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Examining the Classroom Experience

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Roots of Mathematics Anxiety in College Students

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ABSTRACT A majority of college students exhibit feelings of fear and discomfort when put into situations that require the use of mathematics. These students are characterized to be mathematics-anxious and tend to overlook the idea that one can gain many benefits from learning the subject. This paper investigates the various factors that have led to and influenced the feelings of mathematics anxiety in 13 undergraduate students pursuing non-mathematics-related majors. Through the use of questionnaires and interviews with each participant, the factors contributing to their mathematics anxiety were studied. Participants attributed teacher attitude, poor instruction, failure, and school tracking to initiating their mathematics anxieties. These findings revealed that the development of the participants' feelings of anxiety toward mathematics was somehow rooted to an experience in school, which highly influenced their attitudes toward mathematics and shaped their self-perceptions of their mathematical abilities.

KEYWORDS *mathematics anxiety, mathematics attitudes, undergraduate students, mathematics teacher education*

Introduction

As students progress through their mathematics coursework, we continue to notice the prominence of fear and disdain some of them possess for learning the content. A growing body of research continues to report that the negative feelings students have toward mathematics begins early in their lives, in some cases prior to kindergarten, and places barriers to their ongoing mathematical development (Wahid, Yusof, & Razak, 2013; Geist, 2010). Students move in and out of mathematics classrooms year after year with a mindset that the material is difficult to learn and fail to recognize the relevance the content has to their everyday lives (Levine, 1995). Consequently, students start to believe their mathematical abilities are insufficient and these feelings of inadequacy tend to result in a decline in the students' overall mathematics achievement (Passolunghi, Caviola, De Agostini,

Perin, & Mammarella, 2016; Gunderson, Ramirez, Levine, & Beilock, 2012). These negative views, coupled with the increasing fear found in several mathematics classrooms could be attributed to a phenomenon that has been labeled as mathematics anxiety.

Dowker, Sarkar, and Looi (2016) asserted "mathematics anxiety has been around for centuries" (p. 2). It can be described as feelings of tension and angst that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of practical and academic situations (Richardson & Suinn, 1972). Mathematics anxiety is an issue for many college students, many of whom have exhibited feelings of distress and discomfort for a significant portion of their lives when put into situations that require the use of mathematics (Perry, 2004). They tend to overlook the idea that one can gain many benefits from learning the subject and, thus, this disconnect has led these students to avoid

mathematics-related courses in their post-secondary schooling as well as any mathematics-related activities in their lives. As a result of a limited exposure to mathematics, students who possess mathematics anxiety may not acquire mastery of applying mathematical principles, which, consequently, diminishes their mathematical competence required for success in the workforce (Brunye et al., 2013).

The purpose of this study was to investigate the various factors that have led to and influenced undergraduate students' feelings of mathematics anxiety. The current study specifically focuses on students who were pursuing non-mathematics-related majors. An invitation to participate was extended to them based on their scores on Alexander and Martray's Abbreviated Mathematics Anxiety Rating Scale (A-MARS) (see Appendix A). The study explored answers to the following research question: What factors have contributed to the mathematics anxiety of college students' enrolled in non-mathematics related majors?

The literature offers several studies that examine the presence of mathematics anxiety in elementary school students, middle school students, and high school students. However, only a limited amount of research has focused on studying mathematics anxiety among university students. The present study was designed and undertaken to provide more empirical research on the factors undergraduate students attribute to causing their mathematics anxiety and document students' experiences with anxiety throughout their educational careers, something that few studies have examined. By calling attention to some of the causes, educators may build their understanding of the basis of mathematics anxiety and the reality of how it can develop at any point in a student's life. Moreover, this knowledge may empower them to advocate and work towards preventing and reducing the problem in order to increase their students' morale, understanding, and classroom performance.

Research Context

Etiology of Mathematics Anxiety

Mathematics anxiety is a complex phenomenon that is usually not caused by an individual factor (Taylor & Fraser, 2003). In this section, a review of the etiology of mathematics anxiety is presented with a focus on parental influences, the influence of teachers' attitudes, and the influence of teacher instruction on students' anxiety and mathematical development. The long-term implications of these factors are then identified.

Parent Influence on Mathematics Anxiety

The interactions that occur between a student and his or her parents play an important role in the formation of the child's attitude toward mathematics (Gunderson et al., 2012). The attributions and expectations parents hold are often reflections of their own attitudes toward the content, in which their personal beliefs and anxieties of mathematics may be transmitted to the student. For example, if parents express to children their beliefs about how mathematics is something they do not like to do or a subject that is difficult to understand and perform, the child may develop similar beliefs about mathematics that may ultimately lead to avoidance and underperformance in the subject. Parents' impact on students' development of mathematics anxiety is imperative to consider because parents are the first adults a child encounters and is influenced by with regard to their development.

