

Math Anxiety: A Case Study on the Individualized Nature of Math Anxiety

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This study qualitatively explored the effects of math anxiety (MA) on undergraduate college students. Four undergraduate students were selected using the Abbreviated Mathematics Anxiety Rating Scale (A-MARS) and then interviewed about their beliefs about MA and the symptoms they experience from the anxiety—including the origins of the anxiety and methods with which they cope with (or attempt to cope with) the symptoms of MA. Students reported the onset of their anxiety occurred around elementary school and reported some common experiences such as strong feelings and a physical response. However, participants also showed the individualized nature of MA with different effects and coping mechanisms. This has implications for undergraduate instructors who want to help math anxious students.

Keywords: Math Anxiety, Undergraduate Education, Math Education

MA can lead to lower performance and a tendency to avoid majors that require mathematics (Ashcraft, 2002). Thus, it is important to better understand undergraduate students' MA and how to help them cope with it. We present a qualitative study that examined four undergraduate students and their beliefs about the origin of their MA and how these feelings have impacted their lives both in- and outside of the mathematics classroom.

Literature Review and Conceptual Framework

An individual is said to have math anxiety if that person experiences “feeling[s] of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002, p. 181). There are three components to this definition—anxiety, mathematics, and performance. That is, in order to be considered math-anxious, an individual must exhibit feelings of *anxiety* that specifically relate to *mathematics* (whether that be seeing, doing, or being evaluated over mathematics); and these feelings of anxiety must somehow affect the individual's ability to do mathematics. MA is also often characterized by decreased performance in mathematics (Lindskog, Winman, & Poom, 2016) as well as physical symptoms typical with anxiety, such as sweaty palms or even crying (Ashcraft, 2002). This study will focus specifically on MA in undergraduate students.

There is some division within the literature about the differences between test anxiety and MA, with some researchers finding support for differences between the two constructs and others reporting no such support (Dowker, Sarkar, & Looi, 2016; Kazelskis et al., 2000; Ho et al., 2000). For this study, we follow Ho and colleagues (2000) in assuming that MA and subject-specific test anxiety are separate constructs and can therefore be examined individually.

Origins of MA

The origins of MA have not been a focus of much empirical research, though researchers agree that there is no single cause for MA (Ashcraft, 2002). Possible contributors to MA have been suggested to include genetics, parent feelings about mathematics, peers'/siblings' feelings about mathematics, teacher enthusiasm, classroom instruction, school tracking, mathematics experiences, mathematics ability, and other anxieties such as test anxiety (Ashcraft, 2002; Quan-Lorey, 2017; Wheeler & Montgomery, 2009; Sloan, 2010; Stoehr, 2017). Quan-Lorey (2017)

writes, “mathematics anxiety is a complex phenomenon that is usually not caused by an individual factor” (p. 20).

One qualitative study examined three preservice teachers and found that each experienced MA differently, and that the origins of each participant’s anxiety were different (Stoehr, 2017). One participant developed MA as a result of being separated from the advanced students in elementary school. Another participant always operated with the understanding that she was simply not a math person. The third participant’s anxiety seemed to stem from her perception of a lack of a practical need for the subject. The case study presented here builds on this work, further exploring how undergraduate students experience MA differently.

Performance Effects of MA

MA is important to understand because it has been found to increase difficulty in student learning and decrease understanding (Wheeler & Montgomery, 2009). Students that experience high MA also “tend to avoid college majors and career paths that depend heavily on math or quantitative skills” (Ashcraft, 2002, p. 182). Students with high MA may avoid taking mathematics or quantitative reasoning courses in general. The literature suggests this could also contribute to lower mathematics performance skills. Furthermore, this could lead to less participation in class and lower grades (Ashcraft, 2002; Lindskog, Winman, Poom, 2016).

Classroom Practice Remedies

Researchers have suggested multiple ways to help remedy MA or help students cope with MA. Some suggested remedies for MA include teaching students to use cognitive skills to control their anxiety response (Lyons & Beilock, 2012), implementing math methods courses for preservice teachers (Sloan, 2010), and teaching ‘why’ a problem solving approach works rather than memorizing a formula (Wheeler & Montgomery, 2009). Other suggestions for remedies that help to control emotional responses include creative writing and a change in teaching methods. Geist (2010) suggests that a change to the teaching methods used in elementary classrooms could help to prevent the onset of MA altogether. Several researchers have found that asking students to write about their feelings can help lower MA and decrease the performance gap between low and high math anxious students (Maloney & Beilock, 2012; Park, Ramirez, & Beilock, 2014). Overall, researchers suggest that a focus on helping students decrease their anxiety is a better solution than creating new courses to simplify, or water-down, the mathematics (Lyons & Beilock, 2012).

