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Recognizing and Addressing Mathematics Anxiety in Female Students

Amanda Sost
ap767621@wcupa.edu

Recognizing and Addressing Mathematics Anxiety in Female Students

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Abstract

Mathematics anxiety is a prevalent concern in the world of education. As a female mathematician myself, my own personal experiences led me to research the reasons why mathematics anxiety affects more girls than boys. Specifically this paper explores the basics of anxiety including its definition and causes. This definition provides a meaning behind discussing the authoritarian model of education and the importance behind creating a free democratic society, not only in the classroom but in the world. Specifically, the authoritarian style of pedagogy has many affects on students who are learning mathematics, which will be explored as one of the main causes of mathematics specific anxiety among students. The authoritarian style of education is traditionally seen as patriarchal. These patriarchal influences are major causes of the differences in observed mathematics anxiety between girls and boys. Additionally, history indicates several reasons as to why mathematics is a male-dominated field by exploring the history of females in mathematics and the many obstacles they faced in order to pursue lives as mathematicians. Additionally, the history of anxiety provides insight as to the relevance of mathematics specific anxiety as it currently exists. Several methods are proposed to help alleviate mathematics anxiety in female students including implementing place based education, empowering students with a growth mindset, and teaching students how to cope with their anxiety through mindfulness and meditation.

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Chapter 1

Introduction and Positionality

As a teacher of mathematics, my students have many different needs that may have accommodations implemented through an Individualized Education Plan, a 504 agreement, or they may be undiagnosed. One of the most frequent situations I encounter is the lack of confidence in my students as they complete problems. They are constantly asking questions such as, "Did I do this right?" or making statements such as, "I'm lost and don't know what to do from here." As a teacher, these statements are difficult to hear, as I want all of my students to be and feel successful.

As I increasingly experienced these situations, I began to wonder if other mathematics educators faced the same problems. I wondered, "Why are my students so anxious?" "What am I doing that is hindering their success?" After some research, I found that the teacher has a distinct role in this type of anxiety. Specifically, I came across an article written by Carol D. Jackson and R. Jon Leffingwell (1999) titled "The Role of Instructors in Creating Math Anxiety in Students from Kindergarten through College." The article details the many ways that teachers help and/or hinder their students' success. Specifically, the article discusses the teacher's mood and attitude towards teaching. We will explore this research in greater depth later, but in summary, Jackson and Leffingwell concluded that when teachers enjoy what they are teaching, students are more motivated to learn. The influence of the instructor on the subject is initially what creates this anxiety; however, there are several additional factors that influence a student's feelings towards mathematics including situational factors, temporal factors and gender-roles.

For these reasons alone, I made it a personal goal to create as comfortable of a learning environment as possible, and try to maintain a happy medium between a "structured" and "laid back" classroom. Students do not like feeling embarrassed in front of their peers, which is what happens when they answer questions incorrectly in front of the class as a whole. Because of this, I encourage cooperative learning and small group participation. I also make a tremendous effort to create a climate where students feel that they can interact in an enjoyable way. However, I have noticed that this is a demanding process and that some students are harder to influence than others are. I understand why many teachers struggle with establishing this type of environment. Because I teach high school, my students have sometimes been experiencing this mathematics anxiety for upwards of 10 years. Throughout my research, I will explore more in depth the source of this anxiety in female mathematics students and ways that the teacher can help alleviate and combat it.

How I Relate to this Research

In order to conduct this research, it is important to understand why this topic is so meaningful to me. Anxiety is a sensation I have experienced for many years. As young as 4th grade I have memories of feeling anxious in a multitude of situations ranging from participation in sports and activities to completing school work. As I transitioned through my school years, I recall experiencing anxiety specifically in math class. My earliest of these memories revolves around multiplication facts and the stress of having them mastered for games such as "around the world" and "mad minutes" that we would play during math class. The math itself was not difficult for me, but I often found myself under-performing due to the high stress nature of being timed or "battling" my peers as to who could determine the answer first. As my schooling journey progressed, this anxiety continued to present itself in the mathematics classroom. As a

pre-algebra student in seventh grade, I have a memory of my teacher disclosing an incorrect answer I listed on a quiz to the entire class. Although this teacher did not disclose my name to the class, the teacher made me feel invalidated by my mistake. I felt mortified and was turned off from participating in the future weeks. However, although my anxiety for math still existed, I tended to outperform many of my classmates which allowed me to stay on an advanced track throughout high school. It came as a surprise to my parents when, in high school, I became one of the top students in my mathematics courses; successfully completing calculus my senior year. Although the anxiety continued, I found a way to contain it and was able to learn how to successfully study for these high school level courses – in return not only passing them, but also further maintaining a high-grade point average, a high class rank, and earning a spot in the esteemed National Honor Society.

I was able to identify this anxiety throughout high school, but did not initially recognize my strength in mathematics as I made the journey to college to pursue my undergraduate degree. I always knew I loved mathematics, but experiences I had in the past led me to believe that I was not talented enough to pursue the field as a career. Because of this, I was initially a student in a Pre-Physical Therapy program. This program was not very interesting to me, and I often caught myself saying things such as "I wish I had a math course this semester." After a lot of trial and tribulation, I made the decision that I was destined to be a teacher. When deciding what to teach, I knew I wanted to work with high schoolers, so selecting a subject became my utmost priority. I was seconds away from declaring science as my concentration, as I had already taken many science courses for my Pre-Physical Therapy path, however, decided after a last-minute conversation with my father that the extra year of school would be worth it to teach my favorite subject. During my sophomore year of college, I switched my major to Secondary Education –

Mathematics. Although it was an exciting time, knowing that I finally decided what I wanted to do for the rest of my life, unfortunately this is also when my anxiety began to make its return.

As I began my journey as a student of mathematics, I experienced a fluctuation of feelings. It was almost instant that I realized the influence my anxiety would have on my performance in the classroom. Being a more grown and experienced student at this point then when I was a student in high school, I realized that this anxiety would pose as a complication. One professor in particular truly brought out my inner anxiety. Her teaching style included an around the room style component, similar to when we would play around the world in elementary school. However, it was slightly different, as she used it as a participation technique to make sure we were paying attention. I was always a focused student; I took great notes, and always paid attention. However, math was also something I needed to work at, and would often spend a lot of time after school studying and reviewing my notes prior to completing assignments for the class so I could further develop a foundation of understanding. This specific professor would ask questions as she was teaching us by going up and down rows. You could claim, "pass," if you did not know an answer, but this response was noticeably frowned upon by the professor. I recall several instances where I knew my turn was approaching, and would excuse myself to the bathroom in hopes that she would pass my row by the time I returned. I believe that this truly led me to focusing on the next question she would ask rather than me paying attention to the material, and therefore caused me to truly struggle in her classes. I attended her office hours weekly for assistance. One day when I went to meet with her, she asked "Are you sure this is the right major for you? Are you sure you can handle this? I think you should reconsider your decision." At this point, I knew the reason why I was not performing well in her class. It was not because of the material being too difficult, or the effort that I was putting

in, but the anxiety I felt surrounding the class itself. Moreso, I realized where this anxiety was coming from.

I believe that it was this stress imposed by my professor that caused my anxiety, in turn affecting my performance in her courses. However, due to the cumulative nature of higher-level mathematics, my misunderstandings from those courses spiraled into future coursework. Jackson and Leffingwell (1999) pose a similar argument stating, "Since mathematics requires sequential-thinking skills, and stress in the mathematics classroom will have even more adverse effects because of the nature of the subject." (p. 585). Because of the order that mathematics is processed, understanding the basics is vital in order to be successful in the future. Due to the common themes between my success as a student, and now the success of my students, the relationship between the mathematics teacher and student success is what I will continue to explore.

Upon graduation and earning a job as a math teacher at a local high school, these feelings returned throughout my first year of teaching. Not only now was I in charge, but I was supposed to be the "expert". Although I believe that I am a great mathematician and teacher, there were many times that I, myself, experienced anxiety especially throughout my first year. I was under the pressure to know how to explain specific math problems in multiple ways, knowing answers quickly, and was expected to not make any mistakes. I now had 130 students who relied on me to help them create a mathematical foundation to help them throughout their future courses. I have even had students who have graduated high school to pursue careers in mathematics, including actuarial sciences and becoming a teacher like myself.

I began noticing the anxiety my students faced - specifically my female students. In the survey I always give at the beginning of a new school year, I ask the question "Do you like

math? Why or why not?" I notice that although many students select "no" as their option, they often have trouble explaining exactly why it is that they struggle with the subject. The purpose of this paper is to provide research indicating the many reasons why students experience this anxiety and answer "no" when asked if they like math. It is my hope that by exploring the research and identifying common factors, that there are also methods that can be used to help students, specifically females, who suffer from this anxiety.

The Problem with Mathematics Anxiety

People experience anxiety for many reasons. Anxiety can be as broad as generalized anxiety disorder, where one feels anxious at all times. On the contrary, it could be very specialized and oriented towards specific situations or ideas. In the specific case of mathematics anxiety, it can be developed at different times throughout the schooling process. The development of this anxiety causes students to resent mathematics. Even bigger than the anxiety itself is how this anxiety affects more young women than young men.

My thematic concern therefore revolves around the anxiety female student's face in the mathematics classroom. Identifying where the anxiety stems from, and how the anxiety develops are vital roles in determining how we can help our students refrain from feeling anxious. I would like to examine the role that the teacher has in mathematics education and how a specific pedagogy may influence the confidence of the learner, specifically in the case of exploring why mathematics anxiety affects more young women than young men. Through this research it is my hope to discover the true causes of this anxiety, and also methods to use to help prevent and alleviate mathematics anxiety among students.

The Anxiety Itself

Again, the research suggests that it is mathematics teachers themselves that cause female students to have mathematics anxiety. Exploring this further will help narrow in on my specific critical action research question.

In order to have a better understanding of this mathematics anxiety, more qualitative research is necessary. Throughout previously conducted inquiry, signs kept pointing back to the teacher and pedagogy. A large portion of math teachers utilize lecturing as *the* means of teaching. Lecturing is similar to the process of narration that Freire (1970) discusses in his book, *Pedagogy of the Oppressed*. By narrating to their students, teachers are requiring that they always pay attention and are able to dictate exact words and phrases said by the teacher. This concept of narration will be explored further on in this paper. However, right now it is important to understand the influence the instructor, and their preferred pedagogy has on student performance.

A trait that teachers who tend to utilize the concepts of narration and lecture in their classroom are often viewed as authoritarian leaders. An article written by Timming and Johnstone discussed the similarities between the authoritarian structure and personality traits of those who encompass this personality. Timming and Johnstone (2015) describe submission of subordinates by stating that "obedience and respect for authority are the most important virtues children should learn" and how "every person should have complete faith in some supernatural power whose decisions he obeys without question" (p. 160). This type of leadership in the classroom could lead to a lot of tension among students. If they are expected to accept everything their teacher says as true and irrefutable, it is easy for that student to also assume that they are not allowed to ask additional questions. So much, in fact, that Farrel (2006) states, "Students are

often afraid to ask questions about concepts they feel they should know already, which creates a snowball effect. The student falls behind, and his or her confusion grows with each new mathematical concept. Catching up can seem like an insurmountable task," (p. 1). In other words, once students who are put into this situation fall behind, it will be even more difficult for them to catch up.

It could be easily said that teachers who create this type of culture in their classroom will have students who feel apprehensive about seeking extra assistance. The nature of mathematics is highly cumulative. One topic builds on another, and courses are ordered in a way that ensures prior knowledge will be retained. By creating an anxious student who falls behind, they are losing this retention, and often tend to spiral. This causes teachers to develop and identify their ideal and esteemed student -- which will most definitely not be the student suffering with mathematics anxiety. It has even been said that "Some studies have shown that American math teachers think their best students succeed because they are gifted, while teachers in other countries think their highest-achieving math students succeed because they work hard," (Farrell, 2006, p. 1). By creating this stigma, we, as teachers, are allowing not only our students but the world to know that authoritarian style teaching is harming our students and stunting their mathematical growth.

In conclusion Farrell (2006) states, "Some mathematicians may never agree to give up the lecture approach. But a few professors say requiring all math instructors to take at least one education course would help them reach students more effectively," (p. 1). With a plethora of newfound teaching methods, it is important as ever to make sure as educators we are keeping up to date with this data and perseverance towards creating a less anxious environment for our students.

