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### Math Anxiety from All Angles

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**Math Anxiety from All Angles**

Katie Harmon

Honors Thesis

April 16, 2021

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### **Abstract**

The purpose of this thesis is to display the causes and impacts of math anxiety for students, especially in secondary education, and how to prevent math anxiety or help students with math anxiety. Three main groups, teachers, parents, and students, are discussed in this thesis. Overall, research is used to emphasize the significance and relevance of math anxiety and the ability of teachers and parents to help prevent the development or increased intensity of math anxiety for individual students.

## Introduction

Mathematics is an important part of the world around us, but unfortunately, many people and students have a lot of negative emotions surrounding mathematics. Anxiety is abundant in schools throughout modern society and is only increasing over time. In schools, there are different types of anxiety affecting students, including test anxiety and a variety of anxiety disorders. There is more anxiety and stress in schools than ever before in previous eras. When combining math, a subject surrounded by fear and negativity, and the increasing phenomenon of anxiety, math anxiety appears in our schools and even in adults throughout society.

What is math anxiety? Math anxiety can be defined as “feelings of fear, tension, and apprehension that many people experience when engaging with math” (Ramirez, 2018, p.145). Math anxiety can affect different students in different ways. Math anxiety can result in a lack of success in mathematics classes, distress on students in class, and added stress during homework. Students may begin to dread their math classes or even going to school at all due to their math anxiety. Unfortunately, many students are not aware of why they are anxious while doing math so instead of dealing with the issue of math anxiety itself, they turn to other methods of coping with anxiety. Students often turn to either perfectionism or procrastination in order to deal with their anxiety. Both of these things have a negative effect on the students’ mental health and success in school and other areas of their lives.

The outcomes of math anxiety affect both the student and their individual experience in school but also affect our society as a whole. Math anxiety can affect a student’s development of specific skills learned through mathematics that are needed in other content areas and for life skills. These skills include “mathematical thinking ability, receiving information systematically,

making logical predictions, making reasonable and accurate comparisons, and making inferences based on information or data” (Akabayir, 2019, p. 62). Many students may be discouraged from going into STEM (Science, Technology, Engineering, and Mathematics) careers due to the presence of mathematics in those careers. The fields included in STEM are in need of diverse backgrounds and thoughts, but math anxiety may limit the amount of diversity and people that choose to go into these career fields.

Who has math anxiety? All kinds of students have math anxiety, including students with learning disabilities in math and without learning disabilities in math. Many students with math anxiety even perform well in their math classes and on math exams. While some research studies say that there may be a difference between males and females, other studies show that there may not be any difference at all. The studies that show a difference say that there are more females with math anxiety than males, contrasting the studies that say there are equal amounts of math anxiety in the two different genders (Ramirez, 2018). When teachers in the United States were surveyed, “67 percent told the EdWeek Research Center that math anxiety was a challenge for their students and 1 in 4 said they often feel anxious doing math themselves” (Sparks, 2020, p.1). When students were asked about their feelings involved with math, “59% of the 15- to 16-year-old students reported that they often worry math classes will be difficult for them; 33% reported that they get very tense when they have to complete math homework; and another 31% stated they get very nervous doing math problems” (Luttenberger, 2018, p.312). Math anxiety does not end when students graduate high school; “in the United States, an estimated 25% of 4-year college students and up to 80% of community college students report moderate to high levels of math anxiety” (Ramirez, 2018, p.146). Math anxiety is not only relevant in the United

States; as found in a survey of 65 countries through the 2012 Programme for International Student Assessment (PISA), “33% of 15-year-old students, on average, reported feeling helpless when solving math problems” (Ramirez, 2018, p.146). Beyond students, “1 in 5 US adults” claim to have severe math anxiety (Sparks, 2020, p.1). While around 20% of adults have severe math anxiety, “approximately 93% of adult US-Americans indicate they experience some level of math anxiety” as demonstrated in figure 1; for most of these adults, their math anxiety originated during the school years (Luttenberger, 2018, p.312).

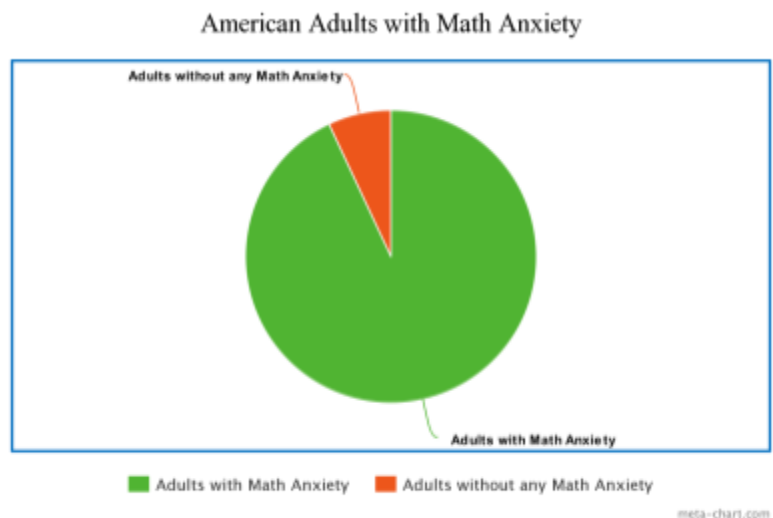


Figure 1

How does a person determine whether they have math anxiety? Similar to some other forms of anxiety, many people do not have an actual diagnosis but the symptoms are clear in their day-to-day lives or in their math classes. However, there are ways to confirm a person’s math anxiety. In 1972, Richardson and Suinn created the Mathematics Anxiety Rating Scale, also known as MARS; the MARS survey involved individuals rating “themselves on the level of anxiety they would feel in everyday situations, such as trying to refigure a restaurant bill when they think they have been overcharged or taking a math test” (Ashcraft, 2002, p.181). Shortened versions of the MARS survey are commonly used and can be found on the internet. Despite these

opportunities to confirm math anxiety, people are often unaware that they have math anxiety either due to not knowing about math anxiety or denying the presence of symptoms in their life.

### **Causes of Math Anxiety**

Every student has their own journey through school, and therefore, their experience with stress and math anxiety is unique. There are several known causes of math anxiety, but other factors and experiences can cause math anxiety for students. It is known that no person is just born with math anxiety so it must be developed through experiences although certain personality types may be more likely to be anxious.