Holes in the Literature and Project Rationale

A majority of studies on MA have used a quantitative approach, including multiple that use anxiety rating scales (Ashcraft, 2002; Cates & Rhymer, 2003; Goolsby, et al., 1988; Lindskog, Winman, & Poom, 2016; Lyons & Beilock, 2012, Sloan, 2010). Less research has used a qualitative approach to examine MA, though some recent research has used participant interviews, written participant samples, focus-group interviews, and the creation of mathematical timelines (Sloan, 2010; Stoehr, 2017). However, more research using a qualitative approach is needed to better understand how MA develops, how it differs from one individual to the next, and how it can be remedied within the classroom. The goal for this project was to qualitatively explore the symptoms, origins, and effects of MA on highly math anxious undergraduates enrolled in college mathematics, as well as the student’s coping mechanisms. The research questions were:

1. How do math-anxious undergraduates experience symptoms of math anxiety?
2. What do math-anxious undergraduates view as the source(s) of their MA?
3. Do math-anxious undergraduates believe math anxiety has affected their life and schooling? If so, how?
4. Do math-anxious undergraduates have ways they cope with their math anxiety? If so, how and are the methods effective?

Method

Participants were chosen from two different college mathematics courses. The first of these courses, which we will call Math Modeling, is not algebra-based and is designed for students that are not in business or STEM programs; it focusses on modeling mathematics found in everyday life activities, such as financial management. The second course is a traditional, algebra-based pre-calculus course and is typically taken by students that are interested in business or STEM-related degrees as a prerequisite for either calculus or business-calculus.

Participants

While the analysis methods of this study were qualitative in nature, a more quantitative measure was used to locate participants that experience symptoms of MA. For this, a survey was used—the Abbreviated Mathematics Anxiety Rating Scale (A-MARS)—which is a 25-point likert-scale (Alexander & Martray, 1989). A-MARS is scored on a 1 – 5 scale with 1 indicating little to no MA and 5 indicating high MA. Students in six mathematics classes were invited to take the A-MARS survey and 121 did so. Four students with some of the highest scores on the survey, all first-year students, were invited to participate in interviews. These participants were not told they ranked the among the highest levels of MA for the set of surveys returned but were told that their scores seemed to indicate that they experienced MA.

Data Collection and Analysis Procedures

Semi-structured interviews were used to collect qualitative data from participants. Participants were asked about their feelings regarding mathematics, why they believe they have those feelings, if they believed they were anxious about math, and what processes (if any) help them to cope with their math anxiety. Participants were also asked about how MA has affected their lives, and specifically their college experiences (if at all). These interviews were audio recorded, transcribed, and then analyzed using an open coding technique to develop codes inductively from the data. Coding led to creating profiles for each participant, with the goal of comparing and contrasting participants to address the research questions.

Results

Reported below are the results to each of the above research questions. For each research question, there were commonalities among the participants as well as a few stark differences.

Symptoms

The participants in this study had a wide range of reactions to their MA. All four participants expressed feelings of frustration and stress. However, each participant had other strong reactions when it came to discussing their anxiety. For example, Jacob frequently used the term “freak out” when talking about his feelings during mathematics class. When talking about his experience in high school, Jacob commented,

...I [would] literally just freak out. It was really bad for me. ... I felt dumb. I really was just like 'oh my freak. Why can I not get this?' I used to freak out really badly.