A large role the mathematics teacher takes in the classroom, as any teacher, is the expert in the room. As the expert, it is the teacher's job to decide the extent of knowledge their students must know and understand. Something that has assisted mathematics teachers over the course of the introduction of technology is the incorporation of calculators and computers. Unlike the past, there are now tools that are readily available to utilize for any and all calculations. "Mathematics today should actually be easier for students than it was in pre-technological days. It is no longer necessary to learn certain techniques; there is a great need to learn more and different mathematics, but this can often be done with the use of new technology. For example, in the study of calculus there is no need to learn the techniques of differentiation and integration as we had to in the past. The computer, and some graphing calculators, can solve these problems numerically. Instead, we can concentrate on the teaching of basic concepts and on understanding why and when certain calculations are necessary," (Wieschenberg, 1994, p. 1). One would think that the use of technology would help to alleviate some of the mathematics anxiety students are feeling. However, the use of this technology is at the discretion of the teacher. Technology or lack thereof, is a definite way that teachers can instill mathematics anxiety into their students. By removal of these everyday devices, teachers are adding unneeded pressure to their students by forcing them to memorize all processes and not simply focusing on why and when to use specific calculations.

Why Women?

It is quite simple for one to ignore the blatant inequality among genders that still exists in schools today. A lot of this female oppression begins in the home, and carries through culture and brought to the school setting. Gender destiny is described as "the unavoidable situation, tied to gender roles, that awaits men and women," (Palacios, 2012, p. 142). Many cultures still accept

this gender destiny, which in turn, affects the freedom of the individual. Further, it is said, "gender destiny is also related to family expectations regarding the importance of education for men and women, which attribute very little value to women's education," (Palacios, 2012, p. 143). With these types of inequity still in place, female students who come from these households are automatically trained to believe they will not need school or an education. This may, in turn, lead to lack of interest and ultimately, failure.

What I would truly like to take the time to examine is how gender roles influence mathematics anxiety. Research states that more girls are affected by mathematics anxiety than boys. Although not one specific reason can be identified as to why more females experience mathematics anxiety than males, there are several explanations. One major influence that will be researched involves the way that boys and girls are socialized throughout childhood. This often includes conversations with girls about becoming mothers and homemakers, while boys are socialized to believe that they need to obtain high paying jobs in intellectual fields. By socializing young girls differently than boys, it is creating a divide in the girls who feel comfortable entering the world of mathematics, as it is socially and historically seen as a male-dominated field.

The concept of mathematics being a male-dominated field is supported by history and research. Historically, there are more men that are recognized in the field of mathematics, therefore the assumption could be made that men are more inclined to enter the field. The concepts of mathematics anxiety stem from this historical inaccuracy of men being more apt to becoming notable mathematicians. Later in this paper we will explore the gender differences as posed by several researchers. The research indicates many reasons as to why men are more inclined to enter the field of mathematics then women. These reasons include the acceptance of

feelings and emotions, historical influences as well as genetic differences between men and women. By researching and exploring the common causes of mathematics anxiety, why this anxiety affects female students at a higher rate and the history behind mathematics and anxiety, the goal of this program is to provide educators with a tool box of methods that can be used to prevent and alleviate mathematics anxiety.

Chapter 2

Thematic Concern, Conceptual Framework, and Definitions

THEMATIC CONCERN:

The social structures that currently exist promote mathematics as a patriarchal field. Due to this, young female mathematics students are left without female mathematician role models, and are oftentimes influenced to pursue studies in other subjects, although this trend is being to change as more women enter STEM fields. This lack of recognition influences young females' mental health, therefore inflicting anxiety towards the subject of mathematics itself. Accounting for even more math anxiety among female students is the way in which math is taught (i.e. pedagogy). To rectify this inequality, I am proposing a course designed to assist teachers in becoming more aware of the gender bias that exists within the subject of mathematics and provide methods that teachers can use to prevent and alleviate anxiety. The overlying theme of this course will focus on discussions regarding the construct of gender, the history of mathematics anxiety and how to use place based education and mindfulness as a coping mechanism for overcoming anxiety.

CONCEPTUAL FRAMEWORK:

1. What are some of the possible reasons mathematics anxiety exists, and what role does the educator play in the development of mathematics anxiety in students?
2. What patriarchal influences promote the development of mathematics anxiety in women?
3. What historic considerations have led to the development of mathematics anxiety in female mathematics students?
4. What can be done to combat anxiety experienced towards mathematics and anxiety found in female students in general?

DEFINITIONS:

Constitutive:

Authoritarianism — For the purpose of this paper, we will define authoritarian as it refers to the teacher. Oxford Languages (2020) defines authoritarianism as "the enforcement or advocacy of strict obedience to authority at the expense of personal freedom."

Banking Model of Education — A term posed by Paulo Freire in his book *Pedagogy of the Oppressed* (1970) that is used to describe the traditional education system involving teacher-centered curriculum and assessing students by their ability to regurgitate facts.

Ideology — Oxford Languages (2020) defines ideology as "a system of ideas and ideals, especially one which forms the basis of economic or political theory and policy."

Mindfulness — As described by Mindful (2020), mindfulness can be summarized as the ability to be aware of one's self including the mind, body and environment. Mindfulness practices often include meditation and self-reflection.

***Operative*:**
For the purpose of this paper,
the following definitions will apply

Authoritarianism — For the purpose of this paper, we will define authoritarian as it refers to the teacher. Oxford Languages (2020) defines authoritarianism as "the enforcement or advocacy of strict obedience to authority at the expense of personal freedom."

Democracy	A form of government that is a representation of the collective group. The institutionalism of freedom.
Patriarchy	The concept of a male-dominated society. The term patriarchy often refers to the oppression of women as members of the society, demoting women as homemakers instead of considering their strengths as leaders in society.
Political Freedom	The freedom from oppression and ability to live in a social system with individual rights.
Critical Consciousness	An in depth understanding of the world, considering social and political differences.
Place Based Education (PBE)	A form of education that connects learning and the community. PBE often involves the connectivity between education and the environment.
Universal Design for Learning (UDL)	The goal of UDL is to use a variety of teaching methods to organize instruction in a way that removes any obstacles that different types of learners may face throughout the learning process.

Chapter 3

The Narrative

Possible reasons mathematics anxiety exists and the role the educator may play in the development of mathematics anxiety in students

What is anxiety?

As long as I can remember, there has always been someone in every math class asking "Why do we have to learn this?", "When will I use this in real life?" or even simply stating "I hate math." As a student, math came easily to me. I was able to follow along with a few examples, and use my inductive and deductive reasoning skills to work towards a solution. As an undergraduate student I found a group of like-minded individuals who all saw math the same way. As a group we began questioning why it is that math "comes easier" to some than others. Is it the way we are taught when we are young? Is it the hard wiring of our brain? Is it a combination of both? This curiosity is one of the reasons that led me to pursue my degree in mathematics education.

As a teacher, it did not take long for me to notice how anxious my students were in my classroom. In fact, I realized it on the first day of school when I asked the infamous question "Who in this room hates math?" and a majority of my students raised their hands. This forced me to think about the word anxiety, which is a buzzword in the realm of mental health. Exactly what is anxiety? Why do students feel anxious? In a world where everyday stressors are being amplified, outside pressures are exhausting. Students are being held to extremely high standards and the mental health of students has grown to be a major concern within schools. We live in a world where students are affected by not only the pressure to do well in school, but also by peer

pressure, cyberbullying, state testing, parent pressures and so on. It is no wonder why the student mental health crisis is being discussed more and more among professionals.

Exploring where this anxiety comes from is important in understanding exactly why it largely affects young mathematics students. In the book *Your anxious child: How parents and teachers can relieve anxiety in children (2nd ed.*) Dacey and others (2016) explore different types of anxiety in children and coping mechanisms to help them manage their anxiety. It is no surprise that they found "a huge number of children suffer from one (or more) of the eight anxiety disorders -- anxiety is currently the most prevalent psychiatric diagnosis in individuals aged 16 and younger," (Dacey, 2016, p. 2). More now than ever, kids are feeling fear and worry. Although there are many different types of anxiety, the fears that cause anxiety all refer back to only a few major causes. Biological factors, such as hormonal imbalances and abnormal brain activity; psychological factors, including anxiety resulting from disturbing experiences and social factors and how your child interacts with family and friends (Dacey, 2016, pp. 7-10). Although these reasons vary, they all play a part in the development of general feelings of anxiety.

Anxiety towards a subject specifically is an interesting thought. How can one child feel success easily while in the English or social studies classroom, but completely shut down when it is time to learn math? What exactly is math anxiety? Math researchers, according to Finlayson (2014), define math anxiety as a "feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations" (p. 100).

There are many causes that have been explored relating to mathematics anxiety in young students. The influence of peers, teachers, home life and the relation to general anxiety disorders

all have a huge role. However, there are several other reasons as to why mathematics promotes such a strong sense of anxiety in young students. Finlayson (2014), a mathematics anxiety researcher, states that this type of anxiety has several causes. First, most math courses are taught using direct instruction. A teacher provides examples, students practice with a group, practice independently, and then are expected to take an assessment focusing on rote memorization. This rigid approach does not give students a say in their own learning, and in turn, causes students to lack self-confidence. Finlayson (2014) takes it a step further by stating "There is a focus on success and getting results, instead of on understanding," (p. 101). One thing that teachers, in many cases, are able to control is not *what* they teach, but *how* they teach it. If this is truly the case, it could be argued that certain teaching methods influence mathematics anxiety more than others.

The Ideal Utopian Mathematics Classroom

When thinking about mathematics education, it is simple to imagine the "perfect" classroom – a true learning environment where students feel free to explore and discover mathematics through multimedia and many other means. Imagining a world where all students actively participate in the classroom, engage in their learning and conversation with peers, and take ownership of their learning is the ultimate ideal of any teacher. There have been copious amounts of research as to what creates this type of environment, including the importance of "addressing students by name," "using good manners," and having a "zero-tolerance bullying and drug or alcohol use policy." However, what all of these "ideals" lack is the evidence behind why they exist and how they affect the learning environment. This means, in order to determine the ideal learning environment, it is necessary to first explore our (so called) democratic society.

To create this image, one must understand the strong influence culture has on education. When we think of a "democratic society," it is easy to jump right to the conclusion that the word *democratic* means that everyone has a say and that everyone's opinions matter. Many would even argue that living in America, we are already members of a democratic society. However, I believe that this can be easily challenged by simply examining the viewpoint of our Secretary of Education, Betsy DeVos.

One way that America currently represents a democratic educational system is by providing the "choice"—and I use that term loosely— between private and public education. I say this because there truly is no choice unless you are wealthy. Private schools and academies range from religious institutions that strive to instill the ideals of, for example, a strong, Christian woman, all the way to elite boarding schools that only children of the upper class can afford to attend. It is no surprise that many of the people who currently control our country are alumni of such prestigious establishments -- one of the members of this elite social establishment is our very own Secretary of Education, Betsy DeVos. Diane Ravitch, a writer for the magazine *In These Times* (2017) states, "She did not attend public schools, nor did her children. She has never been a teacher, administrator, practitioner or scholar of education. In fact, one wonders whether she has ever actually set foot in a public school." (p. 17). I understand this is not a "theory" of education; however, it is crucial to note the weakness presented in that the person in our government responsible for guiding our country's public educational system is actually against the free, democratic education that the United States' public schooling provides its students. By having members of our society with these beliefs hold such important political positions, we, as Americans, are only setting our needed democratic educational system up for failure.

Establishing the ideal political standpoint is the first step towards understanding what education should look like in a free, democratic society. Bruce Romanish (1995), an American educator, states in his essay titled *Authority, Authoritarianism, and Education* that "The achievement of political freedom in a democratic system results from the conscious plans and actions of a human community" (p. 1). In other words, to truly achieve the standard of creating ideal free, public institutions, it must first be understood that political freedom is unavoidable. One must completely establish his or her political independence to ensure that personal freedom is not relinquished.

Political freedom is just the first step towards creating the optimal learning environment. In the rankings with political freedom lies the importance of creating an engaging, transformative culture inside of the classroom by providing a space where students have a say in their learning. This concept is extremely important – so important, in fact, that a lot of "current research in math education offers tremendous insight into what works (and what does not work) to engage students in mathematics thinking and learning" (Jones, K, Vermette, Jones, J., 2012, p. 171). Identifying these many different methods is the basis of my philosophical position on mathematics education.