The first reason that students may develop math anxiety is having difficulty with math initially and having a fear of failure. Students want to succeed and do well so when they do not immediately understand a concept, they may react with anxiety. This can affect a student's self-concept and self-confidence. Unfortunately, for a student who already struggles with understanding math concepts, their math anxiety may cause them to avoid math in life, procrastinate or even not do their math homework, or refuse to participate in math activities in class. If the student is avoiding math, they will begin to fall behind their peers and begin a cycle of feeling hopeless and that they will never succeed in math. This process could severely hurt a student's academic success in school for many years in math classes and their other classes. Many students begin developing math anxiety as the content in math gets more challenging, whether that challenge is through fraction or later in algebra. For students who had previously worked math problems with ease, anxiety could develop because they think that struggling with math means that they are not smart. In many cases, students have an inaccurate fixed mindset regarding academics and math specifically; "a fixed mindset leads students to fear that making a



mistake or failing a test could prove they have no innate math ability” (Sparks, 2020, p.3). They may also be reluctant to ask for help since they have never had to ask for help before in other classes. Students may develop negative feelings about specific classes or content due to the new difficulty. For example, a student may struggle with the concepts of algebra, causing them to avoid algebra and become anxious in future classes that involve algebra. Since algebra is involved in most required and non-required math classes in high school, the student’s success in future classes could be affected.

Another related cause of math anxiety is bad experiences in math classes themselves, whether the experience is defined by difficulty, stress, or negativity. Within math classes, specific methods may increase the likelihood of math anxiety for students, including “study habits of memorizing formulas, problems and applications that are not related to real life, challenging and time limited exams, and lack of concrete materials” (Mutlu, 2019, p.471).

Another cause of math anxiety is the surrounding opinions that students hear about math. Simple comments like “I did not like math when I was your age” or “math is difficult” or even “I never use math now” from adult influences in a student’s life can majorly impact a student’s opinion of math and their mathematical skills and abilities. Adult influences range from family members to teachers. Students may be discouraged by these kinds of comments or the negativity surrounding math that they hear. Parents can significantly impact a student's opinions and anxiety about math. Teachers may unknowingly limit their students by implying that math is difficult or stressful. Stereotypes in society can also impact the development of math anxiety. These stereotypes may be dependent on differences in culture, race, and gender (Ramirez, 2018). Sometimes, students will act how they believe people expect them to act. Thus, if people expect

them to do well in math, they may feel pressure if they do not naturally understand math content; if people do not expect them to do well in mathematics, they may assume they will fail or not do well and have a negative attitude towards math. Therefore, how people communicate when talking about math is very important and impactful.

### **Relationship between Math Anxiety and Cognitive Processing**

Along with the external causes of math anxiety and the overall impacts of math anxiety, working memory has a significant relationship with math anxiety. For many students, math anxiety works in a cycle as shown in figure 2. The cycle involves low math performance, math anxiety, and a lack of working memory. Working memory is the short-term memory people use

to remember more recent information. Students are using their working memory constantly to remember the skills they just learned or to remember information about a problem, along with all the other things they may be trying to remember at the same time, such as directions given by the teacher or time

limits. The Attentional Control Theory states that there are two attentional systems used in efficient cognitive processing, including a stimulus driven system, which is impacted by the

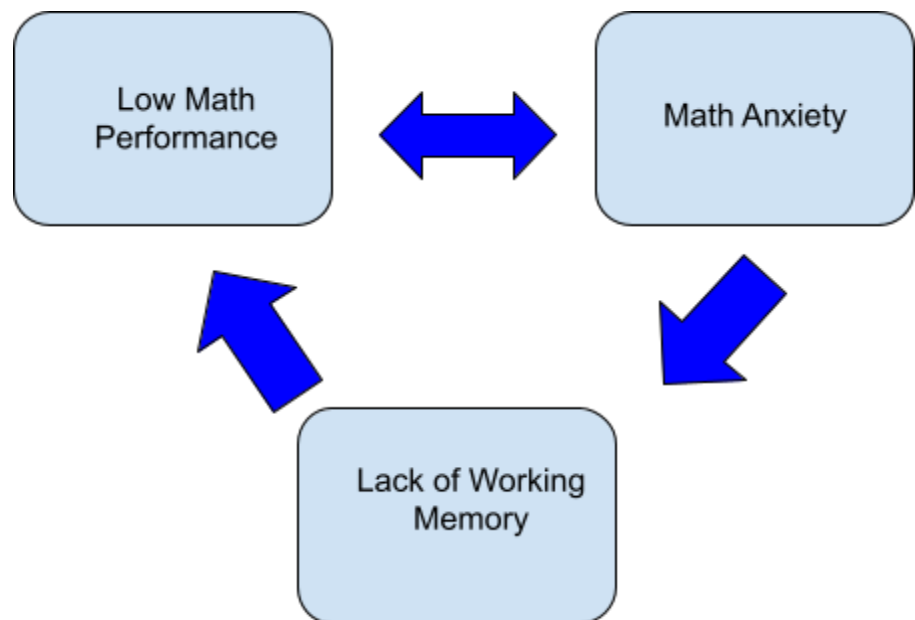


Figure 2

person's environment or stimuli, and a goal-driven system, which is impacted by what task the person needs to accomplish. When a person feels anxiety, there is a disruption of the "balance between these two systems, causing the stimulus-driven system to become dominant" and reduce "the capacity to focus on task-relevant" information, causing the brain to have a more difficult time resisting "the disruption of interference from task-irrelevant stimuli" and focusing "on task-relevant stimuli" (Luttenberger, 2018, p.314) The resulting decreased productivity of a student's working memory can severely hinder them during a test or timed assignment in which they must complete problems quickly. When students have math anxiety, they may feel too anxious to use their working memory properly to remember the information needed for their math work, leading to low math performance; these individuals are devoting their "attention to their intrusive thoughts and worries, rather than the task at hand" (Ashcraft, 2002, p.183).

In the brain, math anxiety can affect "a decision-making process sensitive to number sense"; therefore, students may choose illogical answers during a multiple choice question or not be able to understand that their answer does not make logical sense (Ashcraft, 2002, p.183). Along with students not being able to remember math facts or skills, math anxiety can impair "overarching cognitive processes that depend on fluency" or "reading processes when the text was related to math" (Luttenberger, 2018, p.314). Therefore, when students encounter word problems or even math-related passages in other classes, their math anxiety can cause issues with the effectiveness of their working memory.

Another situation involves students who are already performing poorly in math developing math anxiety, which leads to the lack of proper working memory. Thus, the original problem of low math performance not only continues but may get worse. Due to this relationship

between math performance, math anxiety, and working memory, helping students decrease their math anxiety is impactful on their success. Studies have shown that “when anxiety is controlled, it is seen that the mathematical performance of the students increase significantly;” thus, it is important that “early identification and treatment of the math anxiety” occurs (Mutlu, 2019, p.472).