For Jacob, these “freak out” moments would sometimes get so bad, that his friends would ask, “are you okay? You look like you’re going to burst a hole through the wall or something”. This indicates a level of stress that is not only felt but shown. Other participants did not express quite this level of frustration or visible “freaking out”. However, others did express a similar discomfort. When asked about how she typically feels in a mathematics classroom, Karly responded, “Anxious. Like really ready to go. Even if I am understanding, it’s still not a comfortable feeling. I just want to leave”. Participants also reported a physical response to MA. Both Karly and Laura reported that they cry when doing mathematics. Karly cried during the interview and expressed that simply the act of talking about her anxious feelings toward mathematics caused negative emotions. According to her, crying when thinking about or participating in mathematics is not something that was new to her. In fact, she indicated that she cries a lot when it comes to mathematics. Laura also said that she feels sick to her stomach when it comes to high stakes assignments such as tests in the mathematics classroom. Both Jacob and Macy talked about sweating as a physical reaction to the anxiety.

Despite the strong feelings described by each of the participants, Laura was the only participant that indicated her MA was significantly worse with mathematics tests than with mathematics in general. Each of the participants agreed that their MA was elevated during testing situations, but Laura was the only participant to indicate that her anxiety elevates with math tests no matter how comfortable she is feeling with the material.

Origins

All four participants indicated that the onset of their anxiety symptoms either began in elementary school or that they had MA feelings for as long as they could remember. Macy recalled doing mathematics homework in elementary school with her father, saying:

...there was one story problem I remember. I had my math book, and I had my story problem right there and I remember I cried. We did it so many times, and I still couldn’t get it right. He’s a good guy because he was so patient, but I was crying. I just remember saying to him, ‘I’m going to fail at life’. Fifth grade. I remember distinctly being so distraught and upset because, I just couldn’t get it right.

Peer humiliation was a strong factor in the development of Jacob’s, Macy’s, and Laura’s anxieties. Macy recalled timed multiplication tests that were checked by peers and how she was afraid of failing in front of peers. Jacob recounted experiences in elementary school of his classmates being called to the board to work out a problem for the class. He explained how he refused to go to the board out of fear of embarrassing himself in front of his classmates because he did not understand the material as quickly as his peers. Laura’s anxiety onset also seemed to stem from this peer humiliation. When asked why she thought she had these feelings about mathematics, she answered,

I've always struggled with it and been slower than everyone else and everyone else kind of made me feel bad about myself because I wasn't as fast as them or I didn't learn as fast as they did.

While peer humiliation was a factor in the development of MA for multiple participants, Laura was the only participant that indicated peer humiliation was still a strong component of her anxiety toward mathematics. When asked why she had chosen not to utilize a mathematics resource center on campus, she explained that she would not be comfortable going because she would risk other people "judging, or staring, or watching".

On the other hand, Karly did not express these feelings at all. In fact, she does not give any reason for her anxiety. Instead, she simply states that sometime around second grade she realized that mathematics was not her strong suit and her anxiety continued from there. While Karly feels she cannot relate to her peers because she believes mathematics comes more naturally to them, she gave no indication that her anxiety is rooted in this belief.

Participants talked about parents and other role models in the interview. Both Jacob and Karly indicated that neither of their parents exhibited strong mathematics skills, though Jacob talked about a mentor of his that loves mathematics and encourages Jacob. Macy and Laura both had one parent they perceived as good at math and another parent that they related to because of the parent's lack of desire to do mathematics. However, none of the participants attributed their MA to their role models. Each of the participants argued that they formed their math anxieties on their own.

Effect

Participants reported mixed feelings about how their MA has affected their lives and their college experience. Macy, Karly, and Laura all indicated that their MA had not affected their choice of college major but had affected either their choice of math class or their experience in their college math class. For example, Macy reported that her MA has negatively affected her college experience by making the entire experience more stressful. Laura spent some time talking about how her MA has caused her to not want to attend school and how she avoids mathematics as much as possible. Both Karly and Laura reported taking the Math Modeling course because of their MA. Karly had previously enrolled in a different college math course and explained:

I was there and [the professor] was just talking and showing something on the board and I thought 'I can't stay here'. I'm not understanding. I've been here all semester long and haven't been understanding. I even went to the math center and I'm still not understanding, so, I can't stay here. ...and I never came back for the semester.

Karly said the experience she described above was the reason she chose to take the Math Modeling course. Her statement not only shows how her MA played a role in her course decision, but also showcases how Karly's MA has led to her avoiding mathematics where possible. Laura showed even stronger avoidance tendencies than Karly. When asked about how she reacts to her MA, Laura responded, "if I get frustrated, then I just completely shut down and I don't do it. I just give up".