In order to understand what the ideal mathematics educational philosophy is, it is important to understand exactly what it is not. The concept of narration is a perfect example of a dictatorial trait that all teachers are guilty of in one way or another. By narrating to their students, teachers are requiring that they always pay attention and are able to regurgitate exact words and phrases said by the teacher. Within this concept, Paulo Freire (1970) states in his book, *Pedagogy of the Oppressed*, that

> Narration (with the teacher as a narrator) leads the students to memorize mechanically the narrated content. Worse yet, it turns them into "containers," into "receptacles" to be

> "filled" by the teacher. The more she fills the receptacles, the better a teacher she is. The more meekly the receptacles permit themselves to be filled, the better students they are. (p. 72)

This practice could be seen as the basis of education throughout history. It establishes the concept that the teacher is the authority figure who teaches, and the students are expected to memorize and regurgitate exact statements and ideas. The concept of learning is to make sense of an idea in a specialized, individual way. To learn is not simply to commit facts to memory, but to dive into the meaning behind *why* a concept or idea exists. However, most examine education from the authoritarian perspective, finding that the teacher is the authority figure and the student is there simply to learn through rote memorization.

The authoritarian model encompasses those who "seek obedience under a condition of control supported by fear" (Romanish, 1995, p. 19). An essay exploring the effects of authoritative leadership in the classroom explains the calls this "high press and low caring." (Dever, Karabenick, 2011, p. 131). In researching studies that assess the effectiveness of authoritarian education in the mathematics classroom, there are also specific parallels between the achievement of the student and his or her specified gender. It is easy to see why students would struggle learning from a teacher who adopts the authoritarian style of teaching. Research conducted by Dever and Karabenick (2011) states "Females showed lower levels of achievement gains and reported less interest in mathematics on average" (p. 140). This is just one specific example of how authoritarian educators negatively affect their female students. By continuing to allow students to be taught via the authoritarian model, teachers are not—and never will be—promoting their students' freedom.

On the contrary, there are countless things that educators can do to develop a conducive culture for learning mathematics. Ideas such as cooperative learning, project-based learning,

teacher questioning, student choice and classroom discussions are a few specific examples. Many of these research-based methods evolved from the thoughts of great philosophers, including John Dewey and, as mentioned earlier, Paolo Freire.

John Dewey's book, *Democracy and Education* (1916), highlights a multitude of aspects regarding education and its foundation, including how education promotes direction and growth as well as explores theories of knowledge and morals. These ideas are fundamental in order to fully comprehend how education can become more democratic. Exploring more in depth, Dewey (1916) identifies that the importance knowledge—or more specifically how material learned in school— should have deeper meaning by stating, "There is the standing danger that the material of formal instruction will be merely the subject matter of the school's, isolated from the subject matter of life- experience," (p. 13). In other words, by completely formalizing instruction, we are removing what makes education great, which is being able to learn through exploration and discussion. This statement specifically summarizes how Dewey views the ideals of education—making learning meaningful for students and for teachers.

I believe that Dewey's view of education directly relates to ideas expressed by Paolo Freire in both *Pedagogy of the Oppressed* and *Education for Critical Consciousness*. Freire believes strongly in the idea of education for individual freedom and states that once one reaches critical consciousness, he or she can be identified as a free individual, specifically discussing the importance of teaching by means of decoding. Freire (1950), states that, "By stimulating "perception of the previous perception" and "knowledge of the previous knowledge," decoding stimulates the appearance of a new perception and the development of new knowledge." (p. 115). This correlates directly with a current common educational theme of teaching learners by accessing their prior knowledge. By learning new information based on prior knowledge,

students are building on what they already know and are creating a more in-depth understanding of previously learned material. If students are able to learn by means of decoding, they are in return learning to be more comprehensive. In an article by Scott Seider, Jalene Tamerat, Shelby Clark and Madora Soutter (2017), the process of developing a critical consciousness through a character framework is examined. This article states that "critical consciousness is the ability to analyze, navigate, and challenge the oppressive social forces shaping one's life." (p. 1162). By developing critical consciousness through decoding, students are learning how to battle and challenge their oppression. Through utilizing decoding in schools, teachers are shifting from teaching students to regurgitate information, which is a perfect example of the authoritarian model, to seeing the image of a school as an "opportunity structure," where students are learning how to teach themselves.

In addition to exploring how learning is meaningful for students, it is just as important for learning to be meaningful to teachers. Paolo Freire (1998), in his book *Pedagogy of Freedom* explores the idea of "unfinishedness" both from the perspective of the student and the teacher. However, this concept is more meaningful when considering the role of the teacher in the classroom. Think back to your high school years. Can you remember a teacher who just knew it all? Who was the total authoritarian figure? What they said, goes? Unfortunately, this is the reality in many classrooms around the world. I have seen this first hand in mathematics classrooms throughout high school and as an undergraduate student. Teachers with an authoritarian view of education demand respect from the classroom, do not allow for discussion, and create a tense environment where students do not feel comfortable discussing with classmates, or even asking the teacher a question. Teaching is not just transferring knowledge. It

is creating a space where students feel free to openly converse and have a say in their own learning, which is where the idea of “unfinishedness” comes into play.

As a teacher, one must also be a learner. The concept of being a learner-teacher is a never ending loop. Teachers must consider how their presence affects a room full of students. Being an unfinished being does not end with simply knowing of your unfinishedness, but also allowing others to understand that you are still learning. Freire (1998) states, “As a teacher with critical acumen, I do not cease to be a responsible "adventurer" disposed to accept change and difference. Nothing of what I experienced as a teacher needs to be repeated. However, I hold that my own unity and identity, in regard to others and to the world, constitutes my essential and irrepeatable way of experiencing myself as a cultural, historical, and unfinished being in the world, simultaneously conscious of my unfinishedness” (p. 31). By being aware of this unfinishedness, it creates the capacity for students and teachers to learn coherently in the classroom by creating a mutual respect between teacher and student.

Capacity could be defined many ways. The maximum amount something can contain, the amount of knowledge a person is able to stably hold, the ability to complete something, learn something or do something; capacity means something different for every situation. However, when it comes to the capacity to apprehend reality as a learner-teacher, I believe Freire (1998) states it best by saying “Our capacity to learn, the source of our capacity to teach, suggests and implies that we also have a capacity to grasp the substantiveness / essence of the object of our knowing.” (p. 66) First, exploring the concept of “learner-teacher”. One’s capacity to learn is directly influenced by one’s capacity to teach, and vise-versa that one’s capacity to teach is directly influenced by one’s capacity to learn. The two are cyclical. However, the term

"capacity" changes this statement. One's willingness, capability, ability, to teach and learn are directly affecting their teaching and learning.

Through research and experience, there is a direct correlation between student achievement in mathematics and their teachers' methods of educating. There are several suggestions as to what this anxiety stems from, including fear of failure, peer influence, and teacher-driven dismay. Although every student who suffers from mathematics anxiety has his or her own story, these are central ideas as to why mathematics anxiety exists. Understanding why this anxiety exists and how it develops is the first step towards identifying a way to prevent these feelings in future generations.

Teacher Influence

It is easy to begin by identifying the role of the teacher and how he or she influences students. It is proven that the authoritarian style of teaching is more strict and many students do not benefit from this style in the classroom. It is quite simple to think of those who suffer with this anxiety as oppressed, referring to the teacher as the oppressor. By teacher influence, students who suffer from this anxiety are emotionally dependent on their teacher because that is where their anxiety stems from. Freire (1950) states, "The oppressed are emotionally dependent" and later continues, "This total emotional dependence can lead the oppressed to what Fromm calls necophilic behavior: the destruction of life—their own or that of their oppressed fellows," (p. 65). Overall, if the oppressed student is emotionally dependent on the teacher, the oppressor, he or she will be unable to learn and in return may develop this mathematics anxiety.

On the contrary, it can be argued that the more "laid-back" teacher also creates this type of anxiety. A case study in Turkey discovered the correlation between the personality of the teacher and student learning. The study observed three different teachers: one whose leader was

very democratic, the second whose leader acted authoritarian, and the third whose leader was very flexible. As stated by the case study by Ici and Oksuz (2014),

> Children managed by democratic leader had less work than children managed by authoritarian leader. When democratic leader leaved from classroom, productivity of children did not decrease much more (from 50% to 46%) and children continued to study willingly. However, when authoritarian leader left, productivity of children decreased suddenly (from 70% to 29%) and some of students tended to fight and assault. Some of the students from the same group looked like too kind but did not study without the leader. In the third group with the flexible leader, children were seen uninterested, passive and bored. Productivity of the children found at 33%. (p. 3204).

Having already discussed the effects the authoritarian teacher has on students, I would like to move ahead to examining the flexible leader. In the case where a teacher is too flexible and free-spirited with his or her students, it is creating a lethargic culture where students learn to believe the subject is not worthy of their attention, which in return leads to lack of interest. These students who are not interested in the subject will not want to practice this material and ultimately will not be successful on assessments. This is another way that mathematics anxiety can develop.

A separate study exploring the influence of student characteristics and interpersonal teacher behavior in the classroom conducted by Karen Petegem, Antonia Aelterman, Hilde Van Keer and Yves Rosseel (2007) shows how students who are led by a submissive-cooperative teacher are also often found uninterested:

> This kind of teacher allows the student a lot of individual space combined with less leadership and guidance. A definite sense of structure and of task orientation is lacking. The students are not always attentive and are often preoccupied with other matters. The more motivated students do pay attention and the teacher needs to address them loudly to overcome classroom noise. Appeals for attention have little or no effect. Even so, the teacher continues helping the students and will time and time again re-explain, all the while knowing that the students simply weren't listening. Students often consider this type of teacher as too nice. This behaviour can be explained by taking the general student attitude towards mathematics into consideration. (p. 288)

This study proves something slightly different from the other, in exposing that students who are led by a submissive-cooperative teacher lack structure, which leads to students becoming uninterested and creating an off-topic classroom culture. When in this type of setting, an environment is created that allows students to lose focus and learn to identify math as a class that is unimportant.

Carol D. Jackson and R. Jon Leffingwell, mathematics anxiety researchers, go into detail about the many ways that teachers help and / or hinder their students' success. Jackson and Leffingwell (1999) stated, "Instructors must be aware of their impact on students. Students tend to internalize their instructors' interest in, and enthusiasm for, teaching mathematics. Conversely, if students think that the instructor is not happy teaching and does not enjoy being with them in the classroom, they will be less motivated to learn." (p. 585). I notice this in my own classroom – students respond better to my teaching when I am enthusiastic about a topic and that students complain more, and are less successful in classes where their teachers are not as involved with the subject and student learning.

However, it is not just simply the teacher, but the classroom culture the teacher creates. "Situational factors creating math anxiety may include the personality of the teacher, instructional strategies, classroom climate, and test anxiety. Math anxiety does not necessarily arise from the mathematics itself but rather from the classroom mathematics instruction experienced," (Goldsby, 2013, p. 1). There are clearly many different factors that affect the success of students. Nonetheless, throughout the listed causes of anxiety, there is one common theme – almost all of the causes stem from the pedagogy of the teacher.

Influences on the development of mathematics anxiety in women

Gender Roles

Although gender equality has come a long way, we are still living in a male-dominated society. Men are still on average making more than women in the workplace, and continue to hold many positions of power within businesses, the government and even the home. Sylvia Walby (1990), a patriarchy, gender and feminist social theory researcher describes patriarchy as "a system of social structures, and practices in which men dominate, oppress and exploit women" (p. 214). Instead of individualizing patriarchy as one main form of oppression, Walby breaks down the concept into smaller sub-categories. In short, Walby (1990) explores patriarchy through six structures: production relations in the household, paid work, the patriarchal state, male violence, patriarchal relations in sexuality and patriarchal cultural institutions (p. 214). The area we will focus on in this section is the patriarchal state, in other words, how the male influence on state structures shapes the fields of education and schools.

Historically in education, dating back to one room school houses, teaching has been seen as a women's profession. However, more esteemed education titles, such as being a professor, have been predominantly male-centered. Exploring the cultural institution of education, Walby (1990) states "The educational system has been important in both differentiating men and women and providing men with more credentials. The forms of closure against women are usually more subtle because of the explicit discourse of 'meritous achievement'," (p. 227). Although the divide between men and women as educators is seen as faint, there is a separate argument to be made about the historical advantages men had over women as mathematicians which will be explored later.

Due to the nature of this research aligning with gender studies, feminism is a critical application of philosophy. One important figure is Mary Wollstonecraft, a philosopher and advocate for women's rights. Mary firmly believed that education should be used as a way to create equality in the household. If men and women were not equal, there would be an unbalance in the household, which would jeopardize creating a just, democratic society. I believe this viewpoint is vital to understanding the relationship between gender and mathematics anxiety. Gender inequality has a long history and still remains an ongoing battle. Although, as a society, we have come a long way since Wollstonecraft, we as teachers are still (sometimes unknowingly) participating in similar practices by treating male students differently than female students. By concluding that mathematics and science are male-dominated fields, we are oppressing female students. Although I do not believe with Wollstonecraft's entire viewpoint of education, as it is true that she believes, "Children should be educated at home, where the 'domestic affections' can be instilled in them while spending a 'great part of their time, on terms of equality, with other children" (Frazer, 2011, p. 613). Although this seems somewhat contradictory, it can be said that her beliefs on instilling this version of equality is what counteracts her viewpoint on educating in the home.