### **Areas for Growth**

In recent years, mental health as a whole has begun to be looked at in schools, and schools have begun having programs to help students with mental health issues. When it comes to math anxiety, not much has been done past the research and suggestions. While math anxiety is not life-threatening, it can cause students to have less opportunities, less happiness, and more stress in their life. As educators, we should care enough about our students to see this problem and want to help our students. The first step to helping students with math anxiety is creating an awareness of this issue. Creating awareness can help students know they are not alone in their anxiety and provide them with resources to help them succeed. Next, there are many small steps that can be taken by the main three groups of people involved: teachers, parents, and students themselves. Throughout the rest of this thesis, I will discuss specific ways that each of these groups can help overcome math anxiety and create a better experience for these students.

### **Teachers**

The most common place that effects of math anxiety will be displayed for students is in the classroom; therefore, teachers have an important role in reducing the students’ anxiety and helping them succeed despite any impacts of math anxiety. With a good understanding of math anxiety and its effects, teachers can use effective teaching strategies to help their students. These

strategies will help not only students with math anxiety have a better learning experience but will also improve the experience for students with math anxiety.

### **Understanding Math Anxiety**

\_\_\_\_\_First, teachers must acknowledge that math anxiety is an issue that will appear in their math classroom. Then, teachers need to consider the age of their students and how math anxiety will appear in their classroom based on the students' ages and abilities. Math anxiety tends to peak "around ninth grade" or the "beginning of high school" (Ramirez, 2018, p.155). Knowing this fact can help teachers evaluate the amount of math anxiety that may be present in their classroom. Teachers should also consider the abilities of their students or how their students view their abilities. For example, a teacher who is teaching a remedial Algebra 1 class will need to consider that their students may lack confidence, motivation, or a good grasp of previous mathematical content. Unfortunately, these students may have math anxiety because they have been told they are not good at math or not smart. Looking at the perspective of these students will help the teacher find the best teaching strategies to help these students. On the other hand, a teacher who is teaching a Honors Algebra 1 class may need to consider other causes of math anxiety. Math anxiety can be just as prevalent in the honors class as it may be in the remedial math class. For this class, the teacher needs to consider that students may feel pressured to be perfect and may be afraid to ask questions. Knowing your students is the key to being a great teacher, and that idea continues to be important concerning teaching students with math anxiety. For teachers, understanding a few specific aspects involved in math anxiety that affect students and focusing on the causes, outcomes, and variables that can increase anxiety for students can lead to a well-rounded and useful understanding of math anxiety.

## **Teaching Strategies Based on Different Causes of Math Anxiety**

There are a variety of causes of math anxiety that teachers can look at in their own lessons and classrooms. According to Yilmaz Mutlu, some causes of math anxiety include “lack of the appropriate mathematical background of the students, study habits of memorizing formulas, problems and applications that are not related to real life, challenging and time limited exams, lack of concrete materials, difficulty of some subjects of mathematics, type of personality, negative approach on mathematics, lack of confidence, and the approaches, feelings, and thoughts of teachers and parents on mathematics.” While some of these causes cannot be affected by how a teacher runs the classroom, some of them can be helped. In the following pages, these causes will be looked at individually.

### **Cause: Students lack appropriate mathematical background.**

Tips: Since math is often cumulative and based on other mathematical skills, students who struggle with previous mathematical concepts will have anxiety when facing new concepts to learn. The first step to helping these students is doing proper review of previous concepts and learning what the students do not know, need to know, and what they already know. Teachers can use pre-tests and diagnostic assessments to evaluate where their students are at in their understanding of previous concepts. Second, teachers can meet the students where they are at instead of trying to force them through new concepts that they are not ready for yet. For example, if an Algebra 1 student does not understand the basics of multiplying polynomials, they may not be ready to jump into learning how to factor quadratics. Teachers can take the time to work with the students on a former concept to help them have an easier time learning the new concept. Constant review throughout a course is also helpful for students. The review can be

short and simple as seen in bellringers or homework problems, or the review can be longer in the form of a review game or day. Teachers cannot change what the students did in their previous classes, but they can meet them where they are at when they come into their class.

**Cause: Students struggle with study habits involving memorization.**

Tips: Some math classes may emphasize the need to memorize a lot of formulas or math facts; some students will find this overwhelming and never get a good understanding of the actual concepts involved. Making assignments and tests heavily leaning on memorization can get in the way of students being able to learn and demonstrate their understanding of an overall concept. Due to the access of calculators and the internet in today's society, it is not as important that students memorize some formulas as it was in the past. Therefore, putting an emphasis on the mathematical concepts instead of memorization can help the students who struggle with memorization. Providing formulas or cheat sheets for tests can also help students have less anxiety and will also allow the students to demonstrate what they know in a better way.

**Cause: Students cannot relate to the content.**

Tips: For some students, they find their math classes irrelevant to their lives; these students may struggle with motivation and learning the content, leading to math anxiety. One way to help these students is by using their interests while teaching the concepts. Music, art, sports, video games, and other common interests can be incorporated into lessons and at times, even used to demonstrate the relevance of a math topic. Another way to help these students through their interests is providing them with opportunities for personal connections to the topics. Projects and reflections where students can be creative or choose from a variety of topics can help students relate to the content. Teachers can also include real life application problems into lectures and

assignments that deal with actual situations in the lives of their students. For example, a teacher could include an assignment about college tuitions for their high school students.

**Cause: Students struggle with abstract concepts.**

Tips: Some students are lacking in the critical thinking skills and abstract thinking that is often needed to learn different math concepts. To help these students, teachers can add more concrete materials into their lessons, including the use of manipulative and visuals. Manipulatives and visuals can help visual or kinesthetic learners better grasp the concepts. Setting a basic understanding through manipulatives and visuals can lead to a deeper understanding later.

**Cause: Students have a negative approach to math.**

Tips: Due to their surroundings and others' opinions on math and challenging work as a whole, students may have a negative approach to math that leads to math anxiety. Teachers cannot change the students' surroundings at home or in other places, but they can create a more positive environment and attitude in their own classroom. Teachers can focus on positivity about math and create an attitude that success can follow mistakes. Encouraging the students after they make mistakes can help them have a more positive outlook on dealing with challenging content.