Parents also contribute to a student's anxiety toward mathematics by implanting the idea that a student's mathematics struggles are inherited (Wahid et al., 2013; Tobias, 1978). Parents who may not possess strong mathematics skills adopt a belief that because they were not good at mathematics as a student, their children will also not be mathematically inclined. They attribute a student's poor mathematics performance in school to a lack of inborn ability to work with numbers, rationalizing to their child that "you've either got it or you don't" (Godbey, 1997, p. 5). Consequently, students move through their schooling and mathematics classes assuming that their difficulty in becoming proficient in mathematics is a hereditary result.

Teacher Influence on Mathematics Anxiety

The development of mathematics anxiety from school may be a direct consequence of learning from teachers who are anxious about their personal mathematics abilities (Stuart, 2000). If a teacher does not like the content or does not feel he or she possesses a mastery of the material, then it is fairly inevitable that the teacher will not feel confident when required to teach the content to students. The root of mathematics anxiety does not stem from the mathematics itself, but rather from the way it was taught to teachers when they were students (Boyd, Foster, Smith, & Boyd, 2014; Stuart, 2000). With today's schools filled with these teachers, the propensity of those who possess mathematics anxiety puts classrooms at a higher risk of having these feelings toward mathematics passed down from teachers to their students; thus, contributing to an unceasing cycle of mathematical disdain.

Teacher behavior has also been found to make an

impact on students' feelings toward mathematics in which many overt and internalized behaviors demonstrated by teachers may result in mathematics anxiety. Furner and Duffy (2002) argued that teachers often exhibit hostility, gender bias, an uncaring attitude, anger, and unrealistic expectations for their students. Students with unsupportive or uncaring teachers can become anxious and demonstrate the following: avoiding making eye contact with their teachers, becoming fearful of asking questions, and choosing not to participate in mathematics related tasks (Turner et al., 2002). Once mathematics anxiety surfaces within the student, other factors, such as bad grades, can fuel students' anxiety, hence making it harder for teachers to alleviate it and change their mindset that mathematics is difficult and impossible to learn. Additionally, factors such as communication and language barriers, quality of instruction, evaluation methods, and difficulty of material also played an equal part in contributing to this uneasy feeling in students (Mutodi & Ngirande, 2014).

Learning, Instruction, and Mathematics Anxiety

As much as teacher behavior may have an effect on the way a student feels about mathematics, methods of delivering information can also impact a student's attitude. One method that is often connected to mathematics anxiety is "chalk and talk" instruction, which emulates a more traditional form of delivery of the material (Farrell, 2006; Finlayson, 2014). Elements of this delivery method consist of teachers' use of direct instruction in which the teacher assumes an authoritative role while students work independently and collaborative learning is scarce. Direct instruction is often coupled with mathematics teaching that caters to a classroom where all students possess the same learning style, mathematics ability, and working pace. It often relies on learning through repetition, speed drills, and timed activities to build mathematics skills. This approach forces students to passively engage in their learning, and rote memorization serves as the main method of mastering the content (Finlayson, 2014). These classroom strategies of teaching mathematics as a subject that places an emphasis on right or wrong answers disregards the aspect of understanding of the reasoning behind concepts and does not build students' self-confidence in their mathematics skills. Since students are trained to attain only correct answers, they may move through their mathematics classes year after year not knowing how to take risks and experiment with problems.

Aside from instructional methods, Farrell (2006) examined another cause of mathematics anxiety, which

she called "dropped stitches," a term she attributed to a professor at Western Michigan University. The term can be defined as a gap in a student's prior mathematics education that holds him or her back from learning more complicated concepts. Farrell found that the existence of dropped stitches is very common because many students do not master every basic mathematics lesson they are taught. In addition, she pointed out that this causes teachers to revise their curriculum in order "to mend" the gaps so students gain the tools needed to meet the learning objectives set forth for their present course; thus, increasing the long-term frustration for both teachers and students. These frustrating feelings and gaps in their knowledge may lead students to develop anxiety when faced with challenging material due to a lack of feeling prepared.

Long-term Effects of Mathematics Anxiety

Mathematics anxiety may lead to detrimental consequences in one's everyday life and work (Allen, 2011). The presence of mathematics anxiety has led to a "global avoidance pattern" in which students avoid taking mathematics classes and situations where mathematics would generally be involved. Ashkraft and Krause (2007) stated "math is an important topic in schooling and preparation for careers. Skill at math is often a filter in terms of career pathways" (p. 246).