Influencing Anxiety

What I would truly like to take the time to examine is how gender roles influence mathematics anxiety. An article in the *Association for Psychological Science* states that "female students report higher levels of mathematics anxiety than do male students," (Goetz, Bieg, Ludke, Pekrun, Hall, 2013, p. 2079). Due to existing gender roles in society, it has been a long-standing stereotype that the fields of mathematics and science are male-dominated. This cultural trend has recently been somewhat reversed by a rise in the number of female mathematicians, but

this does not allow us to forget the past and how the fundamentals of mathematics was discovered and developed by men. In order to fully understand why this separation occurs, we must examine the sex-role and how mathematics is cultivated in the initial socialization of adolescents.

Research on mathematics anxiety and its effects on students has been conducted all over the world. Specifically, one article, *Gender Difference of Chinese High School Students' Math Anxiety: The Effects of Self-Esteem, Test Anxiety and General Anxiety* by Fang Xie, Ziqiang Xin, Xu Chen and Li Zhang (2018), explores a study completed in China with a population of 751 total students ages 12-18, 450 of which were young girls. This study explored three main things: the differences in reported math anxiety between young men and young women, the relationship found between a child's self esteem and their reported math anxiety, and took the concept of self esteem one step further and explored how it affects math anxiety through control beliefs (Xie, 2018, p. 1). The results were astonishing. Overall, this study found that women have overall higher general anxiety.This is no surprise, as young girls are more self conscious and worried beings. Additionally, the research showed that girls self esteem, test anxiety and general anxiety had an indirect effect on math anxiety and that improving girls self esteem also improved the anxiety they felt (Xie, 2018, p. 8). In this day in age, with the ever popular increase in use of social media among kids, I believe that young girls especially feel peer pressure more so than ever before. With the instant gratification provided via social media, girls are always posting "for likes" and overall are a lot more self-conscious and self-aware. This to me plays into self-esteem, and proves as no surprise that like mental health in general, self-esteem plays a large role in young girls anxiety in the classroom -- especially math, which is known to be a largely male-dominated field.

Another study conducted in the Netherlands returned similar results. However, this study instead examined 124 elementary school children, 62 of them in second grade and 62 in fourth grade. To explore the differences in boys and girls, several math achievement tests and the Tempo Test Arithmetic (TTA) was used - which measures the production of basic arithmetic performance (De Vos, 1992). Upon examining results, it was found that girls and boys performed equally on the math test, although boys performed slightly better at the TTA (Van Mier, 2019, p. 8). This shows that although there is little difference in students' performance on math achievement tests, basic arithmetic proved to be problematic for young girls. So young, in fact, that research showed "math anxiety is already negatively linked to math performance in girls as early as 2nd grade," (Van Mier, 2019, p. 11). By narrowing in on this math anxiety sooner and providing intervention, teachers and parents will combat the lifelong consequences of avoiding math and math related tasks.

Although not one specific reason can be identified as to why more females experience mathematics anxiety than males, there are several explanations. One, as suggested by Amy Devine, Kayleigh Fawcett, Denes Szucs and Ann Dowker (2012) state, "the different ways in which boys and girls are socialized during childhood may differentially affect the anxiety experienced by males and females in certain situations. This hypothesis, known as the sex-role socialization hypothesis, argues that because mathematics is traditionally viewed as a male domain, females may be socialized to think of themselves as mathematically incompetent and therefore females may avoid mathematics and when females do participate in mathematics activities they may experience more anxiety than males," (p. 6). In other words, by socializing females to believe that they are not as competent as men, steering them away from mathematics and science related fields, parents and teachers are telling these female students that they are not

good enough. This, in turn, promotes a self-image where girls may think of themselves as inferior, which ultimately creates anxiety revolving around the subject matter itself. This is not the only reason mathematics anxiety occurs more in women than in men, but it can definitely be one of the major causes.

This stigma is one that has been adopted by society and accepted as the truth. By confirming that mathematics anxiety is present more in female students than in male students, society is truly burying gender equivalence and once again creating a divide. However, there is one simple way that society can help to halt and prevent mathematics anxiety. Another societal stereotype is that men are conditioned to contain their feelings and not let their superiors know when they are feeling upset, stressed or anxious. This concept dates back with our military—specifically, in creating men who are in the field to complete a job—not letting fear overcome them. These military practices have carried into society, helping parents to create strong (but unemotive) male children. Devine, Fawcett, Szucs and Dowker (2012) state that "Another possible explanation for the gender difference in MA is that females may be more willing to admit to feelings of anxiety than males because the expression of emotion by females may be accepted whereas the expression of anxiety in males may be viewed as less acceptable," (p. 6). By creating a culture with our male children that indicates expressing feelings is acceptable and necessary, it will help to expose the anxiety levels sooner, which in turn will help to create ways to help diminish this experienced mathematics anxiety.

Home and School

As big of a responsibility as the parents have in creating an environment where their children feel comfortable with expressing their thoughts and feelings, teachers have just as big of a commitment to creating a classroom where all students are treated equally and all voices are

fairly heard. In an article written by Carol D. Jackson and R. Jon Leffingwell, the role of instructors in creating mathematics anxiety is explored. Jackson and Leffingwell (1999), state that gender bias is one of the main reasons as to why this anxiety is developed stating "Instructors told some females that girls do not need mathematics … Girls were ridiculed more overtly than boys when they asked for clarifications … Teachers did not intervene when girls were verbally abused and belittled by their peers … Instructors repeated explanations more often to boys than to girls … Boys, regardless of ability were helped to substantial degree more than girls" and even "When girls asked questions, some teachers laughed at them or told them in class that they were stupid" (p. 584). By creating an environment where all students do not feel equal, it is instantly developing a classroom culture where students do not feel comfortable asking questions or pursuing clarification. If this is indeed affecting more female students than male students, it is likely that teachers are not allowing their female students to receive the help they deserve and are hindering their success.

It is important for teachers to take the reins to end this idea that male students are more naturally inclined in mathematics than female students—so important, in fact, that by ending this stigma, we, as educators, are truly affecting future generations by creating an environment that evens the playing field. "By encouraging girls to not shortchange their potential for success in these domains, the gender gap in perceptions of math anxiety, and the detrimental consequences of girls' beliefs that they experience more anxiety than they actually do, may be substantially reduced" (Goetz, Bieg, Ludtke, Pekrun, Hall, 2013, p. 2085). It is important to understand that it is not that our female students are *not capable* of success in mathematics, but that it is our job, along with their parents, to *create a culture* where female students feel that they have the same opportunity for success in mathematics as their male counterparts.

Patriarchy and the authoritarian model often coexist, as the oppression of women is a primary aspect of authoritarian forms of control. Authoritarian leaders require control in all aspects of their leadership, often demean their subordinates, and inflict embarrassment and angst. Unfortunately, the authoritarian style of education is still a prominent form across the world and is arguably one of the major causes of the development of mathematics anxiety in young females. Abolishing the authoritarian model of education as a classroom teacher is the ultimate first step towards minimizing mathematics anxiety in young female students.

However, the teacher is not always the savior of preventing math anxiety. In fact, it has been shown that many teachers themselves experience math anxiety. Researchers have found that many teachers do not feel comfortable teaching mathematics because they are unsure of their own mathematics abilities. This anxiety is especially prominent among female mathematics teachers. An article titled *Female Teachers' Math Anxiety Affects Girls' Math Achievement,* explores when the math-anxious individual is a female elementary school teacher, their math anxiety carries negative consequences for the math achievement of their female students (Beilock, 2010 p. 1860). This is extremely interesting, as it shows that not only does math anxiety affect females as students, but as educators as well. This article explored teachers who experienced math anxiety, and teachers who did not experience math anxiety and their effect on student performance and self-reported math anxiety. At the beginning of the school year, there was no reported relation between the teachers math anxiety and student math achievement. However, “by the school year's end, female teachers' math anxiety negatively relates to girls' math achievement, and this relation is mediated by girls' gender ability beliefs” (Beilock, 2010, p. 1861). One has to wonder how many children this type of anxiety has influenced, and how this may be different if math anxiety was addressed in pre-service teacher courses.

By exploring just a few of the causes behind mathematics anxiety, specifically in female students, it is easy to see how this is a concern in modern education. Large strides have been made over the past several years to create equality among genders. In order for our society to take the next step, it must be understood that educators need to put serious effort into promoting gender equality. Abolishing the patriarchal influences in education will allow young girls to have more freedom over their education, creating a more democratic society.

Historic influences on the development of mathematics anxiety in female students

The history of mathematics anxiety in female students is not black and white. There is not simply an exact history. Instead, to understand how mathematics anxiety in girls came to existence, it is important to take this complicated phrase and break it down; while considering the history of each individual piece that creates the respective whole. Thinking of this phrase, several singular concepts must be considered, including the history of mathematics, the history of women in mathematics, the history of women's education and the history of anxiety. Although the history of mathematics anxiety in female students is not limited to these individual concepts, many connections can be drawn from researching these topics individually.

When considering the history of mathematics anxiety in young female students, it is important to first begin by addressing female mathematicians in history. Mathematics is a subject that is historically male-dominated. When asked to name some prominent historical mathematicians, figures such as Leonhard Euler, Carl Fredrich Gauss, Pythagoras, Hippocrates, Plato and Euclid are some popular names that might come to mind. Notice that not one of these mentioned mathematicians is female. Although these brilliant minds are some of the main contributors to modern mathematics, there exists a large gender gap. This is not to say that men

have higher intellectual capabilities in mathematics, but instead shows that there must have been obstacles presented to women who wished to enter the field.

Steven Downes (1997), a mathematics teacher at the City of Portsmouth Girls' School asked the girls in his 8th grade mathematics class to name a famous female mathematician. Realizing that they were unable to name any, Mr. Downes assigned a task for his students to research and present on a famous female mathematician. However, there posed an obstacle when students struggled with their research. Downes (1997) stated, "Many girls could not find anything about women mathematicians at all. The message they received from all these sources was that women and mathematics do not go together and had never gone together" (p. 26). It is easy to wonder exactly why this is the case. As said previously, historically, mathematics is seen as a male-dominated subject. In order to understand the reason why females experience mathematics anxiety, it is important to explore the history behind female's roles in the development of mathematics.

When looking at the history of mathematics, there are very few famous female mathematicians compared to their male counterparts. Loretta Kelley, a mathematician explored this historical imbalance. Kelley (1996), explains that historically, women received little support and many barriers placed in their way of becoming mathematicians (p. 592). Kelley specifically explores the work of six female mathematicians through the course of 1500 years and their successes in the field, despite the many obstacles they encountered. Some of these barriers include resistance from their families, the influence of societal norms and the inability for women to study at universities in the early centuries.

An Early History

Hypatia is the first known female mathematician and lived from the years 370-415 A.D. During the Hellenic age in which she lived, most women were not allowed to participate in academics or intellectual studies. However, she began practicing mathematics alongside her father, who worked as a professor at the University at Alexandria in Egypt. Her father "refused to impose upon his daughter the traditional role assigned to women and raised her as one would have raised a son in the Greek tradition; by teaching her his own trade" (Mark, 2009). The University at Alexandria was home to many of the world's most brilliant minds including Archimedes, Eratosthenes and Euclid (Mark, 2009). Unfortunately, although we know the existence of Hypatia and her commitment to studying algebraic symbols and their use to solve complicated equations, little is known of her discoveries as they were "destroyed when the library at Alexandria was burned in the seventh century" (Kelley, 1996, p. 592). However, it is known that "Hypatia led the life of a respected academic at Alexandria's university; a position to which only males were entitled previously" (Mark, 2009). She delivered regular lectures at the university, and never married, vowing to commit her life to teaching and learning (Mark, 2009). What is most interesting, is that even in the time she lived, she received support from her father and community to pursue her studies. This support allowed her to become the first known female mathematician, and truly paved the way for many female mathematicians to follow.

Prior to analyzing the next three of the world's most famous female mathematicians, it is important to examine the early development of modern schooling as it relates to gendered education. Dating back to the 18th century, single-gendered education was originally the most common form of schooling. Boys in colonial America would attend "dame schools," as a model of home instruction for small groups of children usually led by a woman in her home. It was at

this point in time when women were established as teachers in colonial America (Madigan, 2009, p. 11). These small schools prepared boys for town schools in later years. Young girls also attended dame schools, however only a small fraction continued their education past these dame schools, as girls were not allowed to attend town schools until the 19th century. Even when they could begin attending the town schools, it was often at different times of the day than their male counterparts (Madigan, 2009, p. 11). This societal injustice is one of the first documented differences between formal education of boys versus girls.