In contrast, Jacob claimed his MA was a factor in his decision to major in social work. In fact, he claimed he was upset to learn he needed to take a mathematics course for competency

credit. He said, “if someone had told me that I had to take a math class, I probably would have reconsidered.” For Jacob, the MA feelings are strong enough that they have influenced important decisions in his life.

Coping Mechanisms

The most prominent coping mechanism among the four participants was seeking outside help in some form. Macy talked at length about calling her father for assistance when she was struggling. Laura and Jacob indicated that contacting friends or classmates for assistance helped them to relax their anxieties. Jacob and Karly each indicated that the mathematics resource center on campus was a useful tool.

Another interesting coping mechanism that was brought up by Laura and Jacob was listening to music while working on mathematics. For both participants having a quiet environment with music in the background was one way they were able to cope with MA while working to complete mathematics homework assignments. Interestingly, these were the same two participants that indicated they would reach out to friends for help when they were stuck on a homework problem. However, both argue that they cope best with the anxiety when they are alone to work on their homework.

Karly was the most unique in this study because she indicated that aside from visiting the mathematics resource center once in a while, she does not have any coping mechanisms for her MA. She said that the most she has been able to cope with the anxiety is by trying to detach herself from the mathematics by intentionally not thinking about the fact that she is doing mathematics when she is in class. The way she described this process was:

I’m present, but I’m not really thinking too hard about it. Like, Yeah, I’m doing math but I’m not like really caring that I’m doing it. But if I think, ‘oh yeah I’m doing math. This is annoying me’, then I will start to have those feelings. But other than that, if I just detach myself from it, then I don’t really [have the anxiety]

Aside from the detachment she described above, Karly stated she has no other way of coping with her MA.

Discussion

The results of this study show the individualized nature of MA, which is not developed nor experienced in the same way by different individuals. While many of the participants showed similar characteristics, no two participants in this study were similar enough to formulate a pattern for individuals experiencing MA. The most prominent similarity, the origin timeline for the participants, is the only similarity among all four participants beyond general feelings of stress and frustration that can be expected with any form of anxiety.

Researchers have hypothesized multiple origins for MA (Ashcraft, 2002; Quan-Lorey, 2017; Wheeler & Montgomery, 2009; Sloan, 2010; Stoehr, 2017). However, the participants interviewed for this study showed no evidence of most of these hypothesized origins, such as genetics or role models. The only supported hypotheses were previous math experiences (e.g. timed tests) and participants’ perception of their abilities in mathematics.

Implications

The current study provides a lens through which to view MA. Rather than looking at MA as a whole, this study allows researchers and educators to begin to explore how MA affects students on an individualized basis. Hopefully, seeing how students describe their MA will help educators recognize signs of MA and have better insight into the experiences of math-anxious students. For example, instructors might underestimate how intense the feelings and physical reactions of students experiencing MA can be (as shown by the results of this study). This study also shows how students are coping with their anxiety, including the importance of support from teachers, mathematics resource centers, and family and friends. Undergraduate instructors have an important role to play in providing coping mechanisms for students. Finally, this study again shows that students with MA may avoid majors or classes that are highly mathematics based. Undergraduate advisors may need to pay attention to students' MA, particularly for those students who might leave their programs due to the mathematics requirements. This study opens the door for future research (an example of which is described below) to further explore MA and how it is experienced at the undergraduate level.

Future Research

The current study suggests individuals experience the effects of MA differently. However, the current study is narrow in scope and only focuses on four individuals. A larger study is currently being developed to dig deeper into three aspects of MA—the origins of MA, the effects MA has at the collegiate level, and coping mechanisms that may help to alleviate the symptoms associated with MA at the undergraduate level.

Other future work could examine how instructors could incorporate coping mechanisms such as support from family and friends into their classes. It would be interesting to examine how encouraging students to form cohorts or other networks for support in college mathematics might affect MA in the classroom. Music might also be an interesting coping mechanism to examine. Future work could examine detachment, as experienced by Karly, in greater detail.

Conclusion

The results of this study indicate a need for a more individualized approach to the study of MA. Understanding MA at an individual level can help to shape the way mathematics is taught and how MA is dealt with in the classroom. By creating a more complete picture of MA, educators and researchers will be better equipped to create tools for prevention and intervention.

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