Several projections found in the Bureau of Labor Statistics' (2014) *Occupational Outlook Handbook* indicated that many jobs in the labor market have a requisite of a mathematics or science background, in which jobs requiring the most training and the most education in these fields will be the fastest growing and the most profitable. Additionally, the Bureau of Labor Statistics reported that the continued necessity, development, and prevalence of technology in the workplace will demand that workers possess strong mathematics and science backgrounds, with a mastery of foundational skills learned even before high school.

With the rapid growth of students developing mathematics anxiety throughout their schooling coupled with the knowledge that many profitable jobs are requiring a background in mathematics, it is essential to ensure students feel encouraged and confident to tackle mathematical tasks they encounter in both the classroom and their everyday lives.

The literature is related and important to the present study because it aligns with many of the causes of mathematics anxiety the participants identified throughout their schooling and the effects it had on their subsequent mathematics courses. Although there is limited research

in the literature investigating mathematics anxiety in undergraduate students, the literature presented supports the influences of teacher attitude, instruction, and parents in developing mathematics anxiety and highlights the reality that students can be affected at any age prior to starting college. The results of the study will help to inform parents, teachers, administrators, and society of ways to foster students' interests in mathematical concepts and support their studies in school to ensure their future success and ability to function in society.

Methods

The present study is part of a larger project exploring the impact of stressful situations on mathematics anxiety and mathematics performance in a population of college students. Recruitment and data collection for the study took place in an urban West Coast university in five undergraduate Elementary Statistics classes with students who were in non-mathematics related majors. Participants were selected from a group of students scoring between 3.33 and 5.00 on the A-MARS, which categorized them as mathematics anxious. Of the 86 A-MARS that were initially completed for the larger study, 26 had scores that indicated high mathematics anxiety. Invitations to participate were extended to all 26 students. Of these, 13 agreed.

Data Collection

The study took place over the course of one day at the university. All students who agreed to participate were identified to be highly mathematics-anxious and were given pseudonyms of a name starting with Ma.

The students were first prompted to complete a brief exercise designed to guide participants in reflecting and writing about significant experiences that have shaped their attitudes toward mathematics. Among the prompts on the questionnaire, students were asked to describe their worst mathematics experience. Participants were encouraged to write as much detail about the experiences that they felt comfortable sharing, which included the age or grade the experience took place, who was involved, what happened, and why it was considered significant as being his or her worst mathematics experience.

The study also integrated individual audio-recorded interviews with each participant to gather data about factors that have influenced students' feelings of mathematics anxiety. Participants were asked to consider their overall experiences of learning mathematics throughout their lifetime, focusing on what makes them feel anxious or scared to do any sort of mathematics-related task and

to describe any distinct experiences that could serve as examples of how they typically react when faced with doing something that involves numbers or mathematics.

Data Analysis

Upon completion of the questionnaire, responses were read, annotated, and coded. Major codes that appeared under Worst Mathematics Experience included "TEACHER ATTITUDE," in which the participant attributed his or her worst mathematics experience to a teacher with an uncaring attitude toward students, "TEACHER INSTRUCTION," which mentioned how the student was affected by a teacher who utilized weak instructional strategies in relaying content, and "BAD GRADE," where the participant stated that a receiving a bad grade (i.e., C or below) triggered a feeling of failure and a belief that he or she was not good at mathematics.

Of the 13 participants, eight mentioned that a teacher was the source of their worst mathematics experience. The first code, "TEACHER ATTITUDE," developed from the accounts of five of those participants who 1) experienced unsupportive and unkind words, 2) had their failures publicly showcased, and 3) received condescending comments on their work from their teachers. Among these participants were Mark and Maggie. Mark recalled his experience during his mathematics class senior year. He was in a class of six people and found himself struggling to grasp the material. Whenever he would ask his teacher for help, she would show an attitude of annoyance toward him as if she was too busy to offer any assistance. This eventually pushed him to frustration in which he completely gave up on learning the material. Maggie discussed her 8th grade Algebra teacher who would make comments that made her feel low while passing back her work. She explained how she often found herself not doing well on tests and when the teacher would pass back her exams, he would often say things such as, "It's okay because you're pretty. You don't need to be that good at math." These sorts of comments deterred Maggie from seeking his help, which eventually led to not passing and repeating the course. The second code, "TEACHER INSTRUCTION," emerged from the remaining three participants of the eight who attributed teachers to the development of their mathematics anxiety. Their personal accounts mentioned teachers who 1) moved through material quickly, 2) solely employed lectured-based instruction with little or no opportunity for students to engage or ask questions, 3) were not able to articulate the material in a manner students could easily understand, and 4) managed the class in a way where students felt they had to teach

themselves. Malik was one of these participants in which he reflected on his freshman Algebra teacher. He explained how the teacher was fast-paced which made the teacher difficult to follow. When Malik or his classmates asked him a question of clarification, his answers were always very technical and did not seem to always cater to beginning learners in Algebra. Malik described the teacher as being better suited for an advanced mathematics course as his instruction did not support the level of learners in his freshmen class.