Geniuses Defy Patriarchy

In 1706, Emilie Du Châtelet was born in France. Unfortunately, Emilie did not have the same acceptance to the field as Hypatia. According to Kelley (1996), during this time, women were "expected to be amusing and shallow" (p. 592). Emilie's lack of personable skills led her parents to educate her out of fear that she would never marry. Emilie faced challenges with her love of mathematics, as women studying math during this time was extremely discouraged. However, there existed publications that promoted women's intellectual development. Perl (1979), explored "the Woman's Almanack, an 18th century English magazine devoted largely to problems and puzzles in mathematics, indicates that stereotypes about the inability of women to understand and enjoy mathematics were less strongly believed in the 18th century than they are today," (p. 36). This publication existed in the times of Emilie and shows some of the tribulations she faced as a female hoping to study mathematics. Kelley (1996), states "Although women were not taken seriously for their intellectual achievements, Emilie du Châtelet refused to let her sex interfere with her love of Mathematics," (p. 593). Despite the challenges presented to Emilie by her family, she went on to be a brilliant, self-taught mind. She later went on to

translate Newton's *Principia* to French, which remains the only translation in existence today (Kelley, 1996, p. 352).

Seventy years later in 1776, Sophie Germain was born in Paris to a wealthy family. According to Kelley (1996), her parents did not want her pursuing her love for mathematics and took her heat and light to keep her in her bed and away from studying late at night (p. 593). Although she never had any formal education or schooling, Sophie challenged her parents and began independently studying mathematics with specific interests in geometry and number theory. Sophie's passion led her to write directly under a pseudonym to Carl Gauss, who is one of the greatest mathematicians of all time, about her love of number theory. Gauss learned of Sophie's true identity years later and wrote the following to her:

When a person of the sex which, according to our customs and prejuidices, must encounter infinitely more difficulties than men… succeeds nevertheless in surrounding these obstacles and penetrating the obscure parts of number theory, then without doubt she must have the noblest courage, quite extrordinary talents and a superior genius. (Bell, 1956, p. 333). Although Sophie faced many obstacles, her work and love of mathematics persevered under the support of Gauss.

Sonya Kovalevsky, born in 1850 was the daughter of a Russian general. Her father did not want Sonya to pursue her love for mathematics, and only allowed her studies after she received praise from a professor regarding her obvious mathematical predilection. Sonya decided to leave Russia and travel to Germany to study, however single women were not allowed to travel at this time, so Sonya was forced to marry. Once arriving in Germany, Sonya learned that German universities did not admit women to their programs. However, largely due to her brilliance, she received private instruction from famous mathematician Karl Weierstrass.

Although Sonya was not permitted to attend a university due to being a female, she received an honorary doctorate in mathematics in 1874 due to her contributions to the field (Kelley, 1996, p. 594). A few years later, Sonya secured a position at the University of Stockholm. According to Kelley (1996), “Her appointment aroused controversy, causing the Swedish author August Strindberg to write of her that "a female professor of mathematics is a pernicious and unpleasant phenomenon" (p. 594). External forces such as these are ones that kept many females away from studying mathematics at the time. It is interesting to imagine the thousands of women who were denied studies, and brings into question the brilliance that was lost due to gender inequities.

The tribulations these three women faced were all similar. They were unable to attend and receive a proper formal education, and instead were recognized by their extreme abilities in mathematics by men who dominated the field. They faced the same challenges in not being able to attend universities, despite their love and aptitude for mathematics. They faced the same societal pressures and experienced injustice from their families with fathers who did not approve of their determination to pursue their intellectual desires. These women are not only famous because of their mathematical contributions, but because they were some of the first to challenge societal norms and pursue their passions. For every one of these courageous geniuses, there must be thousands of women who had interest, ability and passion for mathematics. These women were denied the experience to pursue their studies because it was discouraged by the existing male-dominated society. It could be said that these forces are some of the initial influencers of the development of mathematics anxiety in girls.

A New Era

Prior to the mid 1800’s, private, single-gender institutions were the only true options for higher education for women. As the Women’s Suffrage movement fought for equal rights for all

women, it also put pressure on universities to embrace coeducation (Madigan, 2009, p. 12). As time passed, education evolved. By the mid 1800's, affiliations with Harvard, Columbia and Brown allowed women to participate in a limited fashion compared to the opportunities provided to men attending these prestigious institutions (Madigan, 2009, p. 12). Entering the 19th century, select public state universities began allowing women to enroll in degree programs. Private schools did not follow this pattern, and as a result Smith, Mount Holyoke, Wellesley, Barnard, Radcliffe, Vassar, and Bryn Mawr were established to provide women with single-gender university environments designed to meet their specific educational needs (Madigan, 2009, p. 12). Once again, as time passed, educational opportunities became more accessible for women. However, Madigan (2009), states "Despite the emergence of single-gender colleges for women, by the beginning of the 20th century, most public secondary schools and colleges had become predominantly coeducational. Coeducation, however, did not insure equal opportunity in education." (p. 12). Although challenges were still presented to females seeking more educational opportunities, the emergence of coeducation opened many new doors allowing for the acceptance of women in secondary institutions including colleges and universities.

The final two female mathematicians that Kelley analyzes are slightly more contemporary, Emmy Noether (1882-1935) and Julia Robinson (1919-1985). Both of these women studied after the time of the beginning of the Women's Suffrage movement, and therefore encountered slightly different obstacles than Emilie, Sophie and Sonya. Although they still received retaliation from society, formal education was not a large point of contention. They were now able to study at higher education institutions, but there still remained injustice regarding employment as professors despite being some of the most brilliant minds in mathematics at the time.

Emmy, often referred to as the “mother of modern algebra,” (Kelley, 1996, p. 595), worked alongside mathematicians at the University of Göttingen. Like the women previously discussed, Emmy was never given a paid position at the University, and had faculty members refer to her candidacy stating, "What will our soldiers think when they return to the University [from World War I] and find that they are expected to learn at the feet of a woman?" (Osen 1974, p.145). Emmy did receive support from German mathematician, David Hilbert, who stated “I do not see that the sex of the candidate is an argument against her admission. After all, we are a university, not a bathing establishment” (Osen, 1974, p. 145). Unfortunately, Emmy never did receive a paid position at the University and was forced by Nazis to relocate to the United States in 1933. Once arriving, she earned her first paid position at Bryn Mawr College and also offered lectures at Princeton University (Kelley, 1996, p. 595). In 1935, Emmy died unexpectedly. According to Kelley (1996), Albert Einstein wrote her obituary in the New York Times on May 4, 1935: "In the judgment of the most competent living mathematicians, Fraulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began” (p. 595). Although Emmy initially faced hardships with her studies, upon moving to the United States, there proved to be more opportunities for her where she was able to fulfill her passions, with support from many geniuses.

Of all examined female mathematicians, Julia Robinson arguably had the most support as a female in the field. Shortly before Julia was born in the early 20th century, “the Commission on the Reorganization of Secondary Education made a case for the creation of a two-track system: one track steered students, primarily males, toward college preparatory coursework, and the other track provided vocational training. For White, Black, and other minority girls, the vocational track was encouraged” (Madigan, 2009, p. 12). Although female students were given

the opportunity to attend secondary schools and universities, even girls who were strong academically were encouraged to take classes in home economics and domestic sciences. Julia did not follow these recommendations, and was the only girl in her high school to continue with mathematics after studying plane geometry. After high school, Julia attended San Diego State University and quickly transferred to the University of California at Berkeley where she continued to study mathematics (Kelley, 1996, p. 595). Julia went on to win many awards including being the first female mathematician elected to the National Academy of Sciences, and the first female president of the American Mathematical Society. Additionally, she was elected to the American Academy of Arts and Sciences and received a grant from the MacArthur Foundation (Kelley, 1996, p. 595).

We have now seen the result of several women who did and did not receive support in their mathematics education. Historically, institutions have largely been stacked against women wishing to study mathematics. It was not until 1972 that Title IX was adopted in the United States, making it illegal to discriminate based on sex in public schools regarding "athletics, financial aid, career counseling, admission practices, and the treatment of students" (Madigan, 2009, p. 12). Two years later, in 1974, the Women's Educational Equity Act (WEEA) was passed to provide assistance to schools in recruiting girls for their math, science and athletic programs (Madigan, 2009, p. 12). Despite these laws, single-gendered institutions still exist to this day after an amendment to Title IX was made in 2006 to provide school districts with flexibility regarding single-sex programs. Research conducted even showed that "teachers believed that girls demonstrated better peer interactions, a greater emphasis on academic behaviors, a greater degree of order and control, socio-emotional benefits, and safe behavior in single sex environments" (Madigan, 2009, pp. 12-13). It could be said that the patriarchy still to

this day has an influence on girls performance in schools. Single-gendered institutions are a way to provide girls with more equitable and fair opportunities to succeed in their education without having to worry about gender-associated norms. Arguably, it is this inequality and oppression existing to this day that make girls vulnerable to anxiety when simply referring to the subject of mathematics itself.

Early Representations of Anxiety

Similar to the recent acceptance of women studying mathematics, anxiety is somewhat a recent phenomenon as well. The history of anxiety is slightly more complicated. It is often implied that anxiety is a newly coined term and does not have a rich history, generally stated that it was seldom known as a specific illness before the 19th century. However, feelings of anxiety date back to ancient Greek medical texts written by Hippocrates (c 460 BC to c 370 AD) and continue in "Latin Stoic philosophical writings, such as the treatises of Cicero and Seneca, prefigure many modern views concerning the clinical features and the cognitive treatment of anxiety," (Crocq, 2015, p. 320). In times as early as 106 B.C. - 43 B.C., anxiety was used as a term to define a medical illness. Even further, Cicero makes a "distinction between *anxietas* that designates trait anxiety or the fact of being prone to anxiousness, and *angor* that refers to state anxiety or current anxiety," (Crocq, 2015, p. 320). This ancient literature not only defines anxiety in modern terms, but also provides treatments for its symptoms, including Seneca's concept of finding "the ideal state of "peace of mind" (*tranquil- litas*) as a situation where one is undisturbed," (Crocq, 2015, p. 320). This treatment is an ancient example of a modern coping mechanism that will be explored later.

Ancient works also include the beliefs of Epicurus (341 BC Samos to 270 BC Athens), the philosopher who founded the school of philosophy called Epicureanism. According to Crocq

(2015), Epicurus "taught the objective of a happy life included reaching a state called ataraxia where the mind was free of worry. One path to ataraxia was to get rid of negative cognitions about the past and of fears about the future, since the only existing reality is the present moment" (p. 320). Epicurus' definition and treatment imitate those of Cicero and Seneca, despite the philosophers belonging to different schools of thought. It is unknown if Cicero and Seneca modeled their findings off of Epicurus and his definition, however, it is known that many of these definitions and treatments closely resemble similar therapeutics in modern times.

The transition from ancient times to the modern definition of anxiety is slightly more complicated, as the specific concept of anxiety somewhat vanished from written records for a large period of time. Although there existed cases of anxiety, these people were instead diagnosed otherwise. The first notable contemporary description of anxiety did not come about until 1621 when Robert Burton published *The Anatomy of Melancholy.* Although Burton's work commonly explored depression, he was also concerned with anxiety. Crocq (2015), describes Burton's theory of melancholia as not being "limited to depression but encompassed anxiety. Generally, the diagnosis of melancholia could be applied to a variety of clinical pictures with negative affect or internalizing symptoms" (p. 321). In the 18th century, symptoms of melancholia evolved to include published clinical descriptions of panic attacks. These panic attacks remained simply as symptoms and were not classified as a disorder on their own.

Boissier de Sauvages (1706-1767) published the first notable French medical disease classification guide which listed 10 major classes of disease and were further broken down into orders. Boissier de Sauvages identified a disorder mainly focused on anxiety as Panophobia, which is further defined as a panic terror primarily experienced at night. Crocq (2015), described the symptoms as being "constantly extremely worried, and for this reason they avoid company,

preferring to keep to themselves. They complain of pain and bodily tension“ (p. 322). Although this specific disorder focused on night terrors, the symptoms involved feelings of extreme worry at all hours, therefore inflicting anxiety. Furthermore, these symptoms relate directly to the symptoms associated with panic attacks and could be described as such, being brought on by fear of darkness or night time.

