<td>M</td>
</tr>
<tr>
<td>Teacher D</td>
<td>High</td>
<td>9th -12th</td>
<td>7</td>
<td>F</td>
</tr>
<tr>
<td>Teacher E</td>
<td>Middle</td>
<td>7th</td>
<td>20</td>
<td>F</td>
</tr>
<tr>
<td>Teacher F</td>
<td>High</td>
<td>9th -12th</td>
<td>41</td>
<td>F</td>
</tr>
<tr>
<td>Teacher G</td>
<td>Middle</td>
<td>7th</td>
<td>6</td>
<td>F</td>
</tr>
<tr>
<td>Teacher H</td>
<td>Elementary</td>
<td>Curriculum</td>
<td>18</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coordinator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher I</td>
<td>High</td>
<td>9th -12th</td>
<td>10</td>
<td>M</td>
</tr>
<tr>
<td>Teacher J</td>
<td>Middle</td>
<td>8th</td>
<td>13</td>
<td>F</td>
</tr>
<tr>
<td>Teacher K</td>
<td>Middle</td>
<td>7th -8th</td>
<td>15</td>
<td>F</td>
</tr>
<tr>
<td>Teacher L</td>
<td>Elementary</td>
<td>6th</td>
<td>8</td>
<td>F</td>
</tr>
<tr>
<td>Teacher M</td>
<td>Elementary</td>
<td>6th</td>
<td>18</td>
<td>F</td>
</tr>
<tr>
<td>Teacher N</td>
<td>High</td>
<td>9th -12th</td>
<td>14</td>
<td>F</td>
</tr>
<tr>
<td>Teacher O</td>
<td>Middle</td>
<td>7th</td>
<td>9</td>
<td>F</td>
</tr>
</tbody>
</table>
Presentation of Results: Defining Mathematics Anxiety

To properly assess the responses of teacher participants on best practices to alleviate mathematics anxiety, the degree of understanding that teachers possessed on the meaning of mathematics anxiety had to be determined. Richardson and Suinn defined mathematics anxiety as “feelings of tensions and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (1972, p. 2). Consequently, Question 1, What does mathematics anxiety look like, was used to compare teachers’ perceptions of what mathematics anxiety look like among their students across three domains: lack of doing, personal conflicts, and negative reactions. Figure 4.1 was created to outline characteristics determined to be the symptoms of mathematics anxiety. Additionally, Table 4.2 includes the complete list of characteristics by participating teachers.
Question 1: What Does Mathematics Anxiety Look Like?

<table>
<thead>
<tr>
<th>Negative Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior Issues</td>
</tr>
<tr>
<td>Class Clown</td>
</tr>
<tr>
<td>Angry</td>
</tr>
<tr>
<td>Low Assessment Performance</td>
</tr>
<tr>
<td>Cheating</td>
</tr>
<tr>
<td>Disruptive</td>
</tr>
<tr>
<td>Off Task</td>
</tr>
<tr>
<td>Negative Self-Talk</td>
</tr>
<tr>
<td>Complain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personal Conflicts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inaccurate Perception</td>
</tr>
<tr>
<td>Despair</td>
</tr>
<tr>
<td>Little/ No Confidence</td>
</tr>
<tr>
<td>Frustrated</td>
</tr>
<tr>
<td>Learning Gap</td>
</tr>
<tr>
<td>Embarassment or Fear</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lack of Doing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Effort</td>
</tr>
<tr>
<td>Decreased Participation</td>
</tr>
<tr>
<td>Give Up/ Shut Down</td>
</tr>
</tbody>
</table>

Figure 4.1: Characteristics that describe mathematics anxiety. \(N = 15\)
Table 4.2

*Specific Teachers’ Characteristics of Mathematics Anxiety (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Characteristics Listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>give up/shut down, complain</td>
</tr>
<tr>
<td>Teacher B</td>
<td>give up/shut down, embarrassment or fear</td>
</tr>
<tr>
<td>Teacher C</td>
<td>give up/shut down, lack of effort, embarrassment or fear</td>
</tr>
<tr>
<td>Teacher D</td>
<td>give up/shut down, negative self-talk</td>
</tr>
<tr>
<td>Teacher E</td>
<td>give up/shut down, off task, disruptive</td>
</tr>
<tr>
<td>Teacher F</td>
<td></td>
</tr>
<tr>
<td>Teacher G</td>
<td>decreased participation, embarrassment or fear, angry</td>
</tr>
<tr>
<td>Teacher H</td>
<td>give up/shut down, cheating, class clown</td>
</tr>
<tr>
<td>Teacher I</td>
<td>give up/shut down, decreased participation, frustrated, angry</td>
</tr>
<tr>
<td>Teacher J</td>
<td>give up/shut down, class clown</td>
</tr>
<tr>
<td>Teacher K</td>
<td>embarrassment or rear, despair</td>
</tr>
<tr>
<td>Teacher L</td>
<td>embarrassment or fear, learning gap</td>
</tr>
<tr>
<td>Teacher M</td>
<td>low assessment performance, behavior issues</td>
</tr>
<tr>
<td>Teacher N</td>
<td>angry</td>
</tr>
<tr>
<td>Teacher O</td>
<td>decreased participation, little to no confidence, despair, inaccurate perception, angry</td>
</tr>
</tbody>
</table>

Most participants responded with an average of two characteristics; however, one teacher, Teacher O, listed five and one teacher, Teacher E, was not able to identify any behaviors associated with any behaviors characteristic of students with mathematics anxiety. Once the
responses were analyzed and coded, the following three categories of responses relating to what anxiety looks like surfaced from the interviews: lack of doing, personal conflicts, and negative reactions. The most frequently cited behavior characteristic of students with anxiety related to students’ lack of doing, more specifically, the tendency to give up or shut down \((n = 8)\). For example, Teacher A responded, “They say they don’t like mathematics or can’t do mathematics. They shut down, refuse to answer questions, or just complain about why we have to learn mathematics and when we will ever use it in the real world.” Likewise, Teacher C indicated that, “Mathematics anxiety presents itself most often in my classroom as a lack of effort. When a student feels overwhelmed by the content being presented, the most common response I see is that the student will stop trying.” Even though many responses were only mentioned once, many of the listed behavioral characteristics shared similar traits such as the complaining mentioned by Teacher A, the tendency for students to engage in negative self-talk by Teacher D, and Teacher O’s mentioning of little or no confidence.

Alexander (2010) found mathematics anxiety symptoms formed from cognitive, affective, or behavioral anxieties. Responses from participating teachers such as students’ tendency to give up and shut down, engage in negative self-talk, show decreased participation or lack of effort, among other characteristics, are all indicative of the cognitive symptoms associated with anxiety. Likewise, teachers noted the affective symptoms of feelings of embarrassment, fear, frustration, anger, despair, and inaccurate perception of ability in conjunction with complaining. The behavioral symptoms of students’ being off task or disruptive, acting like the class clown, among others, were also noted by participating educators.
Presentation of Results: Research Question 1

This study began with the research question, “What best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety?” To best answer this question, how teachers kept the environment safe with numerous students exhibiting mathematics anxieties was explored. Inquiries were made to find what elements cause students the most stress and anxiety and how teachers use certain elements within their classrooms to relieve such anxieties. Of the fifteen interview questions asked to participating teachers, the questions pertaining to Research Question 1 are discussed below.

How Do You Address Students With Anxieties?

Question 2 of the interview was created to determine what strategies teachers believed worked to alleviate general mathematics anxiety among their students. Referring to Alexander’s (2010) findings on mathematics anxiety, this question sought to determine if participating teachers chose strategies to alleviate mathematics anxiety based on student displays of cognitive, affective, or behavioral symptoms indicative of mathematics anxiety. Teachers who only address one of the symptomatic domains will leave the other two domains subject to becoming more pronounced and overpowering. Responses from the interviews yielded two distinct types of strategies teachers utilized to alleviate mathematics anxiety among their students: strategies to address the student’s ability and strategies to address the student’s anxiety. Figure 4.2 shows the distribution of responses indicated the type of strategies used by participating teachers to address anxieties in students.
Figure 4.2: How do you address visible anxiety? (N = 15)

Of the 10 strategies mentioned by respondents, offering teacher assistance and talking to students were the two most listed strategies teachers used to alleviate student anxiety. Only three teachers did not mention either of these two strategies to help alleviate students’ anxiety; however, two of those teachers did indicate that they would comfort students and give praise. Teacher M was the only teacher who did not list some strategy that put themselves at the forefront of handling their students’ anxiety, leaving the anxiety to be handled by a peer tutor or through individual stress-relief techniques. According to interview responses, Teacher E was the only teacher who attempted to alleviate anxieties at the cognitive, affective, and behavioral level by using “simple reassuring and positive comments to the student to keep them motivated to work,” using “peer tutors the student may have a good relationship with,” and “one on one
interactions with the student.” Table 4.3 shows the complete list of strategies used by participating teachers.

Table 4.3

*Specific Teachers’ Strategies to Address Students and Their Anxieties (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Anxiety Alleviating Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>talk to them, peer tutor, offer multiple strategies, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher B</td>
<td>talk to them, build up confidence, give praise, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher C</td>
<td>build up confidence, offer motivation, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher D</td>
<td>build up confidence, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher E</td>
<td>build up confidence, peer tutor, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher F</td>
<td>talk to them, peer tutor, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher G</td>
<td>give praise, create safe climate</td>
</tr>
<tr>
<td>Teacher H</td>
<td>talk to them</td>
</tr>
<tr>
<td>Teacher I</td>
<td>comfort them</td>
</tr>
<tr>
<td>Teacher J</td>
<td>talk to them</td>
</tr>
<tr>
<td>Teacher K</td>
<td>offer teacher assistance</td>
</tr>
<tr>
<td>Teacher L</td>
<td>comfort them, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher M</td>
<td>stress relieving techniques, peer tutor</td>
</tr>
<tr>
<td>Teacher N</td>
<td>talk to them</td>
</tr>
<tr>
<td>Teacher O</td>
<td>talk to them, create safe climate, comfort them, peer tutor</td>
</tr>
</tbody>
</table>

Even though Teachers H, I, J, and N only mentioned one strategy used to alleviate their students’ mathematics anxiety, they did, however, indicate that they had tried other strategies in
the past which were ineffectual. On the other end of the spectrum, Teachers A, B, and O utilized the largest variety \((n = 4)\) of strategies to meet the needs of their students with mathematics anxiety. Among the responses, the majority listed strategies that directly addressed students’ anxiety rather than students’ actual ability. Fiore (1999) found that the presence of mathematics anxiety is not an indication of low mathematical ability because the ability is “masked in anxiety” (p. 404), which coincides with why most teachers chose many more types of strategies to address the anxiety rather than strategies targeting students’ actual ability levels.

**What Stresses Students?**

Question 3 of the interview sought to determine what factors contribute to a student’s symptoms of mathematics anxiety. Butte (1993) listed the following categories of stressors: amount and challenge of school work, relationships with teachers and peers, family issues, emotional well-being, and social media. Responses from the interviews that align with Butte’s work include a perceived learning gap, presentation of difficult concepts, being embarrassed or fearful of responding, and teachers’ expectations; however, one stressor of equal value to participating teachers included the mere mention of impending tests or quizzes. Responses from the interviews revealed three main types of stressors that cause students anxiety: personal, mathematics related, and stress from others. While personal stressors such as embarrassment or fear and lack of immediate satisfaction, emanate from within students, mathematics related stressors and stress from others are generated from external factors like the stated high expectations of their teachers. Figure 4.3 shows the distribution of responses by participants and their perception of the stressors that affect students.
While the mention of test or quiz, difficult concepts, and learning gaps were listed more frequently than any other stressor, expectations of parents and teachers were also frequently cited as causes for creating stress in students with mathematics anxiety. White (1997) found that students’ development of negative feelings and emotions with regards to mathematics can be linked to a shift in the mathematics curriculum during the fourth grade. Consequently, students begin to fall behind as new and difficult concepts are presented, which hinders their ability to be prepared for the following year’s mathematics content. This coincides with what the interview responses found for stressors that lead to mathematics anxiety. While personal anxieties, such as embarrassment or fear, were the least identified causes of stress, which is also the type of stressor that can be difficult for teachers to pick up on. To further the inquiry into the type of factors, both internal and external, that cause the most stress for students, Table 4.4 was created to show
the distribution of answers by participating teachers to pinpoint which teachers had been able to locate multiple types of stressors.

Table 4.4

*Specific Teachers’ List of Stressors to Mathematics Student (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Stressors to Mathematics Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>learning gap, mention of test or quiz</td>
</tr>
<tr>
<td>Teacher B</td>
<td>expectations, lack of immediate satisfaction</td>
</tr>
<tr>
<td>Teacher C</td>
<td>difficult concepts</td>
</tr>
<tr>
<td>Teacher D</td>
<td>mention of test or quiz</td>
</tr>
<tr>
<td>Teacher E</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher F</td>
<td>difficult concepts</td>
</tr>
<tr>
<td>Teacher G</td>
<td>difficult concepts, mention of test or quiz</td>
</tr>
<tr>
<td>Teacher H</td>
<td>expectations</td>
</tr>
<tr>
<td>Teacher I</td>
<td>learning gap, difficult concepts</td>
</tr>
<tr>
<td>Teacher J</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher K</td>
<td>difficult concepts, mention of test or quiz, expectations</td>
</tr>
<tr>
<td>Teacher L</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher M</td>
<td>embarrassment or fear</td>
</tr>
<tr>
<td>Teacher N</td>
<td>mention of test or quiz</td>
</tr>
<tr>
<td>Teacher O</td>
<td>expectations</td>
</tr>
</tbody>
</table>
Teachers B and K were the only two teachers who mentioned stressors in more than one of the identified categories. Picking stressors in the others and self-categories, Teacher B replied, “The inability to find the right answer the first time denies students the immediate satisfaction they desire from a problem, and when they don’t receive that, they stress out. I have also seen students who put a lot of pressure on themselves to be perfect, and, in mathematics, that is almost impossible.”