Four other participants attributed their mathematics anxiety to the effects of receiving below satisfactory grades. This established another code, "BAD GRADE," which was defined by participants' experiences either 1) growing up as a strong mathematics student then receiving a below satisfactory marking or 2) struggling with mathematics for a majority of their schooling. Mandy represented the former sharing the enjoyment she had for learning mathematics until Pre-Calculus her junior year of high school. She explained how after receiving her first failing grade on her first exam in the course, her confidence diminished and as a result, her enjoyment for mathematics did as well. Mackenzie, on the other hand, went through school continuously earning C's in mathematics and feeling as if she could not perform up to standards. She expressed how her below satisfactory markings prevented her from achieving some of her academic goals, which in turn prompted her to develop her disdain for mathematics and the belief that she did not possess the ability to be successful handling numbers. Although each instance examined the effects of bad grades in two different circumstances, receiving one bad grade and continuously receiving poor markings, the researcher decided to categorize them together since both instances were rooted in a student's poor performance.

The final participant, Marion, was also categorized under poor performance since the development of his mathematics anxiety stemmed from being placed into a tracked system early in his schooling. Early tracking directly impacted Marion's confidence and attitude about mathematics. He recalled never having a genuine interest in the subject when he was younger and explained that being labeled as a weaker mathematics student in middle school and high school confirmed for him his inadequate mathematics ability. The lack of interest in mathematics coupled with his low self-confidence in his skills resulted not only in anxiety and hate for the subject but also in an attitude of believing he could not improve or do better than the remedial courses in which he was continuously placed. Although Marion's account sounded similar to Mackenzie's story, a key distinction

that set the two apart were the pressures Marion placed upon himself when comparing himself to his peers and worrying about them passing judgment. This seemed to fuel his dislike and anxiety for mathematics in which he felt helpless in trying to view himself as anything more than a student who could never be successful in mathematics.

Transcripts of the recorded interviews for all participants were also reviewed to identify any additional defining experiences or details that may have been discussed. In reading the responses and coding the interview transcripts, the researcher noted common themes in the anecdotes that related to the responses on the questionnaires with respect to: a) participants' personal experiences of growing up with mathematics anxiety, b) the feelings attached to each experience and the grade or course that triggered the anxious feelings toward mathematics, c) the people who may have been involved in creating the mathematics anxiety, and d) the ramifications these experiences have imposed on the participants now as college students enrolled in their first college mathematics course. The codes associated with the identified common themes from the interviews included "TIME CONSUMING," in which participants attributed feelings of anxiety to the amount of time required to solve problems, especially completing long or multistep problems, "LACK OF SELF CONFIDENCE," where the participant did not feel confident in his or her abilities when required to perform a mathematics related task, "DISAPPOINTMENT," where the mention of not wanting to disappoint significant people in his or her life (e.g. parents, other family members, or teachers) resulted in anxiety toward mathematics, and "INCOMPREHENSIBLE," in which he or she did not understand the mathematics required to complete a task. These codes emerged as the participants discussed how self-imposed pressures and fear of disappointing people they highly regarded were additional underlying factors that affected their experiences of living with mathematics anxiety.

Findings

Similar to what the literature suggests, the root of the mathematics anxiety of the participants was not attributed to a single factor. All of the participants' anecdotes in the questionnaires credited their worst mathematics experiences to something that negatively affected them in school. Their accounts described teachers, poor mathematics performance, and school tracking as defining

moments in their time as mathematics students that caused them to develop negative feelings and anxiety toward the subject. Additionally, personal pressures they placed on themselves as well as the pressure and fear of disappointing other significant people in their lives, such as parents or other family members, were mentioned as factors that contributed to the participants' development of mathematics anxiety. Table 1 displays a summary of the main factors the participants attributed to the root of their anxiety toward mathematics.

Coding the questionnaires revealed two ways students were affected by a teacher: attitude and instruction. Responses were coded as either "TEACHER ATTITUDE," which discussed how the teacher displayed an uncaring attitude toward the participant, or "TEACHER INSTRUCTION," which mentioned how the student was affected by a teacher who utilized weak instructional strategies in relaying content.

In the participants' discussions about their experiences and the effects of an uncaring teacher and a teacher with weak instructional methods on their learning, they asserted the need to feel supported in a way in which their teachers expressed belief in their abilities to succeed and employed pedagogical strategies that cultivated students' various learning styles to promote mastery of the content. Several of them mentioned that when their teachers presented themselves as unapproachable, hostile, or detached from creating an effective and positive learning environment, many of them felt both help-

less in understanding the content and hopeless about performing in their mathematics class successfully. Furthermore, this situation prompted fear of future mathematics teachers and generated feelings of anxiety rooted in uncertainty about the content and their own mathematics abilities.