The next major disorder classification did not come until George Miller Beard introduced neurasthenia in 1869. Crocq (2015), referred to the symptoms as being manifold and “ranging from general malaise, neuralgic pains, hysteria, hypochondriasis, to symptoms of anxiety and chronic depression” (p. 322). Neurasthenia was also commonly referred to as “nervous exhaustion” that “afflicted primarily ambitious, upwardly mobile members of the urban middle and upper classes—especially “the brain-workers in almost every household of the Northern and Eastern States”—whose nervous systems were overtaxed by a rapidly modernizing American civilization” (Stossel, 2014, p. 24). The definition of this disorder came approximately 100 years after the start of the Industrial Revolution and preliminary introductions of capitalism. Drawing off of Darwin’s beliefs of natural selection, Beard concluded that “cultural and technological evolution had out-stripped biological evolution, putting enormous stress on the human animal—particularly those in the business and professional classes, who were most driven by status competition and the burgeoning pressures of capitalism” (Stossel, 2014, p. 25). In short, as industrialization occurred, America also created nervousness as a specific condition.

A Modern Definition

As time passed, the need for classification of mental disorders grew increasingly more important, and in 1952 DSM-I was published. The first publication of DSM- *Diagnostic and Statistical Manual of Mental Disorders* - defined anxiety in more distinct terms by referring to it

as a “psychoneurotic disorder.” This definition changed with the second publication of DSM-II (1968) where anxiety was instead referred to as neuroses. Crocq (2015) referred to the symptoms of neuroses by saying that “anxiety might be felt and expressed directly, or it might be controlled unconsciously and automatically by conversion, displacement and various other psychological mechanisms,” (p. 323). These similar definitions were the precursor of our modern definitions of anxiety that were presented in DSM-III to DSM-5.

DSM-III (1980) introduced an entire chapter dedicated to anxiety disorders. These included phobic disorders, further divided into agoraphobia, social phobia and simple phobia; anxiety states that were further divided into panic disorder, generalized anxiety disorder and obsessive-compulsive disorder; and finally post-traumatic stress disorder. It also included anxiety disorders specific to childhood and adolescence including separation anxiety disorder, avoidant disorder and overanxious disorder. Not much change occurred in DSM-IV (1994), which only added two new categories including anxiety-depressive disorder and acute stress disorder.

A major transition came with DSM-5 (2013) that completely reorganized anxiety classifications into three spectra. These categories included anxiety, obsessive-compulsive disorder and trauma and stressor related disorders. This change was compelling because it is the first time that “knowledge about different brain circuits underlying stress, panic, obsessions, and compulsions, played a role in classification” (Crocq, 2015, p. 324). This presented the first separation of OCD from anxiety disorders, providing a more proper grouping with other disorders that also consist of repetition in thoughts and behaviors.

What is most interesting about the history of anxiety is that although there were many changes in classifications and naming, the overlying symptoms and treatment methods remained

fairly consistent. Many of these treatment methods are still being used today, including holistic approaches of mindfulness and meditation. These treatments are extremely common especially in modern classrooms where students are facing anxiety daily due to outside pressures, external forces and societal norms.

Although much has changed throughout the years for women in the field of mathematics, there still exists to this day a gender bias. The history of the female journey to acceptance is a primary factor of the anxiety that girls studying math still face to this day. Referring back to Stephen Downes, the mathematics teacher discussed at the beginning of this paper, his goal was to allow his students to find female mathematician role-models stating, "when they learn about the history of mathematicians also learn about the way mathematics was constructed as male then they might be empowered to question the reasons why they feel they are discouraged from succeeding at mathematics" (Downes, 1997, p. 27). The history of anxiety has provided the medical definition behind the phenomenon that girls are facing today. Although this anxiety can be classified as general, it is easy to see how the historical influences of female oppression affect this anxiety and create subject-based avoidance for young girls still through modern times.

Combating anxiety experienced towards mathematics and anxiety found in female students in general

Anxiety is a prevalent concern in the world of mental health, specifically among adolescents. Anxiety can be triggered by a number of factors such as everyday worries, social situations or academic pressures. It was not until I became a teacher that I realized the levels of anxiety that today's children are facing. Oftentimes, children are expected to be academically well-rounded and successful, participate in one, or several sports, clubs or activities, spend time with family and friends all while maintaining a clean bill of health both physically and mentally. Although we know that this anxiety exists, and some reasons why students experience it, it is

also important to note some ways to prevent anxiety from happening in the first place, as well as methods students can use to cope with their existing anxiety.

Preventative Measures

As a female mathematics student and teacher, I have always had experiences with questioning my mathematical decisions. Math is often perceived as an answer-based subject. Oftentimes, students will assume there is only one answer to every problem they encounter, and only one way to complete that problem to find the correct answer. When students ask, which they often do, how specific things we are using in class can be used in real life, I always inform them that math is not just about the answer, but about the reasoning that goes into finding the answer. The mindset, often called the *fixed* mindset, develops feelings that lead students to believe there is only one true answer, one way to solve a problem, or furthermore, evokes academic anxiety among students. I believe that the only true way to prevent students from experiencing anxiety is to eliminate fixed mindset mentalities.

In today's society and the world of social media and cyber-bullying, teaching self-confidence to our students is more important than ever. This can be done by transforming a child's *fixed* mindset to a *growth* mindset. "Those with a fixed mindset believe that intelligence is resistant to change whereas those with a growth mindset believe that intelligence is capable of development, especially through effort" (Bostwick, 2020, p. 2). There are several ways to help students to transition to a developing growth mindset. One of the easiest ways to do this is to teach students the "power of yet," by encouraging students to add the word "yet" to the end of negative sentences or phrases you may hear them commonly say in class. Some of these phrases include, "I can't simplify fractions… yet" or a more advanced topic such as "I cannot evaluate logarithmic functions… yet". Luckily, teaching this growth mindset can occur across all areas in

school and home life, and is a simple way of promoting openness to learning, self-confidence and academic well-roundedness.

Some other ways to promote a growth mindset include teaching students to acknowledge and embrace their imperfections both personally and academically, show them how to face challenges bravely and have them embrace valuing the process over the end result. By learning how to embrace imperfections, students will accept humility and allow themselves to be more vulnerable to criticism, and in result, assistance. In my experience, students who suffer from anxiety in the classroom do not ask for help because they have a fear of being told they were incorrect. This behavior only adds to existing anxiety and creates a ripple effect throughout a student's academic career. By teaching students to face challenges bravely, it is assuring students that it is ok to fail the first time, and showing them it is ok to embrace mistakes. If a student is nervous about an assignment, test or project, teaching them to go into the activity bravely will help boost their confidence and, in turn, their performance. Now, as mentioned before, math will most likely always be seen as an answer-based subject. This is a global view, and is accepted as true by many. By teaching students that although the answer is sometimes important in math, it is the process that truly counts. All great mathematicians make mistakes. It is not the mistake that defines the individual, but the process in which they take to identify the mistake and correct their thinking. By eliminating the stressors involved with the fear of failure, teachers can easily help students transition from having a fixed mindset to developing a growth mindset.

Although the development of a growth mindset is what I consider the most important factor to eliminating anxiety, there are several other factors that can also be considered. As mentioned previously, there exists a large gender gap in the field of mathematics. This system can be challenged by creating a culturally-accepted equality between men and women in the

mathematics classroom and encouraging all students to speak up—in other words, creating a truly democratic and free classroom environment. When this culture is created, it ensures that student success is being put first. After all, it is not the gender of the student that determines his or her success, it is the amount of work that the student puts into becoming successful. Devine, Fawcett, Szucs and Dowker (2012), state,

However, we should not forget that despite the stronger relationship between mathematics anxiety (MA) and performance which emerged for girls, girls' maths performance was not significantly different to boys' maths performance. Given that girls reported higher levels of mathematics anxiety than boys it is possible that girls' mathematics performance was actually confounded by MA, or the time-limited testing procedure, and the mean score reported in the current study may not reflect the girls' true mathematical ability: i.e., they might actually have had the potential to perform better than the boys. (p. 7).

This research indicates the distinct level that mathematics anxiety affects female students' performance. By eliminating this anxiety, female students have the opportunity to become equal in the mathematics realm. I believe that this is important because without equality among genders in all fields, we will never be able to reach that ideal, democratic society where all members are treated as equals.

Coping with Anxiety

Unfortunately for many students, this anxiety is developed at a young age and only increases over time. Instead of trying to eliminate this anxiety in students all together, it is important to provide them with ways of coping with the stressors that anxiety in mathematics creates. Many of these alleviators stem from the Education for Sustainability movement. The Australian Government of Education and Training (2015) describes this movement by saying

"Education for Sustainability (EfS) is an educational approach that aims to develop students, schools and communities with the values and the motivation to take action for sustainability – in their personal lives, within their community and also at a global scale, now and in the future" and furthermore "aims to build awareness and knowledge of sustainability issues but also to develop students and schools that are able to think critically, innovate and provide solutions towards more sustainable patterns of living." Using what Education for Sustainability stands for, by teaching students using place-based education, mindfulness and meditation, students can find ways to cope with anxiety they are experiencing.

Mindfulness involves developing a conscious understanding of one's self. It involves acceptance, and learning to pay attention to our own thoughts and feelings. Oftentimes mindfulness is seen in forms that interact with the outdoors and the natural environment through meditation and self reflection. Teaching students mindfulness is quite possibly one of the best methods we can use to decrease anxiety in mathematics. Teaching students mindfulness "may improve academic performance by supporting students' ability to cope with anxiety in high-stakes testing situations" (Bellinger, DeCaro, Ralston, 2015, p. 124). Furthermore, in regards to female mathematics anxiety, Weger, Hooper, Meier, and Hopthrow (2012) found that "a brief mindfulness intervention boosted women's math performance when a negative stereotype that "men are better at math" was activated" (pp. 471). This same performance boost was not found when the phrase was not stated. Therefore, channeling mindfulness techniques was a proven technique of reducing anxiety.

The first technique studied involved focused breathing, in which students were "guided through instructions and practice opportunities centered around an attentional focus on the sensations of the breath (inhalation and exhalation.)" (Burnyé, Mahoney, Giles, Rapp, Taylor

and Kanarek, 2013, p. 3). It was found through their study that brief moments of focused breathing indeed helped students calm themselves and gain control of their attention, regulate negative emotions and be in the present moment. The second method they studied involved unfocused breathing, in which students were told to relax and "simply think about whatever comes to mind. Let your mind wander freely without trying to focus on anything in particular" (Burnyé, Mahoney, Giles, Rapp, Taylor and Kanarek, 2013, p. 3). Although this method was not as successful, it still did show growth in student performance. Allowing the mind to wander and disengage allowed students time to gather their thoughts and relieve themselves of their worries in a less-structured environment.

The impact of mindfulness being taught in schools to students, especially female students, who suffer from mathematics anxiety is highly notable. By giving students methods to use to cope with anxiety, we are allowing them to focus their attention on the math itself instead of external factors contributing to their anxiety. Additionally, providing a place based education allows students to make connections to their own environment, allowing them to see the benefits of math in their everyday life. These factors are great contributors to preventing and reducing math anxiety in students.

Math anxiety is often caused by students who "devote a considerable amount of cognitive and attentional resources towards intrusive thoughts and worries, rather than the processing demands of the arithmetic task, resulting in underperformance" (Burnyé, Mahoney, Giles, Rapp, Taylor, Kanarek, p.1, 2013). This implies that the connection is not between the math itself and the learner, but the methods the learner uses to understand the math. Teaching anxiety coping techniques is one way of preventing anxiety from inhibiting performance on math related activities. Researchers Brunyé, Mahoney, Giles, Rapp, Taylor and Kanarek (2013), professors

from Tufts University, the US Army and Northwestern University studied several techniques that can be used to relieve the mind of math anxiety. Practicing mindfulness techniques were found to allow individuals to maintain full attention of their present situation. However, practicing long-term mindfulness training has proven to be beneficial in regulating mental function.

However, teaching our students mindfulness does not just revolve around their connections with self, but also their connections with place. The concept of place-based education is highly studied in the realm of education for sustainability. In order to understand the benefits of place-based education, one must consider the effectiveness of interactions with nature alleviating anxiety.

One method to reduce or even prevent anxiety in students is to provide them with opportunities to engage with nature and the outdoors. A study conducted by Ileana L. Vitalia (2017), a professor at the University of Pitesti in Romania conducted a study exploring the impacts of nature experiences on mental and physical health, including the levels of anxiety students experienced after interacting with natural objects (p. 152). At the beginning of the study, students were asked to take the State and Trait Anxiety Inventory (STAI), and then were asked, as a homework assignment, to take time to reflect outdoors. They were asked to find an object that they felt exemplified their feelings of nature, and explain how it represented their experience. After each student shared, students were invited to interact with each other's natural objects, and then were asked to participate in the STAI again. Results showed that "A group provocative exercise designed to facilitate the sensory contact with natural objects is an efficient method to reduce the level of anxiety (state anxiety) because it is associated with relaxation, decreased irritability, worry and fear" (Vitalia, 2017, p. 154). Through interaction with the outdoors, although completely separate from the mathematics classroom, anxiety was reduced

among students. So, the question remains, how would this same situation be beneficial in specifically the mathematics classroom?