Teacher K’s responses aligned with stressors in the mathematics related and others categories stating, “I think the students are stressed because mathematics is not always connected to their experiences and they have to think in a different way. I also think parent expectations with grades and testing requirements contribute to the problem. Too much emphasis on grades instead of understanding and learning the skill will stress the students.”

Nine of the 15 teachers, however, only selected stressors relating to either being behind mathematically or struggling over a current difficult concept.

**What Classroom Elements Relieve Anxiety?**

Question 8 of the interview sought to determine what classroom elements implemented by participating teachers were the most effective in relieving students’ symptoms of mathematics anxiety. Alexander (2010) observed that supportive classrooms had teachers who were respectful to all students, enthusiastic about mathematics, humorous, held high expectations for students, were caring and helpful to all students, and were constantly encouraging students.

Results from the interviews revealed two overarching themes in the responses that align with Alexander’s findings: building relationships and maintaining an effective and consistent classroom. As Figure 4.4 depicts, the majority of participant responses fell in the building
relationships category, which include classroom elements that make sure everyone respects each other, no one is afraid, and that students feel valued.

<table>
<thead>
<tr>
<th>Question 8: What Classroom Elements Relieve Anxiety?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective and Consistent Classroom</td>
</tr>
<tr>
<td>Allowed to Move in the Classroom</td>
</tr>
<tr>
<td>Decorated Classroom</td>
</tr>
<tr>
<td>Model Expected Behavior</td>
</tr>
<tr>
<td>Create Social Contract</td>
</tr>
<tr>
<td>Trusting Relationship with Teacher</td>
</tr>
<tr>
<td>No One is Afraid</td>
</tr>
<tr>
<td>Students Must Feel Valued</td>
</tr>
<tr>
<td>Create Team Atmosphere</td>
</tr>
<tr>
<td>Everyone Respects Each Other</td>
</tr>
</tbody>
</table>

![Figure 4.4: Classroom elements that relieve anxiety. (N = 15)](image)

Of the nine different classroom elements identified as effective for relieving mathematics anxiety among students, model expected behavior, no one is afraid, and everyone respects each other were the three elements most frequently identified. Moreover, either one or all of these three classroom elements were mentioned by at least 10 of the 15 participating educators. The five teachers who did not mention these elements, however, listed similar elements, such as create team atmosphere and create social contract. The majority of responses indicated those elements responsible for building relationships were the most important classroom elements responsible for the alleviation of mathematics anxiety. While only one teacher listed moving around the classroom and creating a social contract as important classroom elements that help
alleviate mathematics anxiety, it was important to see whether or not these tools were used in conjunction with other identified elements to effectively relieve anxiety. For that reason, Table 4.5 shows which classroom elements each participating teacher employed in order to help relieve mathematics anxiety among their students.

Table 4.5

*Specific Teachers’ Classroom Elements that Relieve Anxiety (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Elements that Relieve Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>no one is afraid</td>
</tr>
<tr>
<td>Teacher B</td>
<td>everyone respects each other, no one is afraid, trusting relationships</td>
</tr>
<tr>
<td>Teacher C</td>
<td>create team atmosphere, trusting relationships, create social contract</td>
</tr>
<tr>
<td>Teacher D</td>
<td>create team atmosphere</td>
</tr>
<tr>
<td>Teacher E</td>
<td>student must feel valued, model expected behavior</td>
</tr>
<tr>
<td>Teacher F</td>
<td>students must feel valued, decorated classroom</td>
</tr>
<tr>
<td>Teacher G</td>
<td>no one is afraid, model expected behavior</td>
</tr>
<tr>
<td>Teacher H</td>
<td>everyone respects each other, model expected behavior</td>
</tr>
<tr>
<td>Teacher I</td>
<td>create team atmosphere</td>
</tr>
<tr>
<td>Teacher J</td>
<td>everyone respects each other, no one is afraid</td>
</tr>
<tr>
<td>Teacher K</td>
<td>students must feel valued, no one is afraid</td>
</tr>
<tr>
<td>Teacher L</td>
<td>model expected behavior</td>
</tr>
<tr>
<td>Teacher M</td>
<td>everyone respects each other, model expected behavior</td>
</tr>
<tr>
<td>Teacher N</td>
<td>trusting relationships</td>
</tr>
<tr>
<td>Teacher O</td>
<td>everyone respects each other, trusting relationships, decorated classroom, allowed to move in the classroom</td>
</tr>
</tbody>
</table>
While the majority of respondents ($n = 10$) identified at least two classroom elements used to relieve mathematics anxiety, the five teachers listed one classroom element that they found to work in alleviating mathematics anxiety. Teacher N, whose response only aligned with one of the identified classroom elements, replied to this particular question by stating:

The most important thing in the classroom is for the students to feel comfortable with the teacher. I talk to them like I am one of them. I don’t want them to be intimidated by me. I let them know that I am learning along with them.

Similarly, Teacher A explained that in her classroom:

No one is afraid or embarrassed to answer after a few times. Obviously, it doesn’t start out that way unless students are shown procedures on how to act and behave during this time. Students need to feel comfortable answering incorrectly.

On the other hand, Teacher O indicated that there are many classroom elements that help alleviate anxiety among her students:

I like grouping, but only if I assign the groups. I like lots of colors in my class. My students know that I do not tolerate nastiness or disrespect of any kind. I love to joke around with them, and they joke with me, but they also know when it is time to be serious. I teach my students how to critique each other for improvement.

While not every teacher utilized the same elements in their classrooms to lessen the anxiety of their students, they all claimed to have at least one effective element to help target and relieve their students’ anxiety.

**How Do You Use Humor to Relieve Anxiety?**

Godbey (1997) found that mathematics cartoons, jokes, puns, riddles, stories, and even
certain spontaneous behaviors that contain unexpected or out of context elements become memorable events in the minds of students. To determine if the classroom element of humor was ever used as a means of anxiety relief among students, the following question was posed to participants: *How do you use humor to relieve anxiety?* From the responses, the following two themes that coincided with Godbey’s findings emerged: humor built into the routine and spontaneous humor. The largest variety of responses appeared to be elements where humor was embedded into the lesson on purpose through the use of silly games, funny additions to lesson, or the inclusion of jokes and cartoons. Figure 4.5 shows the distribution of humor strategies and which ones were used most by participating teachers to relieve a mathematics anxiety.

**Figure 4.5:** Classroom humor examples that relieve anxiety. \(N = 15\)
The most commonly listed humor technique used by participating teachers was the inclusion of jokes and cartoons built into the routine; however, teachers also listed a variety of other humor elements that were actually planned out ahead of time, such as the use of silly games or other funny additions to the lesson. Of the seven teachers listing the aid of jokes and cartoons into the routine, only Teacher A responded to using an additional element of humor to aid in the classroom environment. Funny teacher stories and a funny addition to a lesson were the next most commonly listed humor elements used to relieve anxiety. These attempts at humor were sometimes planned ahead to make sense to the concept of the day or simply added at the spur of the moment. A majority of teachers, \((n = 6)\), responded that they used spontaneous humor, such as funny teacher stories and funny class openers, over other elements.

Of the 15 participating teachers, only two teachers reported using humor elements that were both built into their classroom routines and spontaneous. One of those teachers, Teacher B, explained,

I usually try to start class off on a fun note with one-liners and witticisms. When I teach triangle congruency theorems, I have a slide that pops up, and it’s a picture of a donkey with a red circle with a line through it around it. I also have this funny ‘hee-haw’ sound that play. The students never see this coming so they just bust out laughing.

Similarly, Teacher C shared that, “Other than the general goofy pun or silly one line, I typically have used humor to introduce a new concept on the spur of the moment. Humor is a great way to get students interested and thinking about something.” Only one other teacher reported using two humor elements that were built in the routine, and the remaining teachers sporadically using one element of humor element at some point throughout their lessons or units. In order to specifically see which humor elements participating teachers use effectively, Table
4.6 was created to show what humor strategies were used to relieve anxiety, per participating teacher.

Table 4.6

*Specific Teachers' Strategies to Incorporate Humor to Relieve Anxiety (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Incorporated Humor to Relieve Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>jokes and cartoons, silly games</td>
</tr>
<tr>
<td>Teacher B</td>
<td>funny class opener, funny addition to lesson</td>
</tr>
<tr>
<td>Teacher C</td>
<td>funny class opener, funny addition to lesson</td>
</tr>
<tr>
<td>Teacher D</td>
<td>jokes and cartoons</td>
</tr>
<tr>
<td>Teacher E</td>
<td>jokes and cartoons</td>
</tr>
<tr>
<td>Teacher F</td>
<td>funny teacher stories</td>
</tr>
<tr>
<td>Teacher G</td>
<td>funny teacher stories</td>
</tr>
<tr>
<td>Teacher H</td>
<td>funny addition to lesson</td>
</tr>
<tr>
<td>Teacher I</td>
<td>funny teacher stories</td>
</tr>
<tr>
<td>Teacher J</td>
<td>funny addition to lesson</td>
</tr>
<tr>
<td>Teacher K</td>
<td>jokes and cartoons</td>
</tr>
<tr>
<td>Teacher L</td>
<td>funny teacher stories</td>
</tr>
<tr>
<td>Teacher M</td>
<td>jokes and cartoons</td>
</tr>
<tr>
<td>Teacher N</td>
<td>jokes and cartoons</td>
</tr>
<tr>
<td>Teacher O</td>
<td>jokes and cartoons</td>
</tr>
</tbody>
</table>
Presentation of Results: Research Question 2

After examining the responses associated with best practices concerning the environment of the classroom, the line of inquiry was expanded to include the second research question:

*What best practices, concerning classroom instruction, do secondary teachers believe have a positive influence on reducing mathematics anxiety?* In order to best answer this question, each participating teacher’s daily routine was examined to identify patterns and consistency within the classroom. This primary goal of this question was to assess which parts of a daily mathematics lesson were most influential in the learning process of mathematics and the alleviation of mathematics anxiety. Participating teachers were also asked to identify a variety of instructional strategies they used as a means of coping with students with and without anxiety. Finally, what methods participating teachers used to communicate expectations and self-regulating strategies for stress relief for students was sought. Of the fifteen interview questions asked to participating teachers, the following five questions of the interview pertaining to Research Question 2 are discussed below.

Describe a Daily Routine

Question 5 of the interview was created to determine what specific elements the participating teachers incorporated in their classrooms as a means of effectively instructing mathematics to all learners. The findings from the interview responses determined that all participating teachers divided their classroom schedule into three main sections: an introduction, lesson, and practice. All 15 participating teachers listed an introduction, guided lesson, and practice segment of their daily routine. While checking homework was the least mentioned part of the class routine, other forms of introductory segments mentioned included using a class opener and review from the previous day. Figure 4.6 shows the distribution of routine elements
in the participating teachers’ classrooms.

Figure 4.6: What elements appear in a daily mathematics routine? \( N = 15 \)

Class openers and review the previous day were the two most selected introductory responses to the daily routine and because there was an interest in how the teachers utilized this time effectively, participating teachers were asked for more detail into what the introductory part of their daily routines looked like. Teacher B replied, “We review the previous day’s lesson and assignment. I give students the chance to present their work and we discuss solutions.” Teacher G responded that student routinely “come into my class and have an entry ticket on the concepts or processes we learned the day before. We finish the problem as a class in order to clear up any misunderstandings.” Teacher K used a 10 question check where students “self-grade and discuss as a group.” Students in these three teachers’ classroom each begin with some kind of entry
review that concludes with the class discussing it as a whole to clear up any misunderstandings.

Table 4.7 shows the entire daily routine characteristics of each participating teacher.

Table 4.7

*Specific Teachers’ Characteristics of a Daily Mathematics Routine (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Daily Mathematics Routine Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>check homework, review previous day, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher B</td>
<td>class opener, review previous day, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher C</td>
<td>review previous day, guided lesson, group work, partner work, independent practice</td>
</tr>
<tr>
<td>Teacher D</td>
<td>class opener, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher E</td>
<td>class opener, review previous day, guided lesson, group work, partner work</td>
</tr>
<tr>
<td>Teacher F</td>
<td>review previous day, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher G</td>
<td>class opener, guided lesson, group work, independent practice</td>
</tr>
<tr>
<td>Teacher H</td>
<td>class opener, guided lesson, partner work</td>
</tr>
<tr>
<td>Teacher I</td>
<td>class opener, check homework, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher J</td>
<td>review previous day, guided lesson, partner work</td>
</tr>
<tr>
<td>Teacher K</td>
<td>review previous day, guided lesson, partner work</td>
</tr>
<tr>
<td>Teacher L</td>
<td>review previous day, guided lesson, group work</td>
</tr>
<tr>
<td>Teacher M</td>
<td>review previous day, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher N</td>
<td>class opener, check homework, guided lesson, independent practice</td>
</tr>
<tr>
<td>Teacher O</td>
<td>review previous day, guided lesson, partner work</td>
</tr>
</tbody>
</table>

Independent practice was the most widely listed type of practice the participating teachers
used, but the research continued to see if participating teachers used other means of practice leading up to independent practice. Teacher C indicated that group work, partner work, and independent practice were used in succession in the classroom to build students towards working alone. Teacher E reported using group work to go over worksheets from the lesson and then checking students with an “individual assessment through an exit ticket” while Teacher G used group time to “work with my lower level students in a more intimate setting to ensure their mastery of the concepts. Once group work is finished, as a class we go over the problems. Individual classwork is assigned to be completed in class.” Each of these teachers reported working from a whole class to group to an individual assessment to give students a chance to fully understand the concept.