Teachers can also encourage students for small victories and learning in the classroom. Another way to help students have a more positive outlook on math is by giving students more options and input in their math class (Akbayir, 2019). Giving students options for how class activities, small groups, or other aspects of their work are determined or done can help students feel like they have more significance in the class and are better set up for success.



**Cause: Students lack confidence.**

Tips: A lack of confidence is often combined with anxiety throughout school as a whole. In math, a lack of confidence seems abundant. Often, students are not confident that they can solve problems or understand complex concepts in math. Building students' confidence can have a major impact on decreasing anxiety and increasing success. Possible ways to help students build their confidence is allowing students to solve problems in a variety of ways and giving positive feedback for small achievements (Sparks, 2020). When students discover that they can figure out methods to solve problems on their own, they may feel more confident in new mathematical situations as well. Teachers should also avoid comparing students to others in class. Instead, teachers can emphasize how well a certain method worked and encourage the students to behave a certain way or think about a problem from a different perspective. All students should feel encouraged in class independent of their skill level.

**Cause: Students have a fixed mindset.**

Tips: The students' mindset is at the center of their math anxiety. Students' confidence, motivation, and behavior in a math class and while doing assignments outside of class are all dependent on their mindset. Teachers should encourage students to have a growth mindset instead of a fixed mindset. A student with a fixed mindset involving math will not see their ability to improve, learn, or grow. They will view challenges with anxiety instead of motivation. In *Beyond Math Anxiety: 99 Insights (and a Calculation's Not One!)*, Osburn emphasizes the importance of understanding the students' mindset. She uses a pyramid as seen in figure 3 to demonstrate the importance of the students' mindset in decreasing their math anxiety and increasing successful learning. Before considering teaching methods to increase success,

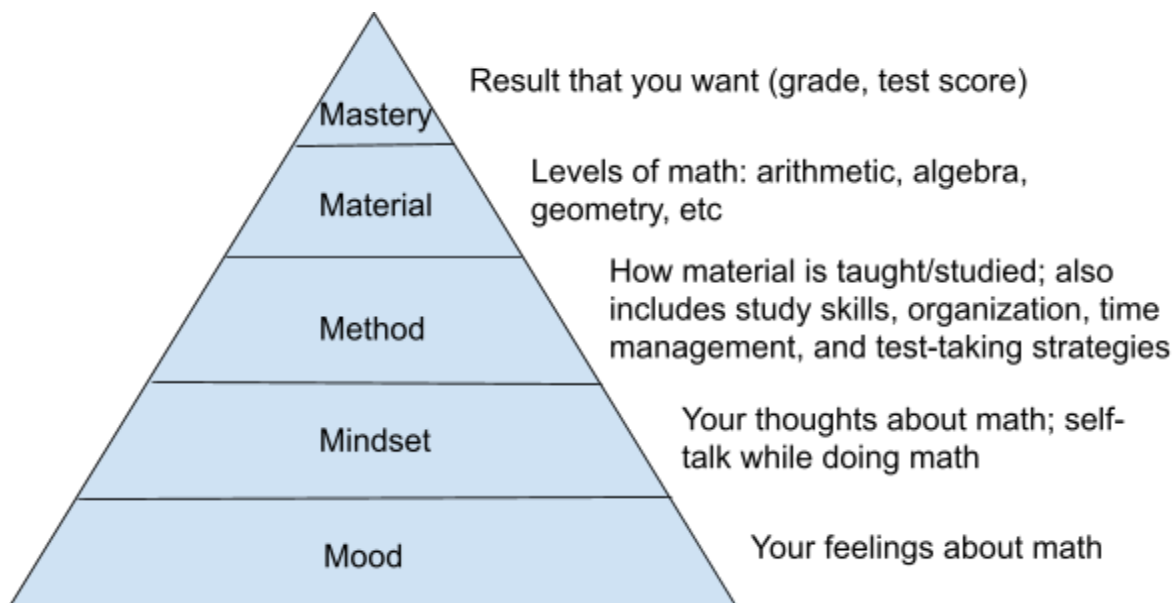


Figure 3

focusing on changing the students' mindset can drastically help the student learn. Teachers need to keep a positive attitude when discussing math as a subject, challenges, and the students' mathematical abilities. Since "students are interpreting what they witness in the classroom and forming a story about the domain of math, their teachers, and themselves," positive communication surrounding math is essential to helping students create a growth mindset (Ramirez, 2018, p.151).

**Cause: Students have anxiety due to challenging and time limited exams.**

Tips: Test anxiety is a common challenge that many students face; combining test anxiety and a student's discomfort with math can lead to math anxiety. When students doubt themselves and their ability to do well, anxiety will be an automatic response (Mutlu, 2019). Students who lack self-confidence will also likely feel anxious. Challenging questions with a time limit can cause students' anxiety to increase and cause the students to be unable to truly display what they

understand and know. These challenging and time limited tests often do not fulfill the purpose and original intention of the assessment. There are other ways to assess students that will not cause the same amount of anxiety.

While time limited tests are sometimes needed due to class restrictions, there are ways to decrease the students' anxiety involved with the test. First, a great way to help students feel less anxious is by providing test corrections after the test is graded (Osburn, 2018). Test corrections involve students looking at the questions they answered incorrectly on the exam and later, turning in a written explanation of the mistakes they made and the correct solution to the problem. The teacher determines how much credit the student can get back by correctly filling out the test correction; a common percentage is for the student to receive half of the credit back. This allows students to know that if they make mistakes on the test, they will have an opportunity to still do well in the class. The students are motivated to still study for the exam but will still learn any content they had not properly prepared for the exam. The teacher can either provide a form like the one shown in figure 4 or can have students do test corrections on notebook paper. Another way to help students have less anxiety on time limited exams is by providing students with a sample test beforehand (Kardamis, 2019). The sample test will display the types and amount of questions that will

Question # _____
Explain why your answer was incorrect.
Explain how to get the correct answer.

Figure 4

appear on the exam. There is not a need for the students to be surprised by the types of questions or the length of the exam. The best way to decrease students' anxiety involved with tests is to prepare them properly and letting them know what to expect. Other possibilities for decreasing anxiety involved with tests is providing retests or “dividing the learning content into several smaller examinations instead of one extensive examination”; these opportunities could decrease anxiety by not putting too much pressure on one exam (Luttenberger, 2018, p.319). The retest option could decrease anxiety by letting students know they will get another chance if needed and for students who do not need the retest, “the opportunity itself eases strain” (Luttenberger, 2018, p.319). Anxiety can occur from the fear of the unknown.

