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How Math Anxiety Affects Educational Trajectories

Whitney M. Perkins
Florida Atlantic University, wperkins2022@fau.edu

Introduction

I excelled in math and really enjoyed it until the 6th grade; that's when I had a very stern teacher named Mrs. Kucs who yelled at me because I just couldn't understand fractions. She would take me out into the hall and reprimand me because she couldn't figure out why I wasn't getting it. She made me feel really, really stupid. That was the year my math anxiety began, and it never fully stopped. I chose to do the bare minimum in high school for math classes, which affected my college applications. I scored high on the verbal portion of my SATs, but I only took the test twice because I hated the math part and scored fairly low on that section. I also avoided any majors in college that would require too many math classes. Like me, many people suffer from math anxiety, especially females. Unfortunately, also like me, many of these individuals make educational and career decisions that avoid this anxiety. Since it's so prevalent, hopefully educators can make a positive impact through different teaching strategies.

What is Math Anxiety

According to the American Psychological Association, "math anxiety is defined as apprehensiveness and tension associated with the performance of arithmetic and other mathematical tasks. It frequently causes distress, disrupts the use of working memory for maintaining task focus, negatively affects achievement scores, and potentially results in dislike and avoidance of all math-related tasks." Unfortunately, math anxiety negatively affects many people throughout the world, with the majority of those being females. According to the National Library of Medicine, a staggering 93% of surveyed adults in the United States say they have suffered from math anxiety, with 17% having high levels of anxiety. Math anxiety has been shown to have emotional, physiological, and cognitive effects on individuals, even affecting working memory. Physiologically, people experience increased heart rates, upset stomachs, clammy hands, and lightheadedness.

How Math Anxiety Affects Primary Education

Mathematical anxiety has been widely studied and documented over the past 70 years since it was first discussed in the 1950s by an educator who published a paper on her student's "emotional difficulties" with math. Since then, several published studies have shown a link between math anxiety and working memory with primary school children. One such study that was documented in the The Impact of Mathematics Anxiety on Primary School Children's Working Memory (2012), determined through the researchers' findings that just the presence of

numerical data caused a decline in working memory for the 9 to 10-year-olds studied and correlated to the reported instances of math anxiety. In another study, researchers Ashcraft and Kirk (2001) found that their study subjects with high math anxiety were more negatively impacted when tasked with the assignment of math involving carrying while concurrently completing a task that involved working memory. “The findings suggested that attention to their mathematical anxiety was competing for participants’ cognitive resources.” Many researchers have theorized that the central executive system, which is responsible for working memory, plays an important role in mathematical tasks. “Even a relatively small disruption in central executive functioning could be sufficient to make a considerable difference to mathematical performance.” The same research suggested that there is a cyclical nature to math anxiety because when it causes decreases in math performance, then that in turn, causes more math anxiety.

How Math Anxiety Affects College Education

Several studies discuss how math anxiety leads students to avoid math classes, including STEM courses. One such study, found evidence that the association between math anxiety and lower STEM grades was strongest among students performing well in non-STEM courses. “This result supports the notion that math anxiety can prevent otherwise high-achieving students from realizing their potential in STEM, suggesting that math anxiety may be a particularly pernicious contributor to the ‘leaky pipeline’ in STEM, possibly preventing talented students from succeeding in STEM courses.” Having math anxiety is especially stressful for the students who are otherwise accomplished, high-performing students. When I was attending college, I took only what math courses were required to graduate. I purposefully chose not to pursue careers that would require too many math courses, such as marine biology and business, two of the careers I had wanted to pursue when I was younger. “Many students who suffer from mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum number of required mathematics courses, which greatly limits their career” (Eispino et al. 2017).