What Instructional Strategies Do You Use on Anxious Students?

Question 6 of the interview was created to discover which instructional strategies participating teachers used as a means of reducing mathematics anxiety. Martinez and Martinez (2003) found that the way a teacher instructed the lesson and the depth of content presented in mathematics class directly affected mathematics learning and instructing. Knowing the importance of consistent and effective classroom instruction, three categories of instructional strategies were discovered after careful analysis: teacher provided assistance, lesson additions, and student provided additions. Teacher provided assistance included prompting students, offering quick reminders and hints, and providing students with lesson notes such as study guides. The most widely mentioned category, lesson additions, included the use of games, activities, differentiation strategies, and many examples through multiple procedural strategies. Student provided assistance was mainly characterized by allowing students to work with other students. Seven of the 15 teachers reportedly used more than one lesson addition to help reduce
anxiety. Moreover, three of the 15 teachers mentioned using an instructional strategy that fit into each of the three identified patterns of instructional strategies. Figure 4.7 shows the distribution of instructional strategies that participating teachers have used to effectively reduce mathematics anxiety and Table 4.8 lists specific instructional strategies by participating teachers.

![Figure 4.7: What instructional strategies do you use to reduce anxiety? (N = 15)](image-url)

Table 4.8
### Instructional Strategies to Reduce Mathematics Anxiety by Participating Teachers ($N = 15$)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Instructional Strategies that Relieve Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>games, manipulatives</td>
</tr>
<tr>
<td>Teacher B</td>
<td>teacher proved notes, activities</td>
</tr>
<tr>
<td>Teacher C</td>
<td>partners</td>
</tr>
<tr>
<td>Teacher D</td>
<td>offer teacher assistance, lots of examples, partners, group work</td>
</tr>
<tr>
<td>Teacher E</td>
<td>differentiation, offer multiple strategies</td>
</tr>
<tr>
<td>Teacher F</td>
<td>manipulatives, activities</td>
</tr>
<tr>
<td>Teacher G</td>
<td>activities, partners, group work</td>
</tr>
<tr>
<td>Teacher H</td>
<td>teacher provided notes, differentiation, offer multiple strategies, partners</td>
</tr>
<tr>
<td>Teacher I</td>
<td>offer teacher assistance</td>
</tr>
<tr>
<td>Teacher J</td>
<td>offer multiple strategies</td>
</tr>
<tr>
<td>Teacher K</td>
<td>teacher provided notes</td>
</tr>
<tr>
<td>Teacher L</td>
<td>manipulatives, activities, partners</td>
</tr>
<tr>
<td>Teacher M</td>
<td>activities, lots of examples, partners, group work</td>
</tr>
<tr>
<td>Teacher N</td>
<td>partners</td>
</tr>
<tr>
<td>Teacher O</td>
<td>offer teacher assistance, activities, differentiation, partners, group work</td>
</tr>
</tbody>
</table>

As previously mentioned, three of the 15 participating teachers included instructional strategies that fit into each of the three identified categories. Teacher D reported using “group work, peer teaching, one-on-one instructing, and lots of practice questions” because “students sometime cannot understand what I am saying but can understand when their peers say it.”
Teacher H not only offers “think-pair-share, scaffolding, effective modeling of expectations, stressing perseverance, and showing how mathematics problems can be solved in different ways,” but students are constantly taught to “choose the way that makes most sense to them.”

Teacher O continues the pattern of using a variety of strategies by using “buddy practice, group games, lecturing, differentiation stations, and students working out problems on the board.” All three teachers attempt to employ various intervention strategies to alleviate mathematics anxiety by helping students not feel alone or struggle academically.

**How Does Group Work Impact Your Anxious Students?**

Question 7 of the interview was created to determine the impact that group work had on alleviating mathematics anxiety. Hodges (1983) discussed several sociological elements that cooperative groups had on anxiety, such as allowing students to work together which gives students opportunities to work with different types of students, a chance to work in a competitive nature, and trigger the social aspect of learning. Blazer (2011), on the other hand, stated that teachers had the responsibility of presenting mathematics in a way that allowed students to think critically, make decisions, explore new procedures and possible solutions, and use the attained knowledge they have in a different manner. The impact of group work elicited different responses from anxious students by either allowing them to work safely, do not work, or a combination of some work, some do not. Figure 4.8 was produced to show the distribution of group impacts on the relieving of mathematics anxiety.
Unlike most of the interview questions that elicited a wide variety of responses, the impact of group work by participating teachers produced only one response from teachers. Eight of the 15 teachers reported that while group work allows some anxious students to work comfortably and safely with a group of students, some students just do not take the opportunity to benefit from group work. While only one teacher responded that group work had no positive effects on the anxious, stating that “the most anxious students just don’t work,” six other teachers reported that group work positively impacted anxious students. A particular interest was taken in determining what elements led to those groups either causing students to work or not to work. Table 4.9 shows the impact that group work has on anxious students of participating teachers.

Figure 4.8: Effects of group work on anxious students. (N = 15)
Table 4.9  
*Specific Teachers’ Impact of Group Work on Anxious Students (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Group Impact Categories on Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher B</td>
<td>anxious do not work</td>
</tr>
<tr>
<td>Teacher C</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher D</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher E</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher F</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher G</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher H</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher I</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher J</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher K</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher L</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher M</td>
<td>anxious work safely</td>
</tr>
<tr>
<td>Teacher N</td>
<td>some work and some do not</td>
</tr>
<tr>
<td>Teacher O</td>
<td>some work and some do not</td>
</tr>
</tbody>
</table>

Teacher B replied that group work did not elicit more work from anxious students merely because “it is not worth the time and effort it takes to complete group work” and “anxious students do not like to work in groups because they end up feeling inferior to those who can do the work.” Teacher C disagreed and stated that group work “only works within structure with
clear procedures in place for accountability” and “group work reduced the pressure on students with mathematics anxiety. It allows them to ask the questions in a safe environment.” Teacher D shared the same views as Teacher C but added, “I try to have at least one strong and confident person in a group where a weak and not so confident mathematics student is located. I try to make sure the ability levels are about the same so they are on the same page.” Teacher K agreed with grouping by ability and approaches grouping with the understanding that it “makes the students feel comfortable with their level of understanding and gives the students an equal level of participation. It becomes a group effort and not the responsibility of the highest achiever.” Grouping tends to carry a more positive impact when the groups are thought of ahead of time and students take responsibility.

**How Do Your Students Know Your Expectations?**

Question 14 of the interview was created to learn how students were informed about teacher expectations while in the classroom. This question aligns with Muro’s (2006) findings that when teachers express their expectations at the beginning of the year, the environment continues to stay light and positive. Participating teachers expressed their expectations about behavior and academics either through First of the Year Procedures, Daily Posted Expectations, or through Verbal Affirmations. Figure 4.9 shows the distribution of responses to how teachers relay their expectations students during their mathematics instruction and routines.
While only 11 of the 15 participating teachers responded with related to going over expectations during the first week of school, it seems difficult to believe that teachers do not express their expectations at the beginning of each new year or term. After the analysis of responses by individual teachers, it became apparent that some teachers interpreted this question as in daily academic expectations and not necessarily procedural expectations. This would explain why seven of the 15 participating teachers responded with writing the Agenda on the Board as a means of relaying expectations. In order to better see the breakdown of responses and what combinations of procedures teachers used to convey their expectations, Table 4.10 was created which outlines in detail how students are made aware of teacher expectations.
Table 4.10

Specific Teachers’ List of Ways to Make Students Aware of Teacher Expectations ($N = 15$)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Ways Expectations are Incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>first week of school, consistent implementation</td>
</tr>
<tr>
<td>Teacher B</td>
<td>agenda on board, objectives on board</td>
</tr>
<tr>
<td>Teacher C</td>
<td>first week of school, agenda on board</td>
</tr>
<tr>
<td>Teacher D</td>
<td>first week of school</td>
</tr>
<tr>
<td>Teacher E</td>
<td>agenda on board</td>
</tr>
<tr>
<td>Teacher F</td>
<td>first week of school</td>
</tr>
<tr>
<td>Teacher G</td>
<td>first week of school, consistent implementation</td>
</tr>
<tr>
<td>Teacher H</td>
<td>first week of school, agenda on board</td>
</tr>
<tr>
<td>Teacher I</td>
<td>agenda on board</td>
</tr>
<tr>
<td>Teacher J</td>
<td>first week of school, consistent implementation</td>
</tr>
<tr>
<td>Teacher K</td>
<td>first week of school</td>
</tr>
<tr>
<td>Teacher L</td>
<td>first week of school, consistent implementation</td>
</tr>
<tr>
<td>Teacher M</td>
<td>first week of school, agenda on board, social contract</td>
</tr>
<tr>
<td>Teacher N</td>
<td>first week of school</td>
</tr>
<tr>
<td>Teacher O</td>
<td>agenda on board, consistent implementation</td>
</tr>
</tbody>
</table>
Teacher M was the only participating teacher who discussed using expectation procedures in all three of the identified categories of answers with the response:

We talk at first about expectations in the classroom at the beginning of the year. The students make a student contract so they know how to act with each other, and they make a teacher contract so they know what to do to meet my expectations. I also have an agenda written on the board each day, and I have a consistent daily classroom routine. Five of the 15 teachers responded that consistent implementation of expectations helped keep students accountable and aware of what was expected daily. On the topic of consistency, Teacher A replied, “we continue talking about it every time work is due or a behavior is shown in class that is expected or not,” while Teacher J commented, “I continue to tell them daily what expectations I expect from them in the school, my class, and for their learning. When they do not meet that expectation, we discuss one-on-one why they are not meeting that expectation.” Similarly, Teacher O responded, “expectations are expressed every day before I start any lesson, group work, station, etc.”

**What Self-Regulating Strategies for Anxieties Do You Teach Students?**

Question 10 of the interview was created to determine what strategies participating teachers taught their students as a means of self-regulating their own stress and anxiety. Participating teachers were found to have used many different types of strategies to help students relieve their own anxiety. Of the 11 different responses, each of the self-regulating strategies mentioned by teachers fit into three different categories: address the mathematics problem, address the anxiety, or allow the students to seek help. Figure 4.10 show the distribution of self-regulating strategies that students were taught to employ.
The most frequently mentioned technique teachers utilized was the encouragement of students to use simple stress relieving techniques such as taking deep breaths, stretching, and taking a step back from the problem and coming back refreshed. Asking for help and breaking problems into smaller pieces were also mentioned by several teachers. Among the three main categories of self-regulating strategies, most of the strategies addressed the mathematics problem rather than the anxiety itself or asking the students to seek help. Table 4.11 outlines the self-regulating strategies that participating teachers reported teaching students to use.
### Table 4.11

**Specific Teachers' Self-Regulating Anxiety Techniques for Students (N = 15)**

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Self-Regulating Anxiety Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>use multiple strategies, relax: everyone makes mistakes, ask for help</td>
</tr>
<tr>
<td>Teacher B</td>
<td>break into smaller steps, take/use good notes, stress relief techniques, ask questions</td>
</tr>
<tr>
<td>Teacher C</td>
<td>build trusting relationships</td>
</tr>
<tr>
<td>Teacher D</td>
<td>break into smaller steps, mnemonic strategies</td>
</tr>
<tr>
<td>Teacher E</td>
<td>break into smaller steps, stress relief techniques, ask for help</td>
</tr>
<tr>
<td>Teacher F</td>
<td>take/use good notes</td>
</tr>
<tr>
<td>Teacher G</td>
<td>safe climate, relax: everyone makes mistakes</td>
</tr>
<tr>
<td>Teacher H</td>
<td>use multiple strategies</td>
</tr>
<tr>
<td>Teacher I</td>
<td>stress relief techniques</td>
</tr>
<tr>
<td>Teacher J</td>
<td>take/use good notes, ask for help</td>
</tr>
<tr>
<td>Teacher K</td>
<td>break into smaller steps</td>
</tr>
<tr>
<td>Teacher L</td>
<td>make it real life, ask questions</td>
</tr>
<tr>
<td>Teacher M</td>
<td>stress relief techniques</td>
</tr>
<tr>
<td>Teacher N</td>
<td>safe climate</td>
</tr>
<tr>
<td>Teacher O</td>
<td>stress relief techniques, safe climate, ask for help, ask questions</td>
</tr>
</tbody>
</table>

Seven of the teachers only reported teaching students one strategy to alleviate anxiety.