### **Aftermath of Math Anxiety**

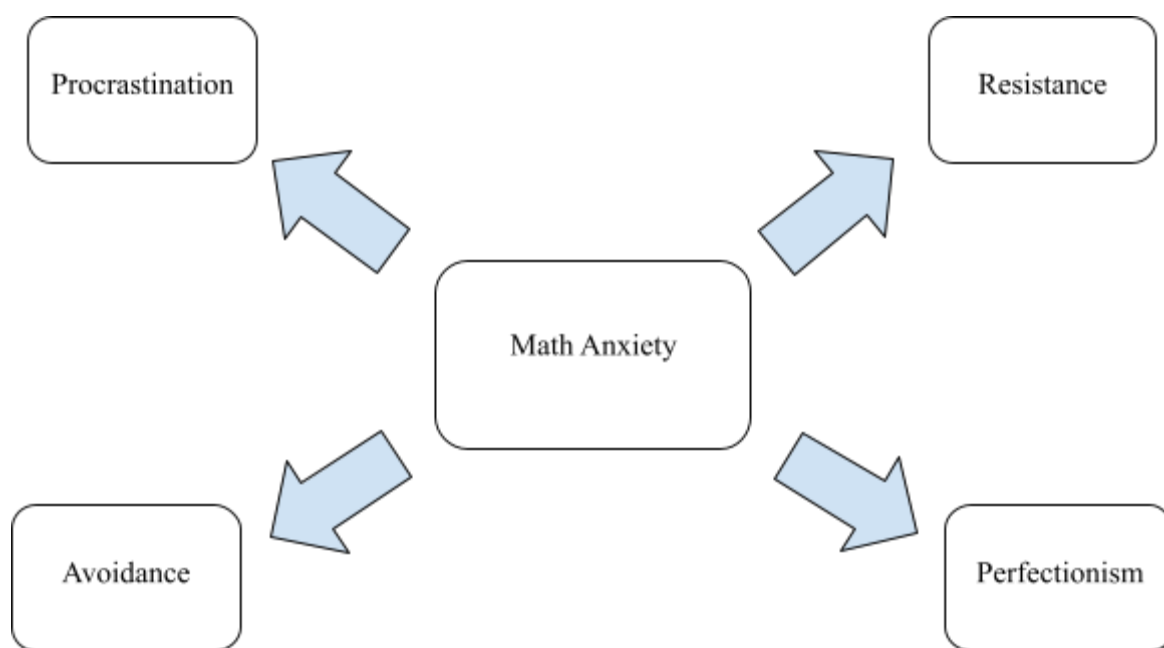


Figure 5

As seen previously, teachers can try to prevent math anxiety from occurring or decrease the effects of math anxiety by looking at the causes and using strategies to decrease those causes

or help students through them. Unfortunately, many students will have either already developed math anxiety before becoming a part of your class or will proceed to develop math anxiety while in your class. Therefore, teachers must also look at the aftermath of math anxiety, how it will affect students' success, and how they can help their students. The four main effects of math anxiety are procrastination, resistance, avoidance, and perfectionism. These effects can significantly impact a student's performance, mental health, and self-esteem.

### **Procrastination**

Due to having math anxiety, students may not want to do their work immediately and may procrastinate completing their homework or studying for quizzes or tests. This behavior can lead to more anxiety and stress from limiting their time from beginning their work to the deadline. Therefore, this can lead to a cycle of procrastination and math anxiety that can hurt students throughout years of math classes. Creating the habit of procrastination could also lead students to perform worse overall in other classes due to stress and the potential to procrastinate in other classes as well. Procrastination could even lead to a lack of sleep and other unhealthy habits. Procrastination is a common habit seen in secondary students and will affect their mental health and overall academic success. Thus, math anxiety that causes procrastination can lead to worse performance and increased anxiety.

To help students who have created the habit of procrastination, teachers can use several strategies. First, teachers can spread out deadlines, especially for big projects. Using "evenly spaced deadlines" can significantly improve performance and decrease overall procrastination. Teachers can also "provide supportive feedback" to encourage confidence and decrease students' reluctance to begin their work. Teachers can also "teach time management and study skills" by

showing students when they should begin studying or how much of their assignments should be done (Terada, 2020). Some students may have never been taught these skills and have just been expected to understand how to manage their time or study. Acknowledging the workload that your students will have can also help teachers decide how much homework they should assign their students. When students are not overwhelmed, they may procrastinate less. For homework assignments, “clear instructions and examples” could help students procrastinate less. When students clearly understand what is expected, they will feel more comfortable beginning their work (Terada, 2020). Decreasing procrastination can significantly help students overcome math anxiety.

### **Resistance**

Students with math anxiety may also resist asking for help when they need help. Due to their math anxiety, students may see asking for help as a sign of weakness and would rather resist learning than seek help. Teachers should encourage students to ask questions and demonstrate to students that not knowing the answer is okay given that the students are willing to overcome not knowing or understanding a concept.

### **Avoidance**

Another common aftermath of math anxiety is avoidance. Similarly to procrastination, students with math anxiety may not want to do math. Unlike students who procrastinate, students who avoid math may not do their homework or study for a test at all. Avoidance would have a major impact on the student’s performance and could even lead to failing a class. Students may come up with excuses about why they did not do their homework. It is important that teachers notice a repetitive habit of making excuses for not turning in their homework because there may

be a bigger issue. Students may also avoid class discussions, small group work, or doing their work in class. In the other direction, a student's avoidance tendencies may lead them to speed through problems to "minimize their time" doing math problems; unfortunately, this habit can lead students to perform more errors in their work (Ashcraft, 2002, p.183). Teachers should encourage the students to participate even if it is just in a small way, such as sharing work with a partner. Sometimes, student avoidance of work can come from "teachers who convey a high demand for correctness but provide little cognitive or motivational support during lesson" (Ashcraft, 2002, p.184). Thus, support from their teachers is key to helping students with math anxiety and avoidance tendencies. Teachers need to listen to their students and in some way, students will display their fears and anxiety.

Beyond homework assignments and class participation, students with math anxiety may "take fewer elective math courses" in high school or college and "avoid college majors and career paths that depend heavily on math or quantitative skills" (Ashcraft, 2002, p.181). This kind of avoidance can have a significant impact on the students' future and career possibilities. Students may not only avoid math classes but also avoid classes involving "science, technology, and engineering" due to these subject's reliance on math skills (Luttenberger, 2018, p.315).