Five of the 13 participants attributed a teacher's uncaring attitude to their worst mathematics experience in their questionnaires. One participant recalled being publicly criticized and humiliated by the teacher in front of her class in the 4th grade.

Mallory: I remember that our teacher gave us a pop quiz and I didn't know how to do any of it, so I guessed. When it was over she looked over my paper and told me and two other students to stand in front of the classroom. She proceeded to say, "These are examples of bad students who don't know anything." I remember it so vividly because I was mentally scarred and still am.

Another subject discussed in his questionnaire how his mathematics teacher's actions made him feel helpless in trying to understand the concepts being taught in the class.

Mark: During my senior year of high school, I was in a small class with only six people, and my teacher was very unhelpful. The class was difficult for me, and when I asked for help the teacher would give me unnecessary attitude. It's not like she had a lot of people to help! It got to a point where I felt so lost I just gave up.

Three participants wrote on their questionnaires that they received offensive or hurtful comments directly from their teacher that made them feel discouraged about their performance in class. The first participant, Malia, explained how in 7th grade, her mathematics teacher distributed progress reports to each student in the class to give updates on each person's current grade and provide comments to assist in improving over the remainder of the quarter. Malia admitted to not feeling confident about her mathematics grade, but felt hopeful after seeing some of the encouraging remarks her peers received from the teacher. Upon obtaining her progress report, she felt disheartened to see a C- accompanied by the comments, "Not your best! You should talk to your parents about getting a tutor for the rest of the quarter because you obviously do not understand what is going on in math class. You should also smile more." Malia felt that the teacher was harsh with her words and thus became unapproachable for the rest of the school year. This

Table 1
Factors Participants Attribute to Their Development of Mathematics Anxiety

Participant	Cause of Anxiety
Mackenzie	Poor Mathematics Performance
Maggie	Teacher Attitude
Malia	Teacher Attitude
Malik	Teacher Instruction
Mallory	Teacher Attitude
Mandy	Poor Mathematics Performance
Maria	Poor Mathematics Performance
Marion	School Tracking
Marissa	Teacher Instruction
Mark	Teacher Attitude
Marla	Poor Mathematics Performance
Marlon	Teacher Attitude
Martha	Teacher Instruction

experience also set a precedent of feeling unsupported and scared to ask for help from future mathematics teachers which, consequently, caused Malia to dread taking any mathematics course for the rest of her schooling.

The second participant, Maggie, recalled her experiences in 8th grade Algebra when her mathematics teacher expressed condescending comments whenever he passed back her examinations.

Maggie: Mr. L would always pass back my tests that I did poorly on (Ds usually) and say degrading things like, “Well, at least you’re nice,” or “It’s okay because you’re pretty. You don’t need to be that good at math.” I would always cry studying for his tests. I couldn’t even take Geometry as a freshman because I had to retake Algebra. He made me feel hopeless about my potential to learn math.

The third participant, Marlon, possessed a different background from the other participants who reflected on the influence of teacher attitude. Marlon was a high-performing student who maintained an A– in his freshman year Algebra course. He explained in his questionnaire that an experience with his Algebra teacher weakened his confidence in his mathematics abilities, causing him to always second-guess himself. In his interview, Marlon further explained how that lack of confidence carried with him throughout the rest of high school and into college, thus playing a negative role in how he presently performs on mathematics tasks.

Marlon: It was the end of the school year and we were all getting our final exam results back from our teacher. She told us that anyone who got an A average in the class would be recommended for AP placement next year. When class ended, my teacher asked me to stay and talk to her. She said that even though I received an A– in the class and did well on the final, she wasn’t recommending me for AP placement because she didn’t think I could handle it. I felt like she had punched me and completely discredited all my hard work during the year. This really weakened my confidence in my math skills and has now made me always second guess myself.

These five accounts illustrated how students of all ages were affected by actions and words shared by a teacher. Although the intentions of these teachers may not have been to hurt the students deliberately, the long-term effects of their actions adversely impacted the students’ feelings about mathematics and their abilities. They also instilled anxiety of having to do anything related to the subject.

The remaining three participants who mentioned that a teacher was responsible for his or her worst mathematics experience on their questionnaires attributed weak teaching strategies to their mathematics anxiety. One participant, Martha, commented that her Calculus teacher never seemed to interact with the class and spent the majority of the period with his back to the students while hastily writing notes and problems on the board. She explained that he rarely stopped to answer questions and that his notes were disorganized and hard to follow on the board. The second participant, Malik, mentioned the frustration he felt throughout his high school Algebra course from a teacher he perceived to be too advanced for freshmen.