Place based education is one way that teachers can promote outdoor and physical learning with their students. With the primary goal of place-based education being learning to be where we are, and teaching students to adapt to the unique characteristics of particular places, we are creating sustainable members of society (Smith, 2002, p. 584). Exploring beyond the importance of place-based education for sustainability, the effects of learning about the environment in the environment is therapeutic to students. Not only does place based education provide the opportunity to work with and around nature, but it allows students to create connections. This philosophy of learning is important to all subjects, as it teaches students how information they learn in school is applicable to their everyday life. Gregory Smith, an associate professor in the Graduate School of Education at Lewis & Clark College conducted research on the importance of place-based education. Smith (2010) states "because place and community-based education is closely allied with other innovations such as service learning, environmental education, and a form of pedagogy called authentic instruction, it is furthermore possible to draw upon related research that points to the value of educational experiences situated beyond the classroom and that involve the application of concepts and skills in "real-world" settings" (p. 74). By creating opportunities for our students to connect their everyday life with what they are learning in their classes, they are developing a sense of belonging to their culture and their world -- hence why place-based mathematics education is a prevalent method of decreasing anxiety among students.

Place based mathematics education is an upcoming trend in the realm of rural education and education for sustainability. Often shortened to PBME, place based mathematics education

"considers the unique history, geography, culture, and community of a place to be valuable resources for enhancing, and being enhanced by, students' learning of mathematics" (Showalter, 2013, p. 1). The goal of PBME is to introduce students to ways they can connect real life situations to the mathematics they are learning, and being shown exactly how it is useful to their quality of life. By fostering relationships with their community and environment, students are increasing their own awareness of their surroundings and are creating connections. These connections provide meaning to their studies, hence improving their drive to learn.

In summary, it is important to start by considering the methods which can be used to prevent mathematics anxiety in girls from happening in the first place. Teachers must work together to create a classroom where students accept, initiate and embrace a growth mindset. By opening minds to the endless possibilities in the field of mathematics, teachers are more likely to help students learn to love math and it's process; rather than simply providing methods that can be used to find the answer. To do this, teachers must create a democratic classroom environment and promote equality among all students. By creating a democratic classroom, teachers are creating students who are able to self-advocate and express their freedom - including the freedoms of success and acceptance of failure.

Unfortunately, it is not always possible to prevent math anxiety from happening in the first place, and it is also important for teachers to provide students with coping mechanisms to help alleviate their anxiety. By incorporating mindfulness techniques, students can focus on their sense of self and channel their inner abilities. Utilizing focused breathing techniques, students will be able to develop mindfulness techniques that they can use at the beginning of each class, when students get frustrated or before an assessment. Mindfulness combined with the benefits of nature can help students find a pure sense of self and provide a calming environment. By

utilizing place-based education, not only will students become more in touch with their environment, but will also see the benefits of mathematics in relation to their everyday lives. If students are able to see why math is important to them, they will be able to accept the subject and therefore, anxiety surrounding the subject should reduce.

Chapter 4

Design

Purpose

In a time where members of society are focused most strictly on quantitative data, it is important to consider the qualitative factors that have a part in the development and betterment of anxiety. In my experience, the world we live in today is largely driven on instant gratification. Unfortunately, this instant gratification also has its own downfalls in the creation of anxiety and teaching students how to maintain a steady work ethic. Mathematics teachers specifically have the task of teaching students about the importance of the process, not necessarily just finding the answer. For students being raised in our society that is focused on instant gratification, this is difficult to do. They can easily google a problem to get an answer, but identifying the process in which they used to solve the problem is the true teaching and understanding of mathematics. When students are so easily answer-driven, it is easy for them to develop anxiety towards the process.

The purpose of this curriculum is to help teachers identify the importance of being able to recognize mathematics anxiety in their female students and provide ways to help those students. First, this program will educate teachers on the fundamentals of math anxiety and explore the tell tale signs of what anxiety looks like in their female students. This program provides a questionnaire that teachers will give to students to self-assess their anxiety. After taking the questionnaire, the class will have a discussion on the concept of anxiety and ways that it can be alleviated, or even prevented. From here, the program provides teachers with multiple coping mechanisms to help alleviate their anxiety as well as creating a classroom environment that

prevents anxiety from occuring in the first place. These include mindfulness techniques, and place based education. Additionally, this program will also give teachers resources to help students develop a growth mindset in hopes of preventing anxiety. By providing ways of preventing and treating anxiety, the educational aims of this program are to reduce mathematics anxiety among female students in and outside of the classroom. Although many of the techniques described in this program can be used for all students and all subjects, the primary focus of this program is to assist teachers in recognizing the oppression of female students in the field of mathematics. With anxiety being a major concern among students today, it is important to understand that the techniques and tools mentioned can be used by all students, and teachers alike to help reduce and eliminate anxiety.

Theoretical Framework

In order to further understand the purpose of this curriculum, it is first necessary to explore the curriculum theory of John Dewey. Dewey's curricular philosophy, called the Experiential perspective can be explained as being "based on the assumption that everything that happens to students influences their lives, and that, therefore the curriculum must be considered extremely broadly, not only in terms of what can be planned for students in schools and even outside of them, but also in terms of all the unanticipated consequences of each new situation that individuals encounter" (Posner, 1992, p. 49). This philosophy directly relates to the concept of teaching coping mechanisms for students who suffer from anxiety. These skills can be incorporated into the curriculum, and can be used in everyday life situations - not just in math class.

Dewey also firmly believed in the power of reflection, and the students' interaction with the world around them. John Dewey researchers, Douglas J. Simpson and Michael J. B. Jackson

(2016), explains Dewey's educational theory saying it "connects both the educative process and educational theory with the student's interaction or involvement with particular societal aims, meanings, and values that emerge from adult experiences" (p. 23). Dewey believed in providing meaningful curricular experiences for kids. His concept of open-mindedness directly correlates with the growth mindset, which will be a large influence on the prevention of mathematics anxiety. He also focused on the development of responsibility in students as well as completing tasks whole-hearted. In short, Dewey believed in providing democratic, meaningful, student-centered experiences.

Before examining the curriculum presented to help eliminate and alleviate anxiety, it is important to consider some potential barriers that may present themselves. Curriculum theorist, George J. Posner, explores curriculum theory through the lens of having to work through limitations on certain frame factors. In his book, *Analyzing the Curriculum*, he explains different limitations posed by temporal frames, physical frames, political-legal frames, organizational frames, personal frames, economic frames and cultural frames. It is not important for us to explore each set of frames and identify how they all contribute to this particular curriculum, however, it is essential to identify some potential barriers. One frame factor that I think all curriculums find as a limitation is the time constraints set by the temporal frame. There are several factors that come to mind when considering these limitations, including considering if teachers have the time to dedicate to this topic, time to implement the research and time to provide students to thrive within the constraints set by the school. I believe this workshop could be conducted during a professional development day, or flexible professional development. However, there are so many educational necessities to consider when planning professional development days that it is difficult to condense everything into the short amount of time

provided. Additionally, if the curriculum is taught and asked to be implemented, teachers are held to the schedule of the school and may not have the time to implement coping strategies, or travel to a location to partake in place-based education.

Additionally, it is important to consider the limitations of the physical frame. Depending on a schools location, place-based education may or may not be possible. Now, of course, place-based education is largely determined by where you live, however a primary focus revolves around the concept of interacting with the natural environment. Schools in inner cities may struggle with this method of prevention for the development of math anxiety. Economic frames also play a role depending on the curriculum imposed by the teacher throughout the place-based education model. This will vary depending on subject and school.

Understanding some limitations of this curriculum helps to better grasp the curriculum presented. The ideal outcome of this curriculum would be to have students reflect on their math anxiety and state that they were able to eliminate the anxiety from occurring. Now, this is a large task, so it is also important to provide students with coping strategies that they can use in the case that the anxiety is not completely eliminated. By implementing this curriculum, the goal is to create a meaningful and democratic math classroom and learning environment where students can apply their learning to solve real world problems.

Course Content and Pedagogy

As a lifetime learner of mathematics who suffers from mathematics anxiety, I can firmly attest to the coping strategies and preventative measures outlined in this program. Mathematics is a complex field, with many different theorists, methods and ideologies. My own oppression in the subject was inflicted by a fellow female mathematician during my collegiate studies. As a female mathematics educator now, myself, it is my goal to present some methods that can be

used both by teachers and students to prevent the same oppression that happened to me by my fellow mathematician, on to other young aspiring female mathematicians.

Referring back to the banking model of education, the implementation of practicing a growth mindset is fundamental to developing a strong foundation as a mathematician. Although the growth mindset has been seen as a tool in classrooms of all subjects, it is actually more than a tool. Growth mindset, in itself, is a form of pedagogy that can be established by the teacher. The development of a growth mindset can be easily insisted through the instructional design of the teacher. Universal Design for Learning (UDL) is a specific framework that teachers can use to develop lessons that takes into account the many different ways that people learn. Allison Posey (2020), a CAST, inc employee and UDL researcher describes UDL as "a powerful approach because from the very start of your lesson, it helps you anticipate and plan for *all* your learners. It can help you make sure that the greatest range of students can access and engage in learning—not just certain students" (p. 3). UDL can be used by mathematics teachers to help provide multiple means of engagement for students, in hopes to find a method of instruction that helps to minimize a students' anxiety.

The article *Building the Optimal Learning Environment for Mathematics* focuses on the importance of incorporating Universal Design for Learning in mathematics classrooms. Eichorn et al., (2019) summarize that UDL helps to teach diverse groups, including students who do not have their physical needs met, students who experience anxiety in math, students who are english learners, and students with disabilities (p. 264). The article focuses on how a mathematics teacher works with his math coach to redesign lessons using the UDL framework by providing students with multiple means of engagement, representation, action and expression. It is implied throughout the article that the primary focus of UDL revolves around providing a safe space to

foster a child's learning and growth. The article suggests that UDL is not often implemented in mathematics classes, and that teachers often teach math the way they were taught math, which is usually by direct instruction. It further explains that, although teachers are often encouraged to take risks, a lot of teachers feel that the balance of classroom management and mathematics content makes it difficult to test new instructional methods. Eichorn et al., (2019) state that teachers "may want to focus solely on transmitting content knowledge to students because maintaining control of the environment is easier if students are expected to copy notes quietly as you write on the board. Also, engaging students in mathematical discourse might result in a loss of control of the content and learning objectives" (p. 265). In other words, teachers are allowing their fear of losing control over their students affect their teaching style. This inherently allows teachers to continue to use direct instruction in their classrooms, which is exactly what UDL was designed to prevent. Eichorn et al., (2019), continues by providing methods to implement UDL in the mathematics classroom specifically by sectioning UDL principles into three steps: Step 1 -- Communicate clear expectations for learning and behavior goals, Step 2 -- Engage students through discussion and Step 3 -- Be flexible with your lesson implementation (pp. 265-266). By following these three steps, teachers are successfully implementing UDL principles that work to assist all students initially, instead of designing the lesson and creating accommodations for students who need them. The main purpose of this article was to provide several methods that could be used by teachers to ensure they are following each step of the proposed mathematics UDL framework. Many are simple, and take only a matter of minutes to implement, while others are more in depth and require preparation. For example, the article recommends having one or two students to restate the teacher's expectations to the class. This encourages the feeling of accountability in students, as well as covers any vocabulary barriers that may exist. The article

also suggests implementing “number talks” and providing students with sentence starters to assist them in engaging in meaningful mathematical discussions. This study and examination of how a teacher was able to shift his lesson design to incorporate UDL is extremely meaningful and important. It is frustrating that the article puts so much focus on how this shift needs to begin with new teachers, as some of the changes that need made are so small, yet so pivotal to student success. By giving specific instructions, this article adds tools to the UDL toolbox that we have been creating throughout the semester, and provides options that are specific to the mathematics classroom. I believe that this study assisted in explaining exactly what UDL looks like in math, and opened my eyes to the many possibilities that UDL holds to benefit the future of education.

The goal for this curriculum is for students to develop strategies they can use to prevent and help cope with math anxiety. Unlike the banking model of education as defined by Freire (1970), the importance of critical thought and student participation are at the core of this curriculum. The curriculum itself will consist of both teacher education and teacher implementation with both teacher and student discussion and reflection.