### **Perfectionism**

Some students respond to their math anxiety with perfectionism rather than resistance or avoidance. Students may feel the need for their work to be perfect and thus, they create unhealthy habits. Students who respond with perfectionism may even begin to procrastinate because they fear not being able to do perfect work. Other students may spend an unhealthy amount of time on their work that will affect their overall health or cause problems when their

time must be limited. Students may not want to answer questions in class or struggle with quizzes and tests due to their desire for perfection. Students may also have more negative reactions to low or average test scores or grades and get discouraged easily.

To help these students, teachers can encourage the understanding that everyone makes mistakes and mistakes can lead to learning and success. Teachers can also show students when some of their thinking was accurate and they made a simple mistake rather than just telling them that they are wrong. A more flexible and forgiving grading system could also help these students. Creating a positive classroom environment where mistakes are simply a part of the learning process rather than something to be ashamed of could significantly help the students overcome perfectionistic tendencies.

### **Behaviors to Avoid**

As demonstrated previously, teachers can help prevent math anxiety or can help students work through the aftermath of math anxiety. These different aftermaths of math anxiety are heavily seen in secondary classrooms and having an awareness of how they will impact students' performance, mental health, and potentially physical health is important. Teachers can have a significant impact on their students' success and how much math anxiety is able to affect them in their classroom. Unfortunately, teachers may also cause math anxiety for their students through different habits. Often, students develop math anxiety due to experiences in math classrooms. Therefore, there are habits in the classroom that teachers should be aware of and avoid if possible.

These behaviors to avoid in the classroom can be either identified as covert or overt actions. While overt actions involve obvious actions, such as what people say, covert actions are



more subtle and may not be as easily recognized, and teachers may not even know they are participating in harmful covert actions. Even though teachers may not recognize their negative covert behaviors, “covert behaviors, although veiled or implied, have the same negative effects as overt behaviors” (Jackson, 1999, p.584). Overt behaviors that may cause math anxiety include refusal to answer students’ questions, nonexistent or inappropriate feedback, or insufficient explanation or tutoring time; these overt actions involve what we more obviously say or do. The covert behaviors that can cause math anxiety often involve negative body language. Since both covert and overt actions of teachers can cause math anxiety, “instructors must be aware of their impact on students” in order to prevent creating more math anxiety for their students (Jackson, 1999, p.585).

Students can develop math anxiety at any age; it is common that students will develop math anxiety either during their years in third or fourth grade or in early high school due to changing difficulty in material and methods of teaching certain mathematical concepts. For elementary students, their math anxiety often originates from the new difficulty of material, especially “memorizing multiplication tables and formulas” (Jackson, 1999, p.583). The time limits, emphasis on memorization, and competitive nature of some of the classroom methods used in upper elementary can cause students to develop long-lasting math anxiety early in their lives. For example, “timed tests in competition with peers” was an anxiety-filled memory for many students who developed math anxiety (Jackson, 1999, p.583). While teachers cannot change the difficulty of the material for students, they can consider the potential for anxiety when they plan lessons and assessments and try to limit or avoid timed competitions between students. Along with these methods, hostile instructor behavior can also cause math anxiety for

elementary students. This hostile instructor behavior may include negative comments to students about their abilities or specifically their math skills, pointing out their mistakes in front of the entire class in a derogatory or belittling way, or being angry when students ask for extra help. Teachers should already avoid these behaviors in order to create an overall respectful and positive classroom environment, but unfortunately, teachers may fall into these bad habits and need to be aware of the consequences of these actions.

For high school students, there are a few different behaviors that students have reported as causing them math anxiety. First, students reported angry behavior from their teachers about students asking questions or for “clarification of problems” as a cause of math anxiety (Jackson, 1999, p.584). Some teachers also had unrealistic expectations for how long it would take students to understand a concept, such as knowing how to do a difficult problem after only one example, or embarrassed students in front of their peers, such as forcing a student to demonstrate how to solve a problem the teacher knew the student did not understand. Students also felt anxious when “test material did not match lecture material” (Jackson, 1999, p.585). Lastly, students reported that some teachers had an “insensitive and uncaring attitude” and did not want to help their students (Jackson, 1999, p.584). All of these behaviors can lead to math anxiety and other issues in the classroom, such as students feeling disrespected or a negative atmosphere in the classroom.

A cause of math anxiety that was reported in all groups was gender bias. There are a few possible explanations of gender bias in classrooms. It has been debated whether more females have math anxiety than males, but some sources say that “while research supports that girls have a similar aptitude for mathematics, they are more susceptible to math anxiety” (Geist, 2010,

p.24). There has also been research done in secondary education that confirms “a gender bias in math anxiety” (Luttenberger, 2018, p.316). In all age groups, this could come from a teacher’s actions that imply males are better at math or from teacher’s comments about females in mathematics. Teachers may unconsciously convey “stereotypes about females’ abilities in math” (Luttenberger, 2018, p.316). Female teachers who do not feel confident in their own math skills may convey these messages, either covertly or overtly, to their female students. Gender bias connected to math anxiety may also be linked to the emphasis on “memorization and rote recitation rather than active concept based learning” in some math classrooms (Geist, 2010, p.25). Overall, to help prevent gender bias causing math anxiety, it would be useful to create a “classroom climate that acknowledges gender differences while considering individual styles and behaviors” (Geist, 2010, p.25).

### **Teachers Conclusion**

\_\_\_\_\_Teachers have an incredibly important role in preventing and decreasing math anxiety. As seen previously, considering the causes, outcomes, and harmful habits involved with math anxiety can give teachers a better understanding of how math anxiety will affect students in their classroom and how to help their students. Overall, creating a positive, uplifting, and well-balanced classroom will help not only students with math anxiety but all students. Caring for students involves caring about not only their performance but their well-being as well.

### **Parents**

Along with teachers, parents hold a significant responsibility in helping prevent math anxiety and helping their children overcome math anxiety. There is a strong correlation between a parent having math anxiety or having had bad math experiences and their child having those

same characteristics. This is not because the children are “bad at math.” The correlation is due to the parents’ influence over how the student views math and how they view themselves. Since a parent with math anxiety may often cause their child to develop math anxiety, this process can be represented as a cycle of math anxiety or negativity towards math. The parents’ views on math “serve as a frame of reference” for their children; therefore, parents are role models for how their children should behave and view math (Luttenberger, 2018, p.315). Mothers especially can “influence their daughters’ attitudes toward math, self-assessments, and math anxiety” due to daughters seeing their mothers as a role model for how they should act as a girl (Luttenberger, 2018, p.315). Therefore, informing parents about how their actions can impact their children is a significant part of decreasing math anxiety for the students. There is also a need for parents to understand that their child’s low performance in math may not be fixed with the attitude of “buckle down and study harder” and they may need extra help instead; parents can help students by finding them extra help or support and telling their student that getting help is okay (Osburn, 2018, p.124). Parents need to also observe and analyze the reason behind low grades or test scores before deciding whether to punish their child for the low grade or test score. Areas that parents can focus on to help their children is how they communicate about math and their math experiences and the expectations they have for their children; parents can also bring math into the student’s home life through showing students when they use math and playing games involving math.