While Teacher N stated “that it is just mathematics and there is more to life than mathematics” to help students create their own safe environment while learning mathematics, Teacher C
approached this question with the belief that if you “strike a balance in your relationship building of mutual respect and a genuine camaraderie with your students, you can open up a vast amount of opportunities to meet your students on a human level.” Several other teachers approached this question as what means they use to address different strategies to help with different anxiety stressors. Teacher B and E used a variety of strategies to help students relieve their own anxiety. For example, Teacher B employed four techniques for students, responding “breathe…take quality notes…which helps the information sink in. Ask questions, a lot of questions. Break problems down into small, manageable steps.” Teacher E taught three strategies to students, stating, “Take small steps. Take a break and come back to a problem. Ask me in private or come to tutoring. I tell them that there isn’t a problem so impossible that we can’t figure it out together.”

**Presentation of Results: Research Question 3**

In order to best answer the third and final research question, *What best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety?*, careful examination was given to how teachers kept the environment safe with numerous students who had visible mathematics anxieties. This research question also sought to elicit responses from participating teachers on what they believed causes anxiety in some students but not others and what interventions they use in the classroom to relive the side effects of those anxieties on achievement. Additionally, finding out what strategies that participating teachers implemented as a means of maintaining progress was sought. Finally, the research question sought classroom elements that allowed students to give feedback to the teacher on their own learning so that teachers could then address those anxieties. Of the fifteen interview questions asked to participating teachers, the five questions pertaining to Research
Question 3 are discussed below.

**Why Do Some Students Have Anxiety Over Others?**

Question 4 of the interview was created to determine participating teachers’ perspectives on why they thought some students’ anxiety while others appear to control their anxiety quite unnoticeably. Blazer (2011) and Godbey (1997) explained that mathematics anxiety takes place in a complex fashion, resulting from a combination of personal, intellectual, and environmental factors. Newstead (1998) also reported that attitudes and emotions towards mathematics learning begins to develop between the ages of nine and 11, which White (1997) explained corresponded with a shift in mathematical learning where the world of the concrete turns to the world of the abstract. Participating teachers categorized their responses to student anxiety as relating to either internal or academic obstacles. Internal obstacles focused on motivation, the ability/inability to handle anxiety, fear of mathematics, confidence levels, and levels of expectations from parents and teachers. Academic obstacles, however, focused more on either a past bad experience in a mathematics class or with a mathematics teacher and the fact that the student appeared to be suffering from a learning gap. Learning gaps were defined as a student not being on the required mathematical level that the current mathematics class expected for students. Figure 4.11 shows the distribution of reasons why participating teachers believed that some students have anxiety while others do not appear to have anxiety.
While the most revealing response to why some students have anxiety and others do not turned out to be no motivation, it appeared equally interesting that both sub-categories in the academic obstacles category had the next highest number of responses. Of the 15 teachers, 10 cited learning gaps and bad experiences as causes of anxieties for students, but, interestingly enough, not a single teacher reported both reasons as a means of explaining why some students appear to have more anxiety over others. While many of the internal obstacles might play into explaining the academic obstacles, it was imperative that the sub-categories remain distinct and separate. In order to look more closely as to which internal and academic obstacles teachers believed were related to why some students have anxiety, Table 4.12 was created of the participating teachers’ reasons that some mathematics students have anxiety over others.
Table 4.12

*Reasons for Mathematics Students’ Anxiety by Participating Teachers (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Overall Reasons for Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>no motivation, can’t handle stress, bad experiences</td>
</tr>
<tr>
<td>Teacher B</td>
<td>no motivation, expectations</td>
</tr>
<tr>
<td>Teacher C</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher D</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher E</td>
<td>no motivation, learning gap</td>
</tr>
<tr>
<td>Teacher F</td>
<td>no motivation</td>
</tr>
<tr>
<td>Teacher G</td>
<td>bad experiences</td>
</tr>
<tr>
<td>Teacher H</td>
<td>scared of mathematics, bad experiences</td>
</tr>
<tr>
<td>Teacher I</td>
<td>no motivation, little/no confidence</td>
</tr>
<tr>
<td>Teacher J</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher K</td>
<td>can’t handle stress, bad experiences</td>
</tr>
<tr>
<td>Teacher L</td>
<td>scared of mathematics</td>
</tr>
<tr>
<td>Teacher M</td>
<td>no motivation, can’t handle stress</td>
</tr>
<tr>
<td>Teacher N</td>
<td>learning gap</td>
</tr>
<tr>
<td>Teacher O</td>
<td>can’t handle stress, bad experiences</td>
</tr>
</tbody>
</table>
Ten teachers listed reasons for anxiety that fell only into the academic obstacles category while five teachers listed reasons for anxiety that fell into both the academic obstacles and internal obstacles categories. Teacher O connected the many factors of anxiety by replying with the following:

Some students do not handle stress very well, and some might have had a bad experience with a mathematics class or mathematics teacher and cannot forget it. On the other hand, some students have home lives that foster learning, perseverance, and hard work, and other homes do not care if a student makes a B over a D. There are many factors that influence how well a student handles challenge, frustration, and failures.

Teacher A added:

Some students don’t want to try and succeed because they think it will not matter. They have no motivation to learn, either from home, school, or within themselves. They might have failed once and decided that they simply can’t do mathematics or are not good at mathematics. Those that do not have mathematics anxiety probably do have it but have some way of controlling it.

**How Do You Help Anxious Students Reduce Anxiety and Improve Achievement?**

Question 11 of the interview was created to determine what specific implementations that participating teachers were using to reduce anxiety and raise achievement. The following three categories of responses were discovered: academic modifications, anxiety-centered changes, and student-centered changes. Figure 4.12 shows the list of teacher strategies that not only target relieving anxiety but strive to raise achievement as well.
A variety of strategies were mentioned in the three aforementioned categories; however, a majority of the responses fit into the student-centered changes category. Teachers found that giving students peer or teacher help was the greatest strategy to relieve anxiety and increase achievement. Moral support was the most mentioned strategy, which included seeking out anxious students early in the year and taking them under the teacher’s wing, giving consistent encouragement, support, and reinforcement, and teaching perseverance; however, several teachers listed using a combination of strategies. Table 4.13 outlines strategies that participating teachers used to simultaneously lower mathematics anxiety while raising achievement.
Table 4.13

*Specific Teachers’ Strategies for Relieving Anxiety and Raising Achievement (N = 15)*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Strategies Reducing Anxiety While Raising Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>modified assignments, preferential seating</td>
</tr>
<tr>
<td>Teacher B</td>
<td>moral support, get to know students</td>
</tr>
<tr>
<td>Teacher C</td>
<td>partners</td>
</tr>
<tr>
<td>Teacher D</td>
<td>make students accountable</td>
</tr>
<tr>
<td>Teacher E</td>
<td>get to know students, partners</td>
</tr>
<tr>
<td>Teacher F</td>
<td>modified assignments, moral support</td>
</tr>
<tr>
<td>Teacher G</td>
<td>moral support</td>
</tr>
<tr>
<td>Teacher H</td>
<td>small successes, moral support</td>
</tr>
<tr>
<td>Teacher I</td>
<td>make students accountable</td>
</tr>
<tr>
<td>Teacher J</td>
<td>tutoring, moral support</td>
</tr>
<tr>
<td>Teacher K</td>
<td>small successes</td>
</tr>
<tr>
<td>Teacher L</td>
<td>small successes, moral support, partners</td>
</tr>
<tr>
<td>Teacher M</td>
<td>stress relief techniques</td>
</tr>
<tr>
<td>Teacher N</td>
<td>create safe climate</td>
</tr>
<tr>
<td>Teacher O</td>
<td>moral support</td>
</tr>
</tbody>
</table>

As mentioned, which combinations of strategies participating teachers found to be beneficial in reducing anxiety and raising achievement with students was of most interest. Teacher F reported giving “more guided attention and often limited or adapted problems to be completed,” whereas Teacher H mentioned that “the number one thing that students with anxiety
need is to have some immediate success. I worked with her encouraging her step by step until she had a small success and then built on that.” Likewise, Teacher J felt that telling a “student that if she had a problem or a question to give me a signal and then I would come back to her seat and she could ask me privately” and Teacher L found that it was important to ask a student a “meaningful but easier question when it is their turn in class,” because it was equally important to “let them know in advance when it will be their turn to answer a question.” Teacher L also believed in “giving lots of praise for each small step they succeed at to better help build their mathematics confidence.” Each of these teachers found strategies to not only help students meet academic expectations, but also personally find a way to succeed without looking inferior.

What Do You Do To Help Students Maintain Academic Progress?

Question 12 of the interview was created to determine what strategies participating teachers implemented to help students maintain academic progress. All the participating teachers reported using strategies that fell into one or more of the following three categories of responses: peer interaction, teacher-student interaction, and academic modification. The peer interaction category included peer tutoring, group work, and the creation of a team and safe climate. Teacher-student interactions included building confidence and stressing perseverance, offering assistance and individual conferences, and tracking mastery. The academic modifications category was comprised of strategies such as the use of modified assignments, spiral reviews, manipulatives, mnemonics, allowing redo work opportunities, and organization strategies. Figure 4.13 shows the distribution of strategies participating teachers used to maintain academic progress for those students with mathematics anxiety.
While allowing students to use a peer tutor or ask a friend was the most mentioned strategy implemented by teachers to maintain academic progress, the other peer interaction strategies were reported as equally as much as certain teacher-student interaction and academic modification strategies. With the large variety of responses, the conclusion was drawn that teachers were willing to try and use many different strategies for students to maintain academic progress. In order to determine if teachers were implementing strategies across different categories, Table 4.14 was created, which lists strategies used to maintain academic progress of students according to each participating teacher.
Table 4.14

Specific Teachers’ Strategies to Maintain Academic Progress (N = 15)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Strategies to Maintain Academic Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>individual conferences, redo work opportunities, modified assignments</td>
</tr>
<tr>
<td>Teacher B</td>
<td>organization tactics</td>
</tr>
<tr>
<td>Teacher C</td>
<td>spiral review</td>
</tr>
<tr>
<td>Teacher D</td>
<td>peer tutor or ask a friend</td>
</tr>
<tr>
<td>Teacher E</td>
<td>peer tutor or ask a friend, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher F</td>
<td>peer tutor or ask a friend, spiral review</td>
</tr>
<tr>
<td>Teacher G</td>
<td>tracking mastery</td>
</tr>
<tr>
<td>Teacher H</td>
<td>redo work opportunities</td>
</tr>
<tr>
<td>Teacher I</td>
<td>build confidence</td>
</tr>
<tr>
<td>Teacher J</td>
<td>peer tutor or ask a friend, offer teacher assistance</td>
</tr>
<tr>
<td>Teacher K</td>
<td>team atmosphere</td>
</tr>
<tr>
<td>Teacher L</td>
<td>peer tutor or ask a friend, group work, organization tactics, mnemonics,</td>
</tr>
<tr>
<td></td>
<td>manipulatives</td>
</tr>
<tr>
<td>Teacher M</td>
<td>safe climate, build confidence</td>
</tr>
<tr>
<td>Teacher N</td>
<td>perseverance</td>
</tr>
<tr>
<td>Teacher O</td>
<td>build confidence, individual conference</td>
</tr>
</tbody>
</table>

Six of the 15 teachers reported using two different categories of strategies to maintain academic progress. Teacher L listed the most strategies used to maintain academic progress. Encompassing two of the three categories, peer interaction and academic modifications, Teacher
L reported using “graphic organizers, mnemonic devices, cooperative learning, team work, tutors, and hands-on manipulatives” to help students maintain their own progress. Teacher A uses peer interaction and academic modifications by stating the following:

I give students a chance to re-do classwork, homework, and even tests. This gives them a chance to come back to the problems when they had a refreshed head and try again. I have also given fewer problems to the student to keep them from feeling overwhelmed, and I will meet with the student individually to discuss their progress and goals so they see that I want them to succeed.

Teacher K only utilized the team atmosphere strategy and commented, “I believe in the ‘I do one, we do one, and you do one’ strategy,” while Teacher M listed safe climate and build their confidence as strategies by replying, “I have made a safe community environment. I have relieved students’ stress through mindfulness. I have increased student confidence by positive reinforcement.” It appears that these two teachers have not branched out to address other positive strategy needs for anxious students.

How Do Anxious Students Respond to Strategies Used to Maintain Academic Progress?