Program Outline

Topic	Learning Targets	Readings and Activities
Teacher Workshop 1: Mathematics Anxiety Introduction	• I CAN define anxiety and identify its common causes among adolescents. • I CAN explain the importance of promoting a free, democratic society in my classroom. • I CAN define mathematics anxiety and identify its common causes among adolescents. • I CAN identify the types of teachers and the effects each type has on the creation of mathematics anxiety in students.	n, C. D., & Leffingwell, R. J. (1999, October). "The Role of Instructors in Creating Math Anxiety in Students from Kindergarten through College." Retrieved from: http://jstor.org/stable/2791118
Teacher Workshop 2: Gender Bias in Mathematics	• I CAN use historical elements of mathematics to explain the gender bias in the field.	, L. (1996). Why Were So Few Mathematicians Female? The Mathematics Teacher, 89(7), 592-596.

Teacher Workshop 3: Mathematics Anxiety in Female Students	• I CAN identify patriarchal influences that promote the development of mathematics anxiety in women.	T., Bieg, M., Ludtke, O., Pekrun, R., Hall, N.C., (2013, March). "Do Girls Really Experience More Anxiety in Mathematics?" *Psychological Science* 24, 10, pp. 2079-2087. https://doi-org.proxy-wcupa.klnpa.org/10.1177%2F0956797613486989
Teacher Workshop 4: The Growth Mindset	• I CAN use the growth mindset to prevent mathematics anxiety.	ick, K. C. P., Collie, R. J., Martin, A. J., & Durksen, T. L. (2020). Teacher, classroom, and student growth orientation in mathematics: A multilevel examination of growth goals, growth mindset, engagement, and achievement. *Teaching and Teacher Education*, *94*. https://doi.org/10.1016/j.tate.2020.103100
Teacher Workshop 5: Mindfulness	• I CAN use mindfulness techniques to help alleviate mathematics anxiety.	ger, D., Decaro, M., & Ralston, P. (2015). Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom. *Consciousness and Cognition*, 37, 123-132.
Teacher Workshop 6: Place Based Education	• I CAN use place based education to prevent and alleviate mathematics anxiety.	, Ileana L. . (2017). Exploring the potential benefits of nature based experience on anxiety. *Current Trends in Natural Sciences,* 6(12), 152-155.
Teacher Workshop 7: Final Reflection	• I CAN identify the techniques that helped prevent and	

	alleviate math anxiety in my students.	

Teacher Workshop 1: Mathematics Anxiety Introduction

Purpose: To provide an in depth exploration of mathematics anxiety and its causes.

Learning Targets:

- I CAN define anxiety and identify its common causes among adolescents.
- I CAN define mathematics anxiety and identify its common causes among adolescents.
- I CAN identify the types of teachers and the effects each type has on the creation of mathematics anxiety in students.

Procedure:

1. Teachers will read the article titled "The Role of Instructors in Creating Math Anxiety in Students from Kindergarten through College"
2. Discussion questions:

a. What is math anxiety? What are some common causes of math anxiety in our students?

b. Why is it important to identify common causes of math anxiety in our students?

c. What is the role of the teacher in the development of math anxiety in our students?

d. How can you change your practices to reduce the potential development of math anxiety in your students?

Teacher Workshop 2: Gender Bias in Mathematics

Purpose: To identify the historical and current gender bias surrounding the field of mathematics to better help understand why female students are at a higher risk.

Learning Target:

- I CAN use historical elements of mathematics to explain the gender bias in the field.

Procedures:

1. Teachers will read the article titled "Why Were So Few Mathematicians Female?"
2. Discussion questions:

a. What historical elements of mathematics cause gender bias in the field?
b. Why were fewer early mathematicians female?
c. How has this bias changed? How has this bias stayed the same?
d. What can you do to eliminate this gender bias in your classroom?

Teacher Workshop 3: Mathematics Anxiety in Female Students

Purpose: To use research to identify why female students are more likely to suffer from mathematics anxiety, and explore the causes.

Learning Target:

- I CAN identify patriarchal influences that promote the development of mathematics anxiety in women.

Procedures:

1. Teachers will read the article titled "Do Girls Really Experience More Anxiety in Mathematics?"
2. Discussion questions:

a. Thinking about the past few workshops, why does math anxiety affect more girls then boys?

b. What other factors play a role in the development of math anxiety in girls?

Assignment:

- Explain math anxiety and its causes to your students.
- Administer the student questionnaire to your students and have a discussion with the class based on the results. Pay attention to any gender differences you may see in the results.
- Be prepared to share results with the group during our next workshop.

Teacher Workshop 4: The Growth Mindset

Purpose: To expose teachers to the benefits of implementing a growth mindset in their classroom.

Learning Target:

- I CAN use the growth mindset to prevent mathematics anxiety.

Procedures:

1. Review results of the pre-questionnaire that teachers administered to students. Use the following questions to guide discussion:

a. What is similar about your results?

b. What is different about your results?

c. Did you notice any gender bias with results in your classroom?

d. Do you feel that the specific course you teach has a role in the information provided in your results? Why?

2. Teachers will read the article titled "Teacher, classroom, and student growth orientation in mathematics: A multilevel examination of growth goals, growth mindset, engagement and achievement."
3. Discussion questions:

. What is the growth mindset? Why is it important?

a. How might using the growth mindset in your classroom help to avoid math anxiety?

b. What are some simple ways to incorporate the growth mindset into your classroom?

Assignment:

- Find two simple ways to implement the growth mindset in your classroom. Be prepared to share these methods during our next workshop.

Teacher Workshop 5: Mindfulness

Purpose: To introduce teachers to mindfulness techniques that can be used as a means of alleviating mathematics anxiety.

Learning Target:

- I CAN use mindfulness techniques to help alleviate mathematics anxiety.

Procedures:

1. Have teachers share which two ways they implemented the growth mindset in their classroom. Use the following questions to guide discussion:

a. How did implementing the growth mindset change your classroom environment?

b. How did your students react to the implementation of the growth mindset?

2. Teachers will read the article "Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom."
3. Discussion questions:

. What is mindfulness? Why might it be beneficial to your students?

a. What are some simple ways to promote mindfulness in your classroom?

Assignment:

- Find two ways to incorporate mindfulness into your classroom. Be prepared to share these methods and some quantitative effects during our next workshop.

Teacher Workshop 6: Place Based Education

Purpose: Inform teachers of the benefits of place based learning and utilizing the natural environment to help prevent and alleviate anxiety.

Learning Target:

- I CAN use place based education to prevent and alleviate mathematics anxiety.

Procedures:

1. Have teachers share which two ways they implemented the mindfulness in their classroom. Use the following questions to guide discussion:

a. How did you incorporate mindfulness into your classroom?

b. Did you notice any quantitative differences among your individual students once implementing mindfulness techniques?

2. Teachers will read the article "Exploring the potential benefits of nature based experience on anxiety."
3. Discussion questions:

. Do you have a natural environment that can be used for place based education?

a. How might you use this environment to not only incorporate it into your lesson, but even just to engage students outdoors?

b. What other benefits are there to place based education?'

c. How might this help our students who experience anxiety?

Assignment:

- Implement place based learning with your students over the course of several class periods.

- Distribute the questionnaire to your students and have a discussion with the class based on the results.
- Be prepared to share the results with the group during our next workshop.

Teacher Workshop 7: Final Reflection

Purpose: To provide time for teachers to reflect on their learning and implementation strategies.

Learning Target:

- I CAN identify the techniques that helped prevent and alleviate math anxiety in my students.

Materials:

- Both questionnaires completed by students.

Procedures:

1. Have teachers reflect individually on the pre-questionnaire results and post-questionnaire results using the following prompts:

a. How did students' answers differ from the pre-questionnaire to the post-questionnaire?

b. What do you think was most beneficial to your students?

c. How does educating your students on math anxiety and its causes help students eliminate this anxiety?

d. What methods of eliminating and/or alleviating did your students find most beneficial?

e. What methods of eliminating and/or alleviating did YOU find most beneficial for your students?

2. Have teachers share their results with each other.

3. Discussion questions:

. What is similar about your results?

a. What can we, as teachers, continue to do to help our students who suffer from math anxiety?

Program Implementation

This program would be implemented by using faculty workshops and professional development time. A proposed schedule is below:

Week 1	Teacher Workshop 1
Week 2	Teacher Workshop 2
Week 3	Teacher Workshop 3
Week 4	Teacher Workshop 4
Week 6	Teacher Workshop 5
Week 8	Teacher Workshop 6
Week 10	Teacher Workshop 7

The purpose of this timeline is to provide time for educating teachers during the first three workshops, and then allowing additional time for teachers to implement strategies throughout workshops 4-6. This program could be implemented using time during school, after school, or by utilizing flexible online professional development. Temporal frame factors may be of issue to those wishing to take more, or less time to complete the program. However, the program is flexible and can be condensed or expanded based on temporal limitations.

Chapter 5

Assessment and Evaluation

The success of this curriculum can be evaluated by studying the results provided by the pre- and post- questionnaire regarding student growth throughout the program. Success will be determined by examining the student reflection and self-growth. Understanding the importance of self-understanding, willingness and ability to learn are key components behind the success of this program. The primary goal of assessment is for students to identify the causes of their own mathematics anxiety, and identify which methods of prevention and alleviation prove most beneficial for them. Examining the qualitative data will provide the information needed to determine the success of the program. There will be no exams associated with this program, as they are one of the main causes of anxiety among students. By having students complete an exam, it would jeopardize the integrity of the program by potentially inflicting the anxiety that the program is trying to prevent.

In order to understand the evaluation methods used in this program, it is important to first consider the measurements of curriculum as outlined by Posner. Posner (1995), explores two methods of curriculum evaluation, measurement based and the integrated approach (pp. 235-242). Posner (1995) refers to the measurement-based style of evaluation as the "dominant perspective on evaluation" (p. 235). Measurement based assessment is the traditional assessment that you think of for a course, including more formal exams and evaluations. It completely supports the concepts of narration and regurgitation as presented by Freire in his book Pedagogy of the Oppressed. The purpose of assessment should not be to simply assess the student's ability

to regurgitate facts, however, consider the individual growth of a student in specific relation to the curriculum.

The integrated evaluation approach "focuses on trivial and contrived tasks. These tasks may not test the students' ability to use their knowledge and skill in the real world," (Posner, 1995, p. 239). In other words, instead of directly assessing the material learned in the curriculum and mastery, it instead focuses on the individual growth and development of the student in specific relation to curriculum application. The main components of the integrated approach include being growth-based, student-controlled, collaborative, dynamic, contextualized, informal and flexible and action-oriented (Posner, 1995, pp. 239-241). Utilizing self-assessment questionnaires, students are assessing their own growth through action-oriented tasks. They are asked to self-reflect on their own individual needs, identify their own personal stressors and strengths, and establish a repertoire of coping strategies that best suit their own personal needs. Utilizing this evaluation criteria, students are at the center of the curriculum, while using the measurement-based evaluation criteria, it is the exact opposite.

Reflection is the most important component to this curriculum. Specifically, student self-reflection as well as teacher reflection on classroom best practices. At the beginning of the program, students will be asked to reflect on their own mathematics anxiety after learning about its many causes. By utilizing this self-reflection at the very beginning of the program, students will be able to identify their own stressors and challenges within the subject. By reflecting critically on their personal anxiety, they will be able to identify exactly what they can work on throughout the second half of the program.

Once completing the second half of the program and incorporating multiple anxiety suppression and elimination techniques, students will again be asked to reflect on their own

personal anxiety. It is at this time that they will measure their growth throughout the course of the curriculum. A majority of this reflection will be driven by student-based discussion and collaboration. The main goal of this assessment is to identify the key strategies that assist students in coping with their anxiety.

Pre-Questionnaire

Do you like math? Why or why not?	
Does math cause you to feel any negative emotions like fear or failure? If so, explain.	
How do you feel about your general math performance compared to your peers?	
Do you feel that you suffer from math anxiety? If so, what causes your anxiety?	

Post-Questionnaire

Do you like math? Why or why not?	
Does math cause you to experience any negative emotions such as fear or failure? If so, explain.	
How do you feel about your general math performance compared to your peers?	
Do you feel that you suffer from math anxiety? If so, what causes your anxiety?	
Did the techniques we used in class help to alleviate any anxiety you may have been feeling before?	

Looking to the Future

As time progresses and youth become more inclined towards instant gratification, the concepts of having to persevere through challenging situations are posing a strong threat. With mental health being a primary focus in the world of education, teachers are at the forefront of the battles against the anxious student. As our world becomes more technological and less natural, it is important for teachers to find a balance. Teachers, ultimately, can be the catalyst for change. By teaching students how to overcome their anxiety, we will be creating more adaptable, attentive and industrious members of society.

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