### **Communication**

\_\_\_\_\_ There are several aspects of communicating about math with a child that are important to think about beforehand. First, since parents create the tone for which their child views math,

creating a positive tone is important. For parents who struggled with math as a student, telling your child or teen “stories about how you hated math when you were young” can create a negative connotation to math before students even get to form their own opinions and experiences (Osburn, 2018, p.135). Thus, parents must be careful when they present stories to their children; they do not have to change stories or lie but creating a positive spin on a story could be helpful. For example, instead of telling a story of how much they hated a math class, a parent could emphasize that while they struggled at times, they worked hard and got help if needed and learned how to overcome an obstacle. Avoiding negative statements towards any school subject allows students to find their own interests and strengths.

When working with their children on math homework, assignments, or studying, parents must also be careful about the kind of language they use. When a student is struggling with an assignment, parents can redirect their child from using excuses to giving explanations of what they need help with or what they do not understand. For example, students may just give up and say “I’m too dumb to do this” or “this is useless,” giving excuses that do not give a direction to success and just keep the student stuck instead (Osburn, 2018, p.133). An explanation “offers clarity” instead; for example, if instead of giving excuses, the student said “I do not understand how to multiply these fractions.” Then, they are pointing out what they specifically need help with and the parent can either help them or find resources to help them. When parents are aware of this distinction, they can lead students in the right direction and demonstrate through their own communication the significance of explanations over excuses. Parents can also focus on “asking ‘how?’ questions instead of ‘why?’ questions” (Osburn, 2018, p.152). Instead of constantly asking students why they are doing poorly or why their grades are lower than desired, parents

can ask how they can help. This helps students know their parents care and focus on “present and future instead of the past” (Osburn, 2018, p.153).

When discussing the student’s academic performance or helping them with math assignments, parents must consider the intent, impact, and insight of what they say. The intent of what the parent said may or may not match the impact the statement has on the student. While a statement may be intended as a caring concern, the impact of the statement for the student may be more similar to an insult. Insight involves “awareness of the other persons’ lenses” (Osburn, 2018, p.155). Therefore, parents must acknowledge how their students will view what the parent says and how it may affect them. Understanding this insight can help parents build a more positive relationship between themselves, the students, and math itself. When a parent is concerned, they may also want to use “I-messages” instead of “you-messages” (Osburn, 2018, p.150). An I-message, such as “I am concerned about this math test grade,” would be “more effective and supportive” than a you-message, such as “you did not do well on this math test” (Osburn, 2018, p.150). I-messages will convey the parents feelings rather than putting blame and shame onto the student. I-messages also convey an attitude of helpfulness rather than shame. Overall, it is important for parents to acknowledge how they communicate about math to their students in order to prevent their students from developing math anxiety or worsening their existing math anxiety.

### **Expectations**

Parents’ expectations of their children can also impact whether their students develop math anxiety. Expectations that are too high or strict can lead to perfectionism and fear of small mistakes that can lead to math anxiety. Expectations that are too low can lead students to feel like

they cannot do math and will automatically be bad at math before they even begin learning math. This can lead students to be unmotivated, afraid of even trying, or have a negative attitude towards math. Having realistic expectations helps students determine their own capabilities and stay motivated to keep trying even after mistakes. “Labeling a child as an ‘A student’ or a ‘B student’ or a ‘C student’ ” can cause a student to not feel like they can only achieve success to a certain extent or feel limited to a certain type of behavior (Osburn, 2018, p.137). Students need to be allowed to do their best, even if their best is an A in Algebra 1, a C in Geometry, and a B in Algebra 2. Students do not have to have the same consistent grade in order to be still doing their best. Parents simply expecting the students to do their best rather than have a specific grade encourages hard work rather than perfectionism, pressure, or procrastination.

Another unfortunate expectation that leads students to develop math anxiety is comparison to other students or family members. First, if parents expect their students to not do well in math just because they struggled with math during their school years, their children will expect to not do well even if that was not going to be the case. Students who expect to not do well will often fulfil that expectation of not doing well due to their attitude, not their ability. These students will not be motivated to study and work hard if they are expected to do poorly anyway. If parents expect their students to be naturally gifted in math because they were when they were in school, the students will feel a lot of pressure to be perfect and may have increased anxiety when they make small mistakes and develop math anxiety and perfectionistic tendencies. Second, parents should avoid expecting their child to be like their siblings. It creates the same anxiety as mentioned previously with comparisons to the parents and creates another unhealthy feeling of competition. The student can begin to feel like they are not good enough on their own

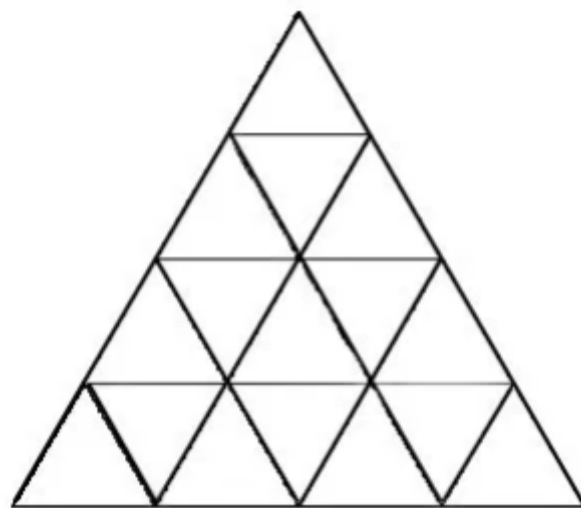
and that they are inferior to their sibling. Third, parents should avoid comparing their child to their peers. This could create an unhealthy anxiety involved with feeling like they always need to do better than their peers. For example, if a student makes a 98% on a test, which is a good score, they may feel discouraged if their peer makes a 100%. These comparisons can harm students in a multitude of ways and create a lot of anxiety for the student.

### **Math at Home**

Another way that parents can help their students with math anxiety is using math at home to create more comfortability for the student with math concepts and even potentially making math more appealing or fun for the student. Parents can point out when they are using math to their children and why math is useful. They can help their children improve their problem solving skills even through activities that do not directly involve math. Showing students math in real life can help them feel more comfortable when they encounter math in the classroom.