Question 13 of the interview was created to determine to what degree the strategies used to maintain academic progress improved the participating teachers’ students. After analyzing results from Question 13, four types of responses were identified that had an impact on either academic performance or student behavior. As noted in Figure 4.14, teachers found that academic performance was positively impacted in terms of increased academic performance or through increased participation. Likewise, behavior was positively impacted by students exhibiting more positive behaviors and more positive attitudes.
Nine teachers reported Increased Academic Performance and seven reported More Positive Attitudes; however, three teachers included both of these impacts in their responses. Teachers who mentioned Increased Academic Performance commented on receiving higher grades, applying previous knowledge to current content, excelling, and responding well to multiple strategies. More Positive Behaviors was the least mentioned impact, but both teachers who included this impact mentioned another academic impact as well. Table 4.15 lists the resulting effects on students from using the participating teachers’ strategies of academic progress.
Table 4.15

Specific Teachers' Student Results of Academic Progress Strategies ($N = 15$)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Results of Academic Progress Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher A</td>
<td>increased participation, increased academic performance, more positive attitudes</td>
</tr>
<tr>
<td>Teacher B</td>
<td>increased academic performance</td>
</tr>
<tr>
<td>Teacher C</td>
<td>increased academic performance, more positive attitudes</td>
</tr>
<tr>
<td>Teacher D</td>
<td>increased academic performance</td>
</tr>
<tr>
<td>Teacher E</td>
<td>increased academic performance, more positive behaviors</td>
</tr>
<tr>
<td>Teacher F</td>
<td>increased participation</td>
</tr>
<tr>
<td>Teacher G</td>
<td>more positive attitudes</td>
</tr>
<tr>
<td>Teacher H</td>
<td>more positive attitudes</td>
</tr>
<tr>
<td>Teacher I</td>
<td>increased participation</td>
</tr>
<tr>
<td>Teacher J</td>
<td>more positive attitudes</td>
</tr>
<tr>
<td>Teacher K</td>
<td>increased academic performance</td>
</tr>
<tr>
<td>Teacher L</td>
<td>increased academic performance</td>
</tr>
<tr>
<td>Teacher M</td>
<td>more positive attitudes, more positive behaviors</td>
</tr>
<tr>
<td>Teacher N</td>
<td>increased academic performance</td>
</tr>
<tr>
<td>Teacher O</td>
<td>increased academic performance, more positive attitudes</td>
</tr>
</tbody>
</table>
All 15 participating teachers reported some form of positive success after the implementation of academic progress strategies. Five of the participating teachers reported seeing more than one positive impact resulting from the academic progress, including impacts from both the academic and behavioral performance categories. Teacher C commented,

Using the spiral review with the student whom I employed the buddy for class, this student was able to have his buddy answer most of the questions without having to ask me for much. It was like he was assessing his own knowledge and correcting his mistakes. He was more confident and excelled better than before.

Similarly, Teacher A reported, “the grade became somewhat higher, his attitude improved to the point that he no longer verbally stated how he disliked mathematics, and he became more willing to participate in class discussions.”

**What Do You Do to Gain Student Feedback From Your Class?**

Question 15 of the interview was created to determine what participating teachers implemented into their classrooms as a means of attaining academic and personal feedback. Callahan (1971) reported that opportunities to track growth and reflection took special consideration because these time frames could be motivational or disastrous for student learning and understanding. He noted that students should take part in keeping up with their progress, such as tracking progress and setting goals. Three emerging patterns were found in participating teachers’ responses. The first group was those that did not use journals but used another form of communication to assess feedback. The second group used journals, which were not effective for all students. The third group used journals successfully for reflection. Figure 4.15 shows the distribution of communication strategies that participating teachers used within their classroom to communicate with students regarding their progress.
The most common response was that teachers do not use journals. While Beilock (2014) found that the achievement gap between those with high and low anxiety was reduced through journal writing, the participating teachers disagreed. The most common form of assessing feedback without the use of journals was open communication. Whether teachers questioned the whole class or students individually, verbal affirmations were the most commonly used form of communication. Very few teachers used journals with success, but a few responses mentioned that the journals were primarily used for tracking data and not expressing their feelings. To look more specifically at participating teachers’ communication method of attaining feedback, Table 4.16 was created, showing the different types of feedback that participating teachers allow students to give in their mathematics class.
Of the 15 participating teachers, 12 mentioned that they did not use journals; however, 11 of those teachers provided an alternate means of assessing feedback with seven of those teachers reporting that their classroom environments fostered open communication. Teacher C reported, “I hope that students are comfortable enough in my classroom environment to speak their mind
and raise any concerns they might have with the class.” Teacher D replied, “I keep open 
communication in my classroom. I let them know at the beginning of the year that the only way 
I know what they think is if they tell me.” Teacher E answered, “I have used journals, but 
middle school students normally aren’t shy about sharing their feelings so we usually sum up our day at the end of class with a simple round robin of questions to see who knows the material and who doesn’t.” Only three of the 15 reported any success with journals. Teacher F commented, “The students were encouraged to write the difficulties noticed and how these difficulties were resolved. Half of the students responded positively to the journal, and the other half did not because they did not see the relevance in setting or making goals.” On the other hand, Teacher J found them beneficial by stating the following:

Students must answer 2 questions at the end of every lesson that sums up their understanding. Students are told before they start answering questions that if they cannot teach the skill to others, they do not fully understand the concept, and then they must answer to me why they do not understand. This keeps them accountable and aware of how much they know.

While the semi-structured interviews sought to gather the most data on which best practices teachers believed aided in the alleviation of mathematics anxiety, further explanation was sought to explain why these best practices worked for certain teachers. Observations were set up with three participating teachers, expressing their beliefs that certain best practices are more influential over others. Likewise, student data were collected on students labeled as mathematics anxious to further show whether or not the best practices had any effect on the anxiety and performance levels of students.
Presentation of Findings: Observation and Data Collection of Teacher A

Successful Best Practices

Teacher A has taught sixth grade mathematics for the past 24 years. She defined mathematics anxiety as a shutting down type of behavior, a refusal to answer, and the constant complaining nature that she hears in her mathematics class. During the interview, Teacher A listed using best practices strategies that fell into the environment, instruction, and growth and reflection categories. As pertaining to the environment, Teacher A mentioned that her students fear tests and are unable to concentrate due to learning gaps. For this reason, she encourages students to talk to each other, ask for help often, and employ multiple strategies for solving problems. This ensures that no one is afraid or embarrassed to make mistakes; moreover, the use of jokes, cartoons, and silly games keep the environment light and positive. With regards to instructional best practices, the class sticks to a structured and simple routine of reviewing the previous lesson, guiding the students through a new lesson, and finishing with independent practice; however, there are times for games to help students understand more efficiently. Group work is rarely used since she has found that most anxious students shy away from participating while a small margin actually join in the conversation during group work. To ensure that every day flows smoothly with few issues, Teacher A makes sure to go over expectations early and consistently reinforce those strategies for behavior and academics. As always, Teacher A has created a classroom environment that is also a safe place to ask for help. In order to grow her students, Teacher A keeps the students with mathematics anxiety in mind by providing modified assignments and preferential seating to those that lack motivation and have had bad experiences with mathematics in the past. Since she prefers the use of verbal affirmations instead of journaling to communicate with students, Teacher A uses individual conferencing and redo work
opportunities which have allowed the most anxious of students to show increases in participation and academic performance while showing a more positive attitude in the classroom. The researcher was most interested in seeing these best practices in action to see how the anxious students respond to the best practices and how the teacher responds to those responses from the students, either positively or negatively.

**Behavior Observed**

Student A, a 12-year-old girl with little confidence and a fear of being wrong from a conversation with Teacher A was identified before the observation. After observing this student during the teacher’s group time period, Student A was observed working well with two other students. After group work, Teacher A went over the answers and Student A had only missed one from the entire worksheet; moreover, Student A had finished the entire worksheet in the time frame allotted for group work. The next section of the lesson was the teacher’s guided lesson where she introduced a new concept, subtracting mixed fractions with unlike denominators. The teacher modeled the first question and then asked for volunteers for the second problem. Student A eagerly raised her hand, but she was not called on. By the third question, Student A eagerly raised her hand again and was called on to answer the problem step-by-step. She appeared confident in her answers, even when the teacher would ask her why she chose a particular vocabulary word or method. She correctly explained each detail of the problem for the class.

**Data Collection**

After the observation, another conversation was made with Teacher A and specific questions about Student A were asked. Teacher A described Student A as a student who started out the school year with little confidence and a fear of being wrong. She started the year afraid to raise her hand, answer out loud, or participate in group work. Her mathematics grade during
the first nine-weeks grading period was a C average. Student A was not performing at a level the teacher knew she was capable. By the time of this observation, a mere five months later, Student A was working well in groups, sometimes leading the group into solving problems, raising her hand frequently, and showing increased confidence in her ability. By January, Student A had gone from a C average to a B average. The teacher predicted that she would be an A student by the end of the year.

**Presentation of Findings: Observation and Data Collection of Teacher C**

**Successful Best Practices**

Teacher C has taught either seventh or eighth grade mathematics for the past six years. He defined mathematics anxiety as the presence of a lack of effort because the student feels overwhelmed. During the interview with Teacher C, he mentioned using best practices strategies that fell into the environment, instruction, and growth and reflection categories. In regards to the environment, Teacher C found that students stress the most when they encounter more abstract concepts that require a different way of thinking to solve problems; consequently, he has found that building relationships, enacting a social contract, and creating a team atmosphere are the keys to creating an atmosphere most beneficial to learning. In order to help keep students from losing interest in lessons, he has used funny class openers and additions to the class that allow students to laugh and see the lighter side of mathematics. As far as instructional best practices are concerned, Teacher C sticks to a fairly simple and consistent daily schedule of reviewing the previous day, working through a guided lesson, and finishing with independent practice. Group work is frequently used during the guided lesson which allows anxious students to build relationships and work safely. Academic and social behaviors are consistently monitored starting from the first week of school by going over expectations and posting the daily agenda on the
board. In order to consistently monitor student growth and progress in the face of many students with varying degrees of learning gaps, Teacher C frequently uses spiral reviews and partners to give students a chance to revisit previously learned material with a friend in order to answer any misunderstandings in private. Since Teacher C uses verbal affirmations as opposed to journals to hear feedback from students, the use of such strategies has allowed the most anxious students to increase their academic performance and show off more positive attitudes in the mathematics classroom. The researcher was most interested in seeing these best practices in action to see how the anxious students respond to the best practices and how the teacher responds to those responses from the students, either positively or negatively.

**Behavior Observed**

Student C, a 14 year old boy with little confidence, a learning gap, mild behavior issues, and a tendency of being off task and disrupting others were identified from a conversation with Teacher C. After observing this student during the teacher’s reviewing of a test, Student C was observed sitting with two other students, each doing different things. One student was working independently on the review, one student was off task, and Student C appeared to be listening to the review, but not writing anything down. Teacher C went over each question of the review and asked for volunteers. If the student he called on missed the problem, Student C would frequently blurt out correct answers, unheard by the teacher. Student C would become frustrated when the teacher would not call on him, but Student C would continue to raise his hand and blurt out correct answers. The next section of the lesson was group work over problems that would be seen on the test covering the methods of substitution and elimination to solve systems of equations. The teacher walked around the room while students re-grouped with other students. The classroom was very informal, with students frequently yelling out questions or answers.
Student C had been absent when this worksheet for group time was started, so he started looking for someone to work with that had been present when the worksheet was initially distributed. Since the researcher was sitting with Student C and two other students, the researcher would occasionally help keep him on track. Even the two other students would ask the researcher questions since the teacher was busy helping other groups. After a few prompting questions, Student C was able to accurately set up and solve systems on his own. He would occasionally ask questions, but the teacher and researcher were able to keep him on task to finish the problems.

**Data Collection**

After the observation, another conversation was had with Teacher C and specific questions were asked about Student C. Teacher C described Student C as a student who started out the school year with little confidence, a learning gap, mild behavior issues, and a tendency of being off task and disrupting others. He began the year very disruptive, always blurting out and trying to be funny. His mathematics grade the first nine-weeks was a D average, slightly higher than his grade by the end of seventh grade, which was an F. Student C seemed to have potential to do the work, but he was not motivated to perform at his potential. By the time of this observation five months later, Student C had been allowed to work with a buddy during every mathematics lesson or group work activity. He was working better in groups, when he had the chance to pick his buddy, showing an increase in mathematical knowledge through either raising his hand to answer questions or through his blurting of correct answers. When he was called on, he appeared more confident in his ability. By January, Student C had gone from a D average to a C average. While Student C was not where the Teacher C thought he should be performing, he predicted that Student C should at least be a B average student by the end of the year.
Presentation of Findings: Observation and Data Collection of Teacher L

Successful Best Practices

Teacher L has taught sixth grade mathematics for the past six years. She defined mathematics anxiety as fear, either of failing or to try. This fear is inflated due to a weak background in mathematics, which can result in a student’s tendency to shut down and or unwillingness to continue trying. During the interview, Teacher L mentioned using best practices strategies that fell into the environment, instruction, and growth and reflection categories. When looking at best practices in regard to the environment, Teacher L commented that many of her anxious students are merely anxious due to learning gaps; therefore, she teaches her students to constantly ask questions until they reach understanding of the problem and to never be afraid to ask for more individualized help. To keep the environment light and positive, she consistently monitors and models expected behaviors and slips in funny stories about her past challenges in mathematics. As far as instructional best practices go, her daily mathematics classes stick to the typical routine of reviewing the previous day’s lesson, leading the class through a guided lesson covering new material, and finishing the class period with group work and independent practice. During group time, partners or groups frequently use manipulatives, activities, and real life examples to allow the more anxious students to work safely. Students are safe in their endeavors due to the fact that Teacher L goes over the required expectations the first week of school and those expectations are consistently monitored and upheld. Teacher L found that while many of her students are scared of mathematics, she helps them gain confidence by praising their small successes and giving them encouragement along the journey. In order to monitor growth and allow students to track their progress, Teacher L found that journals were not the best idea because her students were comfortable enough to share their feelings and frustrations verbally.
Teacher L enlisted the help of peer tutors, organization tactics, mnemonics, manipulatives, and lots of group work which allowed her anxious students to increase their academic performance. The researcher was most interested in seeing these best practices in action to see how the anxious students respond to the best practices and how the teacher responds to those responses from the students, either positively or negatively.