Malik: The teacher I had was very fast paced and was hard to follow. I honestly didn’t enjoy homework because he would give us almost every single question in the chapter to complete! It was like, he graded so hard and we just literally learned the stuff. The lectures also weren’t always clear. When we asked him questions, he would give us a really intellectual sounding answer that made me more confused. He was definitely more suited for a more advanced class.

Similarly, the third participant, Marissa, shared her frustrations with her Honors Pre-Calculus teacher. In her interview, she expanded on the experience and stated that the class was one of the most difficult and challenging mathematics courses she had taken and that the teacher’s lack of support and instruction left her feeling lost in the material.

Marissa: The teacher basically had us self-teach ourselves and the material was really hard to understand. When we would ask for help, she seemed to get annoyed and therefore it was horrible. When it came time to take the final, I was completely lost, and had no idea what I was supposed to do. Consequently, I got a twenty percent on the final and got my first D on my final grade. It dropped my GPA dramatically.

The accounts from these three participants further validated the importance students placed on feeling supported by their teachers. They viewed teacher support as not only actions that displayed care and belief in each of their abilities, but also instructional methods they felt would lead them to mastering the material confidently. Although several of the participants consequently received low grades in the respective courses they mentioned, they all attributed the teachers to the root of the mathematics anxiety they presently possess. Conversely,

other participants who completed the questionnaire indicated that the experience of receiving below-satisfactory markings had triggered their anxiety about mathematics by instilling the notion that their poor mathematics performance defined their overall mathematical abilities.

Poor Mathematics Performance

Of the remaining five participants, four discussed in their questionnaires the psychological consequences bad grades had on their growth as mathematics students. These experiences provoked their feelings of mathematics anxiety and led them to believe they were not good at mathematics. For many of them, their confidence in their abilities was weakened, fear of failure and fear of the subject arose, and the pressure to perform well on assessments and in their courses superseded their interests in mathematics. With an underlying desire not to disappoint their families and even themselves, mathematics anxiety emerged for these participants as a result of not wanting to relive the experiences and emotions associated with their first time of feeling as if they had failed.

Three of the participants reflected on their initial experiences of failure after growing up always understanding and receiving good grades in their mathematics classes.

Maria: I was 14 and it was the end of my first semester of high school. I got a C in Geometry. I struggled so much with that subject and it was my first (and last) time getting a C in anything. I was disappointed not only in myself but I felt I also disappointed my parents. It wasn't an acceptable grade in my family. I felt like I had failed. I remember feeling so devastated and worried I wouldn't be able to handle high school math. I haven't gotten a C since then because every time I have taken a math class (even now in stats), I think about that Geometry class and not wanting to feel disappointed again.

Mandy: My worst math experience was when I was in the eleventh grade. Up until then, I found math to be enjoyable and I was pretty confident. I understood algebra and had little problems in ninth grade math. I made it through tenth grade Geometry honors (although I struggled a little bit). I got to Pre-calculus in eleventh grade and I thought I would have no problem until I got my first test and saw a big fat F on it. Pre-calculus was really difficult. I had to get a tutor and any liking I had for math went down the drain.

I continued to struggle through the rest of high school math and my hatred for math started.

Marla: Math had always come naturally to me but once I started taking Calculus, math class stopped being a "review." At first it was fun because I felt like for the first time I was actually learning something new, but after a few weeks I got completely lost and was never able to catch myself up. I ended up FAILING. Ever since then, I have become really scared of taking any kind of college math and I second-guess any math work I have to do to the point where I feel stressed. I am so scared to fail again.

The fourth participant mentioned her life-long difficulties with mathematics while growing up in which the animosity she developed for the subject emerged from not being able to achieve some of the academic goals she set for herself as a result of her poor performance throughout her schooling.

Mackenzie: For as long as I can remember, I have always got Cs in math. It was the only class I did bad in. I blame it for why I couldn't graduate with higher honors or get into a higher league college. As I got older, it also affected other subjects like science. It just made me feel incompetent that I couldn't do math and it seemed like everyone else could. Whenever I see anything that has to do with numbers, I freak out. I know that I'm not going to be able to do it.

The ramifications of failing an examination or in mathematics classes for these participants have impacted them not only academically but also psychologically. Several of them grew up as confident and high-performing mathematics students. However, receiving a failing grade in their high school coursework made the process of having to complete a mathematics test a stressful task that encompassed feelings of fear, pressure to obtain a certain grade, and disdain. For the other participant who grew up struggling with mathematics and feeling as if she was earning unsatisfactory markings, the task of performing well in her various mathematics classes became intangible. Due to their experiences, these participants have consequently become consumed by their anxieties about mathematics and have very possibly written off the prospect of rebuilding their resilience to tackle and master new material. Moreover, their present levels of mathematics anxiety have inhibited them from feeling confident in their personal abilities to perform a mathematics task.