Building smaller math skills can even help the student become more confident with more complex math concepts in their math classroom.

Students can even see math in fun ways through math puzzles and games that involve math, especially for younger students. Puzzles like the one displayed in figure 6 can help students build problem solving skills that can alleviate anxiety symptoms later for the students. Students can also play games with their families that build math skills or problem solving



How many triangles can you find in this picture?

Figure 6



skills. For example, games, such as Dominos, Farkle, 2048, or Sudoku, can help students feel more comfortable with numbers and math.

### **Parents Conclusion**

Parents can help their students in a variety of ways concerning their math anxiety. Parents can focus on communicating in certain ways about math to their children, creating realistic expectations for their children, and using math at home to help prevent or decrease their child's math anxiety. Parents can help their students at home, but they can also work with teachers to provide their student with the extra help and support they may need. Teachers and parents play significant roles in preventing or decreasing students' math anxiety and working together can create an even more effective approach.

### **Students**

While teachers and parents can significantly help students overcome math anxiety, students themselves are not helpless in the situation. When students are aware of their math anxiety, they can do certain actions and create habits that help them with the effects of their math anxiety. Unfortunately, some students with math anxiety may be unaware of its presence or effects in their lives and academic performance. Therefore, awareness of their math anxiety is key to any of the following actions to help the students themselves.

### **Understanding Their Own Experience**

After students have become aware of their own math anxiety, the next step is understanding how their math anxiety affects their life and experiences in the classroom. The effects of math anxiety can manifest themselves in a variety of ways for any individual student. For example, while one student may procrastinate and avoid math assignments and class work,

another student may unhealthily obsess over their work to the point of sleep deprivation and poor mental health. A process for dealing with math anxiety can be described as the “APR Method” which represents the steps of “awareness, processing, and release” (Osburn, 2018, p. 25).

Awareness involves understanding that their anxiety has a “real biological explanation” and can be helped and is not a reason to be ashamed (Osburn, 2018, p.35). Being aware of their anxiety involves knowing that they may have irrational thoughts concerning their math self-concept, especially when testing is involved. Processing these things leads a student to identifying the effects of their anxiety and finding ways to prevent unhealthy habits.

### **Creating Healthy Habits and Skills**

\_\_\_\_\_Once a student understands their own experience with math anxiety, they can begin to combat negative effects with new healthy habits. For example, if a student becomes aware of their procrastination tendencies, they can begin scheduling time in advance to work on assignments to prevent more procrastination. Students can also learn about new ways to study that may be more effective for them. Students who only study the night before an exam and feel a lot of anxiety during the test due to the feeling of a lack of preparation may be better suited for a method of studying that involves studying in advance through short planned time intervals. Students can also focus on building organization and time management skills that could lessen the effects of their math anxiety. These skills are crucial to success in math and other subjects they will take in school. Being organized could help students feel more in control of their learning and feel more confident. Having better time management skills can lessen the stress students feel and thus, lessen their anxiety induced by stress. Good time management skills can lead to being more prepared for their time in class and exams, which can increase their

confidence and improve their academic performance. Taking control of their learning and studying could significantly help students feel less anxious.

### **Finding the Right Math Classes**

\_\_\_\_\_ While students are required to take some specific math courses, there are a few ways that students can use their choices to decrease the effects of their math anxiety. First, students may be able to choose the timing of their classes. If they think that moving at a different pace will help them, they can choose when they start their algebra sequence or at what level they take their courses. Second, when they are given choices for a math elective, typically during their senior year, they may want to choose a course, such as “statistics, personal finances, and applied math,” that “can make math seem less intimidating and more relevant” (Osburn, 2018, p.76). Therefore, students can take advantage of the opportunities they are given to make decisions about their courses and timing that can help decrease the impact of their math anxiety.

### **Understanding of the Significance of Math**

For students with math anxiety, it may also be important to have an understanding of why they are learning math because a better appreciation of it may help clarify the students’ emotions surrounding it. Demonstrating to students the significance of math in their lives and the skills they learn through the process of learning math helps develop these skills including critical thinking, analysis, problem solving, and logical thinking. Letting students know the career possibilities involving math may motivate them to take math electives or strive to overcome their math anxiety.

### The Myth of “I’m just not a math person”

For an unfortunately large number of people, the belief that they are not good at math and are just not a “math person” is created very early in their lives, often going back to elementary school. These students begin to develop a negative attitude about their mathematical self-concept due to a few challenges early in their school years; these challenges should not define their mathematical abilities or strengths in general but often do. For teachers, parents, and students, acknowledging the falsity of this

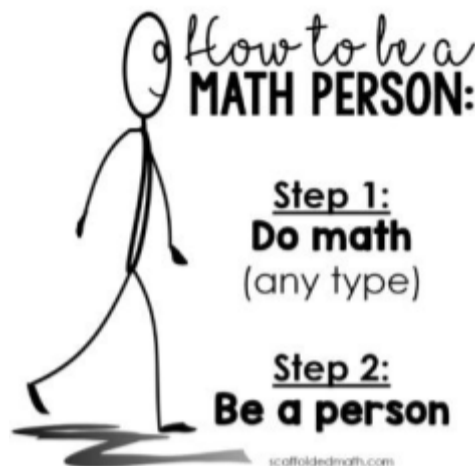


Figure 7

math is important to decreasing math anxiety. No one is born a “math person;” every person has the capability to learn even if it's at their own pace or in their own unique learning style. Letting students believe that they are simply not a math person undermines their ability to learn and their potential to succeed and even pursue a career involving math. It is important that as a society, especially people as authority figures in schools or homes, we encourage younger students to not allow a few challenges in mathematics lead to a “self-fulfilling prophecy” of low performance in mathematics (Kimball, 2018). To help discourage this belief, encouraging an overall classroom positivity and general positivity about students’ capabilities to learn and grow can be useful. Teachers and parents can create an atmosphere and attitude of growth, focus on helping each other learn, and being confident in our abilities.

### Conclusion

Math anxiety is an issue for many students throughout the United States and other countries beginning early during elementary school and potentially lasting their whole lives.

Math anxiety can impact several aspects of a students' life, such as academic performance, confidence, and their future career. Teachers, parents, and students have roles in preventing and decreasing math anxiety through a variety of different actions. Overall, helping students overcome math anxiety can lead to a larger variety and perspectives in STEM fields and an increase in innovation and advances in society. Helping students with math anxiety can help students become more confident while building skills and building a better future for themselves.

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