**Behavior Observed**

Student L, a 12 year old girl with little confidence, a learning gap, a constant need for validation, and many emotional issues with mathematics anxiety was identified after speaking with Teacher L. After observing this student during the teacher’s Five-A-Day review session, Student L was observed working well for a few minutes before raising her hand to ask the teacher if she was doing the problem correctly. After a few more minutes, she would raise her hand again, asking the teacher the same question. When the student got to the third question, she appeared confused, so she pulled out a book and started reading. When the teacher was making her rounds around the students, she stopped by Student L and quietly asked her why she was reading, the student responded that she did not know how to work the problem. Consequently, Teacher L told her that reading would not help her answer it the student put the book away and begin asking the teacher for assistance. Student L started working on the assignment for a few minutes before raising her hand and asking for clarification on the remaining two questions. Teacher L asked for volunteers to go over the problems with the class, and Student L appeared very confident when she raised her hand. When she was not called on, she immediately pulled her book out.

Specific best practices identified during the observation encompassed environmental, instructional, and interpersonal strategies concentrating on student growth. The only
instructional best practice identified included the use of a spiral review segment of class that allowed students to practice concepts in a differentiated manner. Specific environmental best practices observed towards Student L included modeling of expected behaviors and offering assistance for clarity. Student growth and reflection best practices observed included building relationships through encouraging and showing respect. When Student L was given one-on-one attention, the use of these best practices positively affected the amount of participation and correct answers she gave. Unfortunately, when Student L was not given enough one-on-one attention or addressed quickly enough, she tended to give up and go off task. Teacher L’s specific best practices worked on Student L to an extent, but Student L’s lack of motivation held her back and she sustained a small learning gap. Overall, Teacher L’s implementation of best practices positively impacted Student L’s behavior and academic standing.

Data Collection

After the observation, a second conversation with Teacher L was made to ask specific questions about Student L. Teacher L described Student L as a student who started out the school year with little confidence, a learning gap, a constant need for validation, and many emotional issues related to mathematics anxiety. Emotional issues consisted of appearing nervous, embarrassed, fearful of being wrong and going to the board in front of people. This nervousness would cause her to ask to get water or go to the bathroom quite frequently. She began the year afraid to have the teacher very far away from her. Her mathematics grade during the first nine-weeks grading period was a B average. Her grade was this good because she would not stop until she had the answers perfect; however, the amount of time she spent working on tests, quizzes, and classwork meant that she occasionally did not get finished. Her abundance of questions and second guessing meant that she had to leave questions blank a lot. By the time of
this observation five months later, Student L continued to have issues with validation. She was constantly raising her hand and asking questions, but she was mastering the material. Her one drawback was that when she was not called on to work a problem out, she would stop listening and do something else. This had the potential to make her fall behind since she was off task. By January, Student L had maintained her B average due to still not being able to complete tests and assignments and frequently being off task when not called upon. While Teacher L felt this student could easily be an A student, she predicted that this student would maintain this B average if not fall if Student L did not learn to trust her knowledge, stop second guessing herself, and stop doing off task behaviors.

Discussion

The interviews gave an opportunity to discover which teacher best practices participating teachers believed were most successful for use within their classrooms. Teacher-specified best practices fit into either strategies for the environment, instruction, or periods of growth and reflection. By analyzing responses from interviews with practicing teachers, various strategies were identified. The study revealed that regardless of gender, years of experiences, or grade level taught, there are best practices that have been proven to be successful in alleviating mathematics anxiety among students when implemented. Male participants typically agreed with female teachers on how they address general, visible signs of anxiety, what stresses students the most, what humor is used in the classroom, a daily routine, and how expectations were relayed to the students; however, one general difference appeared in what male and female participating teachers believed to be effective classroom elements that relieve anxiety: all the male participants gave strategies that exclusively targeted building relationships, while the female participants suggested maintaining an effective and consistent classroom in addition to
building relationships helped relieve anxiety among students. Another difference between the male and female participants was the type of instructional strategies they use to reduce anxiety. While all the males mention an average of 1.3 strategies, the females used an average of 2.6 strategies with the most mentioned number of strategies was five for females and two for males. Both the male and female participants disagreed on the effectiveness of group work on anxiety with the wide variety of responses. Moreover, there were not any major differences in responses between participating teachers with regard to years of experience and grade level most taught.

**Summary**

Throughout this qualitative study, the researcher identified the best teacher practices that teachers believe are most effective in the alleviation of mathematics anxiety. The three main categories of best practices identified dealt with the environment, instruction, and periods of growth and reflection. Analysis found that each category had various themes. As pertaining to the environment, the following themes were discovered: addressing students’ anxiety, addressing the students’ ability, building relationships, maintaining an effective and consistent classroom, and adding the element of humor. When discussing a teacher’s instructional strategies, the following themes were found: daily routine and expectations, teacher provided assistance, lesson additions, student provided assistance, and self-regulating strategies. Lastly, the period of growth and reflection category addressed internal and academic obstacles, giving academic modification, giving peer interaction and teacher-student interaction, and giving students an opportunity to give feedback during class were common themes addressed. The participating teachers detailed strategies that worked in their classrooms to relieve students of their mathematics anxieties. Chapter Five will discuss recommendations and implications of this study on students who exhibit symptoms of mathematics anxiety.
CHAPTER FIVE
CONCLUSIONS

The purpose of this study was to design a theoretical framework outlining teacher best practices that effectively work towards alleviating mathematics anxiety. Finding positive learning experiences that increase student achievement and decrease mathematics anxiety was sought. The three main aspects of the results focused on the following characteristics:

1. Environment: Elements of the classroom environment include teacher and student attitudes, structure and organization of routines and the classroom, humor, and physical attributes of the classroom.
2. Instruction: The way a teacher instructs affects the way a student learns so instructional styles need to accommodate different types of learners and must include periods of time where students can practice multiple strategies and procedures.
3. Student Growth and Reflection: Teachers can implement classroom time to focus on a student’s growth and reflection through building relationships and holding individual conferences with students, in order to set and track goals and expectations.

Summary of the Study

A grounded theory method of research was used in this qualitative study to examine participant beliefs regarding which best practices work in the alleviation of mathematics anxiety in students. The study involved collecting data through semi-structured interviews with 15 participating teachers who provide mathematical instruction to students in grades six through 12. The interviews were recorded, transcribed, coded, and analyzed for emerging themes in the responses to the 15 questions. Additionally, student gradebook data and behavior logs were collected on three students during three observation settings. The responses gathered in this
study found that teacher best practices fell into three categories: classroom environment, instruction, and student growth and reflection. The following is a descriptive analysis of the findings related to responses from the interview questions that were used to answer the following research questions:

1. What best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety?

2. What best practices, concerning classroom instruction, do secondary teachers believe have a positive impact on reducing mathematics anxiety?

3. What best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety?

Findings

Research Question 1

To answer the first research question, what best practices, concerning the environment of the classroom, do secondary teachers believe have a positive impact on reducing mathematics anxiety, the first step was to assess participating teachers’ knowledge about the signs and symptoms of mathematics anxiety as it appeared in their classrooms. Responses from the participants found that teachers are aware of the signs of mathematics anxiety in their classrooms. Anxiety signs and symptoms noted by participating teachers ranged from simply not doing anything to more overt and negative reactions such as exhibiting disruptive behavior, acting angry, complaining, and performing poorly on assessments. Teachers also acknowledged that students seemed to display anxiety in responses to several factors, including embarrassment, high expectations set by others, and more devastating reasons like learning gaps. With this acknowledgement, the findings unfolded that teachers implemented the following environmental
best practices: addressing student anxiety, addressing student ability, building relationships, maintaining an effective and consistent classroom, and adding the element of humor to the classroom.

**Addressing student anxiety.** Of the 15 teachers interviewed, 14, mentioned directly addressing a student’s anxiety as a practice for alleviating that student’s mathematics anxiety. This practice is exemplified through various best practices such as giving praise to students, finding a means of external or internal motivation, comforting their fears, and building their confidence to help students ease their anxieties. Other best practices included creating a safe climate and introducing stress relieving techniques to make students feel a bit more at ease. Seven of the 15 teachers commented that simply talking to the students helped calm any fears or anxieties about homework or tests that students experienced. Regardless of the practice, each best practice targeted dealing with the anxiety to get students through their struggles.

**Addressing student ability.** Addressing a student’s abilities and difficulties within the classroom was noted to be an important practice in alleviating their anxiety towards mathematics. Of the 15 teachers interviewed, ten believed that if a student’s academic issues are resolved, they will feel better about the concepts. Best practices used by teachers included offering tutoring to students before and after school, one-on-one instruction in class, offering multiple strategies to solve problems, or offering other types of assistance from the teacher such as answering questions, giving hints, or validating work for those students who are afraid of being wrong. These practices primarily focused on resolving academic issues rather than the anxieties themselves so as to prevent anxieties from forming in the first place and encourage positive student growth.
**Building relationships.** All but one of the teachers interviewed mentioned that building relationships was an important factor in the alleviation of a student’s mathematics anxiety. These teachers believed that if the relationships were positive, students would be more comfortable to learn and share their successes and failures. Among the best practices for building relationships mentioned, making sure everyone in their classroom respected each other, ensuring that no one was afraid to fail, and seeing to it that students feel valued were all noted to be of importance. It was also noted that creating a team atmosphere was critical in building relationships because students could learn to trust in other when they were given the opportunity to work as a team. Using social contracts within their classrooms was another method that teachers used to build relationship among their students and with themselves as a teacher. Trust, several interviewees mentioned, can be built through active listening, so when teachers take an interest in their students, it shows the students who their teachers care. These best practices help students realize that when faced with struggles, it can sometimes be beneficial to turn to others for support.

**Maintaining an effective and consistent classroom.** Aside from the general day-to-day classroom routine, making sure teachers maintain an effective and consistent classroom for learning and behaving was noted as a critical component for success. Of the best practices noted to help maintain an effective and consistent classroom was the modeling expected behavior, both socially and procedurally. Likewise, displaying student work and allowing students to help decorate the classroom was shown to give students a sense of pride and ownership, which aided in their increased level of comfort in their surroundings. Other teachers allowed students flexibility to move around the room, whether it was while working in stations or completing investigation activities. Overall, these best practices give aim at using consistent means to help students stay structured and not feel bombarded with chaos.
Adding the element of humor. Every teacher interviewed reported using some form of humor in their classrooms as a practice to alleviate a student’s mathematical anxiety. While not at the forefront of instruction, all practices mentioned were used as a means of giving students a break or allowing them to see the lighter side of mathematics. Six of the fifteen teachers commented that they used spontaneous humor in their classroom, which looked like using a funny opener to introduce the class to a new concept or using a story about the teacher’s past as it related to their experiences with mathematics. When teachers tell personal stories about their bad experiences, failures, and struggles with mathematics, they become more relatable to the students. Purposefully building humor into every day routines with the use of jokes or cartoons and teaching students funny mnemonics or other strategies for memorizing mathematical procedures.

Of all the environmental best practices reported, the following three practices were mentioned by at least ten of the participating teachers: adding humor (jokes) that is built into the lesson, addressing anxiety issues early in the year (social contracts, teaching respect), and taking time to build relationships. These teacher reported best practices contained a common theme of interest. Each of these best practices focus on making students feel safe. No matter the practice that teachers try to implement, when a teacher uses best practices that focus on making students feel safe, valued, and respected, student anxieties are lessened.

Research Question 2

To answer the second research question, what best practices, concerning classroom instruction, do secondary teacher believe have a positive impact on reducing mathematics anxiety, what participating teachers included in their daily routines, how they provided assistance to students, what additions they made to their lessons, and the types of self-regulating strategies
they taught the students were analyzed. Responses from the participants indicated that teachers spent their first week of each school year focused on procedures and expectations by posting agendas and objectives on the board as a means of keeping students updated and aware of how the classroom procedures were run. While responses were consistent with regards to teaching expectations, participating teacher differed in their viewed related to the inclusion of group work as an instructional strategy for improving the anxiety of students. Even though some teachers felt that group work allowed students to work together and feel safe, others found that anxious students had inconsistent work habit when asked to work in groups. Teachers also acknowledged that students seemed to stress over various factors such as embarrassment, high expectations, and more devastating reasons like learning gaps. With this knowledge, the results shown that teachers implemented the following instructional best practices: a daily routine, teacher and student provided assistance, lesson additions, and self-regulating strategies.

**Daily routine.** All 15 of the teachers reported using a daily routine as a means of keeping structure in the classroom. Best practices throughout the daily routine are used as a means of allowing students multiple chances of review and practice to learn concepts. All daily routines begin with an introduction type session. One such best practice used during this time includes a class opener type question, sometimes referred to as a daily warm up or entrance ticket. Another practice is checking homework. The most commonly used best practice, mentioned by ten of the participants, included reviewing the previous day’s concept. All 15 teachers reported that the middle of the class was reserved for the guided lesson of the day. Strategies for instruction included lectures, discovery methods, and class discussion. The last part of the class was typically devoted to practice, which included independent, partner, and group practice. Nine teachers mentioned independent practice as the best means of helping
students feel better about the concepts while other teachers believed independent practice to be futile for anxious students. Anxious students need to be granted opportunities to seek help from positive and friendly sources. These teachers found best practices were to give students many opportunities to ask questions, review what they have learned, and ask for help to monitor and assess their own learning.