School Tracking

The last participant identified school tracking in middle school and high school as his worst mathematics experience and the source of his mathematics anxiety. In his questionnaire, he began by reflecting on how mathematics was never one of his favorite subjects in elementary school. He explained his routine of consistently avoiding and putting off all of his mathematics assignments to the last minute and recalled frequently receiving bad grades on most of his work and tests. He mentioned that although he knew he was not performing well in his early mathematics classes, he vividly remembered his abilities negatively standing out among his peers in middle school and all throughout high school.

Marion: When I reached junior high we would have pop quizzes and the teacher would rank us into three different groups on the white board (this was in sixth grade). Keep in mind that whoever passes the classroom would see that. I was always in the third group and it was embarrassing. While the kids were learning formulas trying find what x is, I would sit there still struggling with the first problem while other students were on their tenth problem. I felt as if I was stupid and the pressure of other kids finishing their math before me felt really bad. Things got worse when we got to high school because junior and senior year we got put into a math class since there were different ones to choose from. Putting it in simpler words, there was math for smart kids, normal kids, and dumb kids. Just like in junior high, I automatically always got put in the math with the dumb kids. It was already expected. At that point I really hated math and even though I was in the dumb kids math, I still struggled. I got an average score of thirty-seven percent, which dragged my whole cumulative GPA down and made me frustrated. I picked a major that I thought I didn't need to do math in only to find out that I had to take this hard statistics class.

The early tracking that this participant experienced contributed to the negative feelings he felt toward mathematics. Its effects not only confirmed his dislike for the subject, but also led him to believe he did not possess the abilities to perform any mathematics tasks, especially when comparing himself with others. Once he felt labeled and ranked as a lower-performing mathematics student, he assumed that role. By the time he reached high school, "it was already expected" he would just end up in the lower-track mathematics class. Such hate and anxiety toward mathematics have carried this participant into his undergraduate studies, in which he ex-

pressed his disappointment in having to enroll in a mathematics course, despite specifically selecting a major that he thought would not involve any mathematics. He serves as a representation of several undergraduate students who continuously choose to avoid mathematics courses and related majors in college.

Self-Imposed Pressures and the Fear of Disappointment

Interviews with the participants revealed additional underlying factors that also influenced their early feelings of mathematics anxiety. After many of their initial accounts that lead them to develop their anxiety toward mathematics, several of the participants explained in their interviews how other self-imposed factors fueled the growth of their fear and disdain of the subject over the years. Many of the participants expressed how they saw mathematics problems to be time-consuming endeavors in which their anxiety would increase when required to solve long, multistep problems. Others discussed how over time, they developed a lack of self-confidence in their skills and as the content became more advanced, the material became incomprehensible to the point they did not understand how to complete many of the tasks presented to them.

Summary of Findings

Participants who were identified by the A-MARS to be highly mathematics anxious attributed various factors in their schooling experiences to the development of their mathematics anxiety: teachers, poor mathematics performance, and school tracking. More than half of the participants expressed how teachers were responsible for the development of their mathematics anxiety. They specifically credited teachers' unsupportive and uncaring attitudes as well as teachers' instructional strategies to negatively influencing their studies of mathematics while in school. Four participants mentioned the detrimental impact on their self-esteem of receiving a grade they regarded as failing. The accounts they shared in their reflections revealed that these feelings of pressure not only elicited their mathematics anxiety, but also caused them to believe they were not good at mathematics. Such long-term effects have led these subjects to become consumed by their anxieties about mathematics whenever they are faced with completing a task involving numbers and have, thus, pushed them to the point where they feel they can never gain self-confidence in their mathematics abilities. Finally, one participant discussed how his experiences of being placed in lower

tracks throughout his mathematics studies in middle school and high school confirmed his early feelings of disdain toward the subject. He described the effects of feeling labeled as a lower-performing mathematics student and how his dislike of the subject became accompanied with inept feelings and anxiety when having to do anything related to mathematics.

CONCLUSION

Mathematics anxiety can be traced back for centuries and continues to exist today among mathematics students nationwide, starting, in some cases, even earlier than kindergarten (Dowker et al., 2016; Geist, 2010). Its causes have been attributed to several aspects of a student's life, as indicated by the literature and the results of this study: a) teacher behavior, b) teacher instructional strategies, c) school policies and environment, d) parent influence, and e) the student. For all of the mathematics-anxious participants in the study, at least one of the causes above led them to their current feelings of angst, fear, and disdain for the subject.