Gender Roles & Math Anxiety

According to a study published by Behavioral and Brain Functions (2012), more than 400 secondary school children, ages 7-10, were evaluated for math anxiety, revealing that females were affected by math anxiety much more than their male counterparts. The study found that although females have more anxiety, their performance scores were still comparable to that of the boys. So, while academic performance wasn’t affected, the anxiety still exists in greater numbers for

females and may result in mathematical avoidance. A recent study, published in PLOS One Journal (2016), looked at survey results from approximately 5,000 college students who were on a STEM career path through college. The researchers asked students who switched out of STEM after Calculus I why they chose to change their path. Thirty-five percent of women, as compared to just 14 percent of men, said they did not feel confident in their abilities to decipher Calculus I material well enough to pursue the required Calculus II. Historically, females have been socialized to view themselves as inferior to males in the fields of math and science, a belief which is hopefully changing.

How Can Teachers Help?

"I've come to a frightening conclusion, that I am the decisive element in the classroom. It is my personal approach that creates the climate. It's my daily mood that makes the weather. As a teacher, I possess a tremendous power to make a child's life miserable or joyous. I can be a tool of torture or an instrument of inspiration. I can humiliate or humor, hurt or heal. In all situations, it is my response that decides whether a crisis will be escalated or de-escalated, and a child humanized or de-humanized," Hiam Ginott. There are many things educators can do to alleviate math anxiety with the main one being, to be aware of which students are experiencing the anxiety. The following are just a few of the recommendations from the National Council of Teachers of Mathematics (NCTM) to address these anxiety issues. Teachers can create a variety of assessments, with some open-ended questions, that aren't always timed. Teachers can assure the students that their math grades do not measure their self-worth. In addition, teachers should emphasize that mistakes are common and the best way to learn is through making these mistakes. Furthermore, teachers can provide different learning approaches through direct instruction, student-directed problem solving, group work and individual work. According to Furner and Duffy (2022), "The way we fix math anxiety in our schools. To put it simply: better teaching." Finlayson (2014) suggests the constructivist style of teaching which emphasizes more student involvement, including soliciting more student questions, building on what they already know, initiating more group activities, and developing more teacher with student interactions. Furner et al. (2005) compiled evidence-based practices for teaching math in ways that reduce anxiety "which include: (a) use of manipulatives (make learning math concrete); (b) use cooperative group work; (c) use discussion when teaching math; (d) make questioning and making conjectures a part of math; (e) use justification of thinking; (f) use writing in math for: thinking, feelings, and prob. solving; (g) use problem-solving approach to instruction; make content integration a part of instruction; (h) use of calculators, computers, and all technology; (i) being a

facilitator of learning; and (j) assess learning as a part of instruction." In addition, Furner suggests that journaling is an excellent way to reduce math anxiety. He also suggests that teachers gauge at the beginning of the school year which students may be experiencing this anxiety through a "Mathitude Survey," which prompts students to answer five questions about their math experiences and feelings. "Students are rarely asked how they feel about learning about different concepts and branches of mathematics. Teachers can really get a better understanding and feel for any frustration students are feeling and can be a corrective strategy for helping students develop math confidence and deal with any previous math anxiety." Furner also suggests that teachers work with school counselors and special education specialists to build a supportive team around the children experiencing these anxiety issues. In addition to all these suggestions, I feel being patient and kind is important, and not chastising a student because they don't know the answer goes a long way.

Conclusion

"We predict that math anxiety is learned in the classroom—for example, when a student is called to the board to work on a problem, does poorly, and is embarrassed in front of the teacher and his or her peers. In short, lower-than-average math abilities and/or working memory capacity, susceptibility to public embarrassment, and a nonsupportive teacher all may be risk factors for developing math anxiety" (Ashcraft et al., 2007). Unfortunately, math anxiety plagues many people, but with some positive teacher interventions and teaching strategies, maybe some of the anxiety can be lessened. Becoming more aware of this anxiety is the first step for teachers. According to Furner (2022), "It is the teacher's obligation to see that all students are prepared for a high-tech society where one cannot afford to not feel confident in their ability to do math. Math teachers need to use corrective strategies to support students' math anxiety and help them work toward becoming more confident in doing mathematics." If some of this mathematical anxiety is alleviated or reduced, then the hope is that more students, especially women, will pursue careers in STEM fields.

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