**Teacher and student provided assistance.** Of the 15 participating teachers, \((n = 6)\), reported providing anxious students with assistance through teacher or peer intervention. These best practices have been used by teachers as a means of relieving a student of his or her anxiety. When asked to clarify what teacher provided assistance looked like, respondents said they would give students pre-made lesson notes or a study guide, which would help students from becoming overwhelmed with a lot of content at once. Further assistance mentioned was walking around the home and offering help to students as needed. More than half of the teachers surveyed \((n = 8)\), commented that partners and groups helped ease students’ anxieties because sometimes a different voice explaining what to do helped smooth over any misunderstandings a student had about concepts. When anxious students do not understand what the teacher is saying, a peer can speak in a language the student understands. These best practices targeted students’ anxiety by providing anxious students an opportunity to achieve academically.

**Lesson additions.** Nearly half of the teachers interviewed \((n = 7)\) reported using games, manipulatives, and/or activities during their daily routines as a means of helping students learn concepts in a positive environment. Teachers used homemade games, board games, and activities such as “I Have, Who Has” to review and practice mathematics skills and concepts. Commonly mentioned manipulatives included algebra tiles, geometry shapes, and equation scales to balance equations. Six of the fifteen teachers mentioned providing lots of examples,
multiple strategies, and differentiation opportunities as a means of helping students stay on level with the content. Differentiation opportunities allowed students to work on problems at their level and progress to a more challenging set of problems. Scaffolding is a similar practice where teachers prepare students to progress without much assistance from the teacher or other students. These best practices were used by teachers as a means of implementing creative and helpful additions to the lesson to give anxious students a chance to experience the concepts in different situations and at different levels of understandings.

**Self-regulating strategies.** Teachers reported three types of regulating strategies for relieving stress: address the mathematics problem, address the anxiety, and seek for help. The majority of teachers interviewed (n = 12) addressed student anxiety by teaching students self-regulating strategies aimed at regulating students’ own stress in a positive manner while working through mathematics problems. To do this, teachers encouraged their students to approach mathematics problems in a more relaxed manner by using stress relieving techniques such as breathing and relaxing. Once the students began a problem, teachers taught students to take good notes throughout new lessons, use multiple strategies to solve the problems, and to break the problem into smaller steps to make the problem easier to conceptualize. Several teachers mentioned the use of mnemonics as a way of helping students learn procedures for mathematics problems and by creating relatable real life situations out of problems.

About one-third of the teachers (n = 4) taught self-regulating strategies to students who specifically addressed their anxiety about the mathematics itself. These best practices included creating a safe environment for making mistakes and stressing the importance of relaxing because everyone makes mistakes. In order to do this, students must feel that the teacher and fellow classmates will not judge them based on their mistakes. A classroom taught to critique
positively will aid in the student’s journey of alleviating his/her own anxieties; however, the teacher must, first and foremost, set the stage for the safe environment by modeling expecting behavior and consistently enforcing the desired behavior.

Allowing opportunities for relationship building was another best practice used by roughly half of the teachers interviewed. Of the 15 teachers interviewed, seven taught students to seek help when they needed help. Another best practice that teachers employed was allowing opportunities for students to build relationships. When students had someone they trusted in the room, they were more apt to ask for help. These self-regulating strategies aimed at teaching students to ask for help and ask questions when confused. These practices become easier to implement when students have opportunities to build relationships with students within the classroom.

Of all the instructional best practices reported, the following three practices were mentioned by at least ten of the participating teachers: maintaining a daily routine, adding supporting additions to lessons, and using self-regulating strategies. These teacher reported best practices contained a common theme. Each of these best practices focus on adding elements where students can have routine and options for learning at different rates. When teachers add a supporting element to a lesson, those additions need to allow students to work through procedures, connecting to what they have already learned.

Research Question 3

When analyzing responses to the third research question, what best practices, concerning student growth and reflection, do secondary teachers believe have a positive impact on reducing mathematics anxiety, responses from the participants found that most teachers did not rely on the use of journaling in mathematics class as a means of reflection because of the age group of their
students. While only one teacher claimed that it worked for her students, the remaining teachers expressed that this age group of students were usually not afraid to speak their minds when it came to talking about the classroom. These teachers relied heavily on verbal affirmations, polls, or quick surveys. When strategies were implemented to help students maintain academic progress, teachers reported an increase in participation, more positive attitudes and behaviors, and an increase in academic performance. With this information, the period of time for growth and reflection could be addressed with the following best practices: addressing internal and academic obstacles, giving academic modifications, giving time for peer interactions, and giving time for teacher-student interactions.

**Addressing internal and academic obstacles.** Of the 15 teachers interviewed, 10 indicated that their students stressed over internal obstacles, which the teacher then had to address. These internal obstacles included a lack of motivation, inability to handle stress, scared, little confidence, and expectations that were too high. Conversely, 10 teachers reported that students stressed over academic obstacles, which were more difficult for teachers to guide students through because they resulted from previous bad experiences in mathematics that led to the students’ gap in mathematical knowledge. In order to address these obstacles, two teachers reported implementing changes to address the underlying internal obstacles that incited current academic deficits, while six teachers reported implementing changes focused solely on academic obstacles. Best practices for overcoming internal obstacles included creating a safe climate and teaching stress reliving techniques. Best practices for overcoming academic obstacles included getting to know each student, providing students with a buddy or partner, and making students accountable during group work. These best practices served to help the teacher assess where a student was coming from and where they will be headed during the course of time the student is
with that teacher.

**Giving academic modifications.** Nearly all of the teachers interviewed ($n = 14$), claimed academic modifications successfully in ensured students made growth. These best practices included modifying assignments which allowed students to have small successes. When students experienced small successes, they were more apt to keep trying. When teachers were asked how to help students maintain their academic progress, teachers reported using organization tactics, mnemonics, manipulatives, and spiral review opportunities to help students achieve academically. Moreover, when students started making small successes and progresses towards academic goals, they saw how these techniques improved their learning and were more apt to continue with the modifications. Several teachers offered tutoring and re-do opportunities for students who did not succeed the first time on a concept. These best practices not only helped alleviate a student’s anxiety, but they helped students maintain their progress and track their own growth, while reflecting during re-do opportunities and spiral review, which is reviewing on previously learned material from early in the year.

**Giving time for peer interactions.** Nearly half of the teachers interviewed indicated that giving time for anxious students to interact with other peers was successful in helping these students maintain their academic progress through the use of peer tutors, friends to talk to, and group work. While teachers were split on whether group work was always successful, those teachers who tied accountability in with group work explained that group work allowed anxious students an opportunity to hear others express strategies for solving problems before speaking up and helping themselves. Other teachers created a team atmosphere and a safe climate to alleviate students’ mathematics anxieties. When students were taught how to work together and be respectful of others and their methods, students had an opportunity to learn from others with
different perspectives and backgrounds. These best practices strived to help students work with others to maintain their progress and reflect upon their own understandings.

**Giving time for teacher-student interactions.** Eight teachers reported taking a more one-on-one approach to tracking the growth of anxious students by teaching perseverance and building confidence in students. These practices required teachers to get to know their students on a more personal level. When students knew teachers cared about their progress, they tended to want to please the teacher. They worked longer to succeed and their confidence blossomed as a result of those successes. Only three teachers specifically mentioned tracking students’ mastery and holding individual conferences with students. During these individual meetings, teachers and students set goals, discussed expectations, talked over any problems the student was having, and praised any successes made from the last meeting. These best practices targeted monitoring anxious students’ academic activity and giving them a front row seat in setting their own goals and monitoring their own successes.

Of all the student growth and reflection best practices reported, the following two practices were mentioned by at least ten of the participating teachers: modifying assignments to allow students to make small gains and addressing academic obstacles (learning gaps and past bad experiences with mathematics) by building relationships. These teacher reported best practices contained a common theme as well. Each of these best practices focus on acknowledging that students come each new year with different backgrounds, level of knowledge, and experiences that must be taken into account individually. Getting to know students allows teachers to work on student confidence, motivation, and the gap in mathematics learning.
Best Practices in Action

During the interviews of teachers, Teacher A encouraged students to talk to each other, ask for help, and use multiple strategies for solving problems. Moreover, Teacher A used jokes, cartoons, and silly games to keep the environment lively. Since group work was rarely used, Teacher A stuck to many discussions and games to get students talking. Teacher A also provided modified assignments and preferential seating to those that lacked motivation, while holding individual conferences and re-do opportunities for students to allow them opportunities to increase their participation and academic performance.

During the interview, Teacher C focused a lot of time and attention on building relationships between the students and between the students and the teacher. A team atmosphere was beneficial to keeping students interesting in learning. Teacher C also used lots of funny class openers and additions to the lesson to allow students to see the lighter side of the mathematics concepts. While sticking with a pretty consistent daily schedule, group work was an integral part of every lesson, which made anxious students feel safe working with others. Spiral reviews and partner work were heavily relied upon to help students review previously learned material to increase their academic performance on cumulative assessments.

During the interview with Teacher L, Teacher L believed learning gaps were the culprit to low motivation and confidence in her mathematics classroom; therefore, she asked a lot of questions and taught her students to ask for help safely. Teacher L spent a lot of time teaching appropriate behavior for expected behavior during class time. She interjected funny stories about her past failures to encourage students to work hard and not give up. Her daily routine included time for groups, partners, and the use of activities and real life examples. Her frequent encouraging words and praise to low motivated students help keep anxious students persevering.
Teacher L frequently enlisted the help of peer tutors, mnemonics, manipulatives, and group work to help increase academic performance.

**Teacher A.** The observation of Teacher A took place during the middle of a group review over the concept of adding and subtracting mixed numbers. During the observation, the identified student with mathematics anxiety, Student A, appeared to thrive from the group time at the beginning of the observation. The student appeared alert, productive, and active in the group discussion. During the next phase of the observation time, Student A volunteered for every question. When called upon, Student A was able to accurately explain every step, answer the teacher’s questions, and find the final answer. Her confidence level appeared high, compared to what Teacher A reported in the post-observation. Over the course of the year, Teacher A handed over gradebook data and behavior records which showed Student A’s performance, attitude, and confidence levels had increased enormously. Group work had helped Student A find her confidence and voice in the classroom; moreover, Student A had been given modified assignments at the beginning of the year and was completing full assignments by the time of the observation. Clearly, Teacher A’s best practices had a positive impact on Student A.

**Teacher C.** The observation time took place in the middle of a group review for a test over solving systems of linear equations. During the observation, the identified student with mathematics anxiety, Student C, was in a group with two girls with his back to the board. While not writing down much, frequent blurtling of correct answers proved he was listening. During the test review, Teacher C asked several questions of the class, soliciting responses from volunteers, a position Student C eagerly raised his hand to fulfil. When not called upon, he would become agitated and upset, but he never stopped trying to answer. When asked, Student C could answer questions about various steps in the process of solving systems of equations. He appeared to be
all over the place during the review, sometimes working, sometimes talk, and sometimes staring off into space. It appeared he was not given enough one-on-one time with the teacher.

The student’s confidence level appeared to be high, even though Teacher C described the student as having little confidence. Through gradebook data and behavior logs, Student C began the year with mild behavior issues, a tendency to be off-task, and a habit of disrupting others, which Teacher A attributed to his learning gap. At the time of the observation, his D average had climbed to a C average. While Teacher C emphasized that this student needed to work one-on-one with another student, he was unable to find a partner who this student worked well with all the time. Student C’s potential was much higher than a C average student and his learning gap had clearly been closed due to Teacher C’s intervention strategy; however, during the observation, a partner was not clearly seen to be working with the student. Since it was noted that a partner was necessary to help this student find success this year, it appeared the instructional practices the teacher had used had positively benefited this student. To properly reduce this student’s anxiety even more, Teacher C needs to continue searching for the right partner for Student C.

**Teacher L.** The observation time took place at the beginning of a class period, devoted to a spiral review over various mathematics concepts. During the observation, the identified student with mathematics anxiety, Student L, was working well on her own for a few minutes before quickly raising her hand for the teacher to ask if she was doing the problem correctly. After a few more minutes, she raised her hand again to ask the teacher for more affirmation that she was doing the problem correctly. After a few of these repeated occurrences, the student appeared confused by the next question on her assignment, noticed that the teacher working with someone else, and pulled out a book to read rather than wait for the teacher’s attention. When
the teacher approached her and told her to put away the book, she also asked why she had given up. Student L indicated that she did not know how to start the problem and the teacher was too busy to help. After the teacher left her this last time, Student L raised her hand on the last two questions, simply to ask if she was correct. Student L never seemed to be really confused about how to work the problems; however, her dependence on affirmation of being correct was astounding. When the teacher asked for volunteers to work the problems out for the class, Student L appeared very confident; however, when not called upon, she lost interest and pulled her book back out.

When Teacher L was asked to gather gradebook and behavioral data and describe the progress Student L had made throughout the year, the teacher replied that this student had not made much progress from the beginning of the year. She continued to have little confidence in her abilities, a learning gap, a constant need for validation, and emotional issues with anxiety. Since Student L lost interest when the teacher did not call on her or help her, her learning gap continued to grow because she would stop paying attention. Group work had little effect on Student L, but she responded well to the frequent words of encouragement and praise the teacher gave her when she would ask if she was correct on a problem. While Teacher L’s feedback had positively affected Student L, other methods did not have a positive effect on her motivation in this class which hindered her ability to close the learning gap.

Conclusions

The researcher sought to find which best practices teachers believed were most influential in the alleviation of mathematics anxiety in students. Throughout the course of this research, three ideas continued to surface: changing the environment, changing instruction, and giving students time for growth and reflection. Through the combined strategies of these three ideas,
teachers found that anxiety issues were resolved or lessened.