The findings contribute to the literature on mathematics anxiety, especially with respect to undergraduate students, by showing that students could develop feelings of mathematics anxiety at any age. Moreover, for many of the participants in the study, the development of these feelings was somehow rooted to an experience in school for which school and the classroom environment were places that have highly influenced their attitudes toward mathematics and shaped their self-perceptions of their mathematical abilities. Although the factors that impacted their anxieties toward mathematics during their schooling varied, almost all of the participants mentioned how their experiences led them to feeling helpless and, for some, hopeless about successfully learning mathematics. Consequently, this had long-term effects on their self-esteem and personal beliefs about their mathematics abilities and instilled feelings of fear when faced with any sort of mathematics task.

The results of the study have significant implications for mathematics educators and teacher education programs. Several of the participants revealed that their worst mathematics experience was during high school, some as late as senior year. For many of them, they grew up enjoying mathematics but a negative experience quickly shifted their attitude to disdain and fear, and further developed into a general anxiety of having to perform anything mathematics-related. Other participants had a traumatic experience at a young age or early in

their schooling and, thus, have lived with strong feelings of mathematics anxiety for the majority of their lives. In either case, these experiences that defined students' anxiety toward mathematics have carried with them to their undergraduate studies where many of them have lived with their fear and negativity toward the subject for so long it seems to have directly impacted their post-secondary school coursework decisions by taking on non-mathematics related majors and in turn, their future career choices. Therefore, the support and belief students require while they move through their mathematics classrooms year after year should be held at the same importance for a senior level course as a mathematics lesson in one of the primary grades. There is sense of necessity for students' level of confidence in their mathematics abilities to be nurtured at all ages, especially from those most important to them at school and at home.

The findings from the study are important for teacher education programs and mathematics educators at all grade levels to consider because they assist mathematics teachers in recognizing the level of regard with which students hold them and the degree of hope students entrust teachers with to guide them in making sense of the mathematics they encounter in school. Teachers must become aware they not only could be the cause of developing their students' mathematics anxiety, but they also could be the solution for overcoming it. Their attitudes and interactions with students are contributing factors for creating a safe and comfortable learning environment for studying mathematics. Moreover, it is essential for mathematics educators to equip themselves with a strong foundation of both content knowledge and pedagogical practices that will cater to the diverse learning styles of the students they are responsible for teaching. By working attentively to reduce feelings of anxiety and improve students' morale, understanding, and classroom performance, mathematics educators may improve student performance and increase students' overall self-confidence. This could result not only in more meaningful experiences learning mathematics in school, but also in more successful lives as critical thinkers who will rise to the challenges they encounter as educational culture continues to associate mathematics mastery with performance in pressure-induced situations.

The mathematics-anxious subjects of this study are a small representation of a larger population of higher education students who live with a phobia they believe they will never overcome. Although they are only a fraction of a growing population, the experiences and feelings they shared and expressed in this study are reflections of numerous mathematics-anxious individuals within society.

With an overarching objective to support students in diffusing the many facets of pressure and curriculum that may lead students to feelings of stress which directly affect their performance and attitudes, mathematics educators, school policymakers, parents, and society must come together to ensure students' success in both their academic endeavors and future careers.

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Appendix A

ABBREVIATED MATHEMATICS ANXIETY RATING SCALE (A-MARS) QUESTIONNAIRE

Please indicate the level of your anxiety in the following situations. Please choose ONE box on each line.

		Not at all	A little	A fair amount	Much	Very much
1.	Studying for a math test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	Taking math section of the college entrance exam.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	Taking an exam (quiz) in a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	Taking an exam (final) in a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	Picking up math textbook to begin working on a homework assignment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	Being given homework assignments of many difficult problems that are due the next class meeting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	Thinking about an upcoming math test 1 week before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.	Thinking about an upcoming math test 1 day before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	Thinking about an upcoming math test 1 hour before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10.	Realizing you have to take a certain number of math classes to fulfill requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11.	Picking up math textbook to begin a difficult reading assignment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12.	Receiving your final math grade in the mail.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13.	Opening a math or stat book and seeing a page full of problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14.	Getting ready to study for a math test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.	Being given a "pop" quiz in a math class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16.	Reading a cash register receipt after your purchase.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17.	Being given a set of numerical problems involving addition to solve on paper.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18.	Being given a set of subtraction problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19.	Being given a set of multiplication problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20.	Being given a set of division problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21.	Buying a math textbook.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22.	Watching a teacher work on an algebraic equation on the blackboard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23.	Signing up for a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24.	Listening to another student explain a math formula.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25.	Walking into a math class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>