**Environmental Best Strategies**

The following specific classroom environment changes were in mind with the beginning stages of research: lighting, temperature, seating arrangements, classroom breaks, and use of humor; however, these changes were found to be less important than those reported during the study. Participating teachers responded implementing environmental changes that fell into one or more of five emerging categories. When teachers addressed a student’s anxiety, they concentrated on giving praise, offering intrinsic and extrinsic motivation, building confidence, creating a safe climate where students could talk freely, practicing stress relief techniques, and talking to students on a personal level. Teachers also addressed students’ abilities by offering tutoring, showing multiple strategies for solving problems, and offering teacher assistance. According to the teachers in the study, building relationships was the key to keeping the environment positive. These practices included building trust with students, making students feel valued and unafraid, and teaching students to respect each other’s ideas and opinions. Teachers were able to keep this positive environment by maintaining an effective and consistent classroom through modeling expected behavior, decorating the classroom, and allowing movement throughout the classroom with structured transitions. The last environment element addressed adding element of humor to the classroom through the use of jokes, cartoons, funny class openers and additions to the lessons, and funny teacher stories.

While more focus was placed on physical changes to the classroom, the study found that teachers focused on the emotional aspect of environment by making the environment positive and addressing the anxiety itself. Hodges (1983) listed four emotional elements of learning within an environment: motivation, persistence, responsibility, and structure. This study echoed
the findings of Hodges in that participating teachers addressed the classroom learning environment by focusing on the emotional elements. Like studies before this one (Jackson & Leffingwell, 1999), this study found that teachers who took the most active role in reducing mathematical anxiety in the classroom were better able to increase student enjoyment and relay true learning of mathematics. Ultimately, it is the attitudes in the classroom that must be addressed before students are expected to work in the safest learning-centered environment.

**Instructional Best Practices**

The focus began on how instructors could address the needs of individual learners and found that individualized and constructivist methods were most beneficial to the success of students in mathematics. Also, the focus was placed on group work, project-based learning, and the following strategies to alleviate psychological stress: break tasks into smaller units, model appropriate attitudes, provide positive reinforcement, and set goals; however, the participating teacher responses were quite different. Participating teachers responded implementing instructional best practices that fell into one or more of four emerging categories. When teachers implemented a consistent daily routine that followed a similar format including an introduction, lesson, and practice, students felt the classroom was more organized and knew what to expect. Likewise, teachers provided students with assistance from either themselves or other students through the use of study guides, one-on-one assistance, peer tutoring, or participation in group work opportunities. The teachers also included lesson additions that allowed the use of games, manipulatives, activities, discovery methods, and differentiation to help them learn a concept in more detail. Lastly, teachers taught students how to self-regulate their own stress by using the following strategies: taking/using good notes, relaxing, using mnemonics, addressing the problem in a real world context, seeking help, asking questions, building relationships, and
keeping the environment safe with positive language.

While the focus was placed on more specific instructional strategies, the study found that teachers focused on supplemental practices to make any instructional strategy worthwhile. Bryan, Mathsur, and Sullivan (1996) found that the frame of mind that students have affect their processing speeds, memory capacity, and creative ability. Consequently, Fiore (1999) found that preparation and thought had to be taken into account when planning how lessons were delivered, which involves knowing what questions students are likely to have, what they might struggle with, and how they could react when frustrated and confused. While different instructional practices have their own positives and negatives, teachers must be willing to develop their practices and discover which practices are most beneficial for each individual student. Thus, the created list of best practices are not a cure all nor are they exhaustive; moreover, teachers need to be reminded that best practices emerge through experience and experimentation (Gill, 2013).

**Time for Reflection and Growth**

Prior to conducting the interviews with participating teachers, the research led the study to checking to see if teachers would use journals, mathematical discourse, challenging work, and private conferences with teachers for students to maintain their academic progress, track their progress, and reflect upon their own learning; however, responses from participating teachers indicated that the best practices for growth and reflection fell into one or more of the following four emerging categories: addressing internal and academic obstacles, making academic modifications, allowing time for peer interactions, and reserving time for private conferences with the students. When teachers addressed internal and academic obstacles, they created a safe climate for making mistakes, taught stress relief techniques, got to know their students, assigned partners, and made students accountable. These strategies put students at the forefront of
maintaining their own progress in the class by ridding the obstacles in their way. Some teachers made academic modifications to allow students small successes. These practices included modifying the assignments, assigning preferential seating, using mnemonics and manipulatives regularly, offering re-do opportunities for classwork and quizzes, offering tutoring, and reviewing in a spiral review manner to practice earlier taught concepts. Each of these practices gave students a chance to increase their academics in the best setting. Teachers also gave time for peer interaction through tutoring, building a team atmosphere, and creating a safe climate for students to work. Lastly, time was assigned for teachers to interact one-on-one with the students. Teachers held individual meetings to discuss expectations, track mastery, build confidence, and teach perseverance.

A much larger emphasis was placed on tracking standards, successes, and failures; however, the participating teachers focused more on teaching students to monitor their own growth and using groups to reflect on misunderstandings. Callahan (1971) defined a diligent educator as one who has the best interests of all students at all times. Taking time for growth and reflection is not a standard so it sometimes gets put on the back burner. Green (1990) found feedback to be an important element in student improvement because it gave students a chance to correct their work and motivated them to try again and achieve. Students need to take part in their own learning, and reflecting on past mistakes is not enough. Students need to be pushed by teachers to see a larger future ahead.

Limitations

Findings in this study are subject to limitations that must be taken into account when interpreting the results. First, this study was limited to 15 mathematics educators in one East Tennessee school district, which limited the number of responses obtained from the interview
questions. Since the study had a narrow focus on which strategies are the most effective in reducing anxiety, the potential sample size was limited to the teachers’ students who exhibited mathematics anxiety and were taught using the best practices. Also, the 15-question interview guide could have limited the participating teachers’ responses, due to the fact that the developed questions were created with a narrow focus.

Addition limitations related to external variables should be noted. Winter weather and subsequent snow days during the time of interviews, in conjunction with a lack of technology, inhibited some teachers from participating in video interviews. Lastly, the intended use of TCAP scores as a standardized measure of academic performance was ultimately replaced by students’ grades in mathematics due to the unforeseen lack of TCAP testing for the 2015-2016 school year.

Recommenations for Future Research

School districts, school, teachers, and future researchers could benefit from this study and continue building on this research. As for school districts, schools, and teachers, professional development opportunities would allow teachers to be informed of teacher best practices that help alleviate mathematics anxiety. These professional development opportunities could allow teachers the opportunity to practice these best practices on their own students, keep track of the results, and then meet back at a later date to discuss how the practices worked or did not work on certain individual students. Teachers need to monitor the effectiveness of these best practices with different learners to understand that some best practices do not work as well with different learners.

Understanding best practices from a teacher’s perspective is important; however, additional research needs to take place to understand what best practices that students feel are
most beneficial. There is minimal research on best practices in mathematics that alleviate mathematics anxiety from a student’s perspective. Future studies should concentrate on interviewing secondary mathematics students about their previous experiences in mathematics, current anxieties, and strategies that help them the most. Even taking into consideration that most students do not realize what helps them the most, further research could test whether students benefit more or less from their perceived notions of best practices over the teachers perceived notions of best practices. Further research could be conducted to follow students from one year to the next to see which best practices have the largest impact. Student achievement data could be analyzed after certain best practices were implemented.

In order to see the full effect of these best practices, further research could concentrate on larger samples of teachers and students to see a larger set of best practices or to see a more narrowed view of which strategies are used. Also, a small group of teachers who referred quite frequently to the use of sarcasm in the humor type interview questions were encountered. Further studies could allow the researcher to differentiate between the use of sarcasm and the use of humor to lighten the environmental mood. Does sarcasm actually help alleviate anxiety, or does it add to math anxiety?

Summary

The findings from this research allowed a more holistic perspective on how best practices are used in the mathematics classroom as a means of alleviating anxiety throughout a variety of mathematics classrooms. These findings may help current and future teachers choose appropriate practices to use within their classroom as a means of improving their classroom environments, instructional practices, and ways of helping students reflect and growth. Not all practices are equal, and educators need to ensure that they are using the best practices to meet the
needs of all students of all abilities. Through the implementation of these best practices, students who experience mathematics anxiety may find that a simple modification may make mathematics more enjoyable. Teachers may also find that their daily routine could benefit from the implementation of these best practices. Success usually follows many failures due to perseverance and motivation. The implementation of these best practices would give students a chance to find that success in mathematics is possible, and teachers might find that these practices help them expand their own knowledge of the students, mathematics, and themselves.

All the best practices worked in conjunction with one another in order to be found effective. The environment must be positive, safe, and learning enriched. Instruction must offer supportive material where students can practice procedures and multiple strategies. Student growth and reflection must start with learning who the students are, working small on their weaknesses to maintain their progress, and building up their confidence, motivation, and perseverance levels. If even one element of the three sets of practices is missing, it subsequently affects the other elements. Each element of the best practices complements the other. In order for effective best practices to be implemented in the classroom, the set of best practices must be utilized appropriately, consistently, and cooperatively.
References

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Appendices
Appendix A

Permission from Superintendent of Schools
November 15, 2016

Dear Ms. Stephanie Taylor,

As the Director of Cocke County Schools, I am aware of the research procedures for your study. I give permission for your study to take place at the schools throughout the county and for you to have contact with the math teachers as described in the research protocol. My permission is contingent upon IRB approval.

Sincerely,

Manney Moore

Director of Schools
Appendix B

Email to Teachers Regarding Research Collection
Letter to Participant

Dear (Participant’s name),

I am a doctoral student in the education department of Carson-Newman University and a Cocke County teacher. I am conducting a research study to examine which teacher best practices that you believe aid in the reduction of mathematics anxiety in students in grades 6 through 12. Mr. Manney Moore, director of schools, has approved this study for research.

I am requesting your participation, which will involve a thirty minute interview. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The results of the research study may be published, but your name will not be used.

If you have any question concerning the research study, please e-mail me at taylors@mail.cocke.k12.tn.us.

If you are willing to participate please reply to this e-mail and indicate whether you would like to be interviewed at your school or participate in a video conference. I have a Zoom account and will invite you to the conference at your convenience. You must have a camera and microphone on your computer to do a video conference. Attached you will find the informed consent form. I will have a hard copy the day of the interview for you to sign. Thank you so much.

Stephanie Taylor
Appendix C

Research Consent Form: Teacher Interviews
Informed Consent Form

Successful Teacher Best Practices for Reducing Mathematics Anxiety in Secondary Students

Please read this consent form carefully before deciding to participate in this study. This research has been approved by the Carson-Newman University Institutional Review Board.

Purpose of the Study:

The purpose of this study is to examine teacher perspectives of best practices for secondary mathematics students in the reduction of mathematics anxiety.

What you will be asked to do in the study:

You will be asked to participate in an interview dealing with teacher best practices you implement in your classroom. Your answers will be recorded and then transcribed.

Time required:

Approximately 30 minutes

Risks and Benefits:

We anticipate minimal risk to you by participating in this study. Potential benefits from participation in this research include a greater understanding of teacher best practices that reduce mathematics anxiety.

Confidentiality:

All data collected in this study will not include any names or identifying information connecting any teacher or school to this research. Your information will be assigned a code that only the researcher knows. Subject identity will remain confidential unless disclosure is required by law.

Voluntary Participation:

Your participation in this study is completely voluntary, with no penalty for not participating.

Right to Refuse or Withdraw from Study:

You have the right to not participate or withdraw from the study at any time without consequence. You also have the right to not answer any question in the interview without penalty.

Whom to contact if you have questions about the study:

Stephanie Taylor, srtaylor@cn.edu

Agreement:

I have read the consent form above, volunteer to participate, and received a copy of this.

Participant:__________________________ Date:________________
Appendix D

Interview Guide: Interview Questions
Warm Up Questions

1. Who was your biggest inspiration in school?
2. Why did you want to become a teacher?
3. Are there areas in your teaching that you wish you could improve?

Interview Guide

1. Thinking of your students, what does mathematics anxiety look like in your classroom?
2. When you see clear, visible signs of mathematics anxiety in your classroom, how do you address the students and the anxieties?
3. Throughout your years of teaching, what do you think stresses students the most in your mathematics class?
4. Why do you think some students have mathematics anxiety issues and others do not?
5. Describe a daily routine in your mathematics class.
6. Think about the last unit or chapter you taught. What different teaching instructional strategies or activities did you use on your students who could help relieve mathematics anxiety?
7. Tell me about a time that you last used group work. What was the impact that group work had on your students with anxiety and those without anxiety?
8. The environment of the classroom is part of the TEAM evaluation rubric for teachers. What classroom elements do you feel are important to a positive and stress-free learning environment?
9. Have you ever used humor in your classroom as a means of lightening the mood in a stressful classroom? Explain a situation where you used humor as an anxiety relieving method.
10. What strategies have you used or taught your students as a means to reduce mathematics anxiety?
11. Think of a student who you have had that you knew suffered from mathematics anxiety in your classroom. How did you help him/her deal with their stress while helping them increase their achievement?
12. What strategies have you tried in the past that helped students maintain academic progress in your class?
13. Think of a student with mathematics anxiety that used the strategies to maintain academic progress. How did that student respond to those strategies?
14. When a student first comes into your classroom, how do they know what you expect from them on a day-to-day basis?
15. How have you used mathematics journals in your classroom? If not, do you do something in your classroom that allows your students to comment on how they felt about the lesson?