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A Menace to Math: When Numbers Attack and Anxiety Strikes Back

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Abstract

In this Capstone Project, the researcher examined educators' perspectives on math anxiety and investigated their personal experiences with math to identify effective approaches for reducing math anxiety. Addressing math anxiety is essential to reduce the tension and fear individuals experience in math-related situations due to environmental factors and teaching methods. The primary stakeholder perspective obtained for this study was that of educators, as they have the most significant influence on student's math comprehension and emotional associations with the subject. Following interviews with participating educators and a review of relevant literature, three emergent themes were identified: making math fun, phasing out timed tests, and ensuring educators are confident in their ability to teach math. Among these themes, phasing out timed tests was found to be the most effective strategy to achieve the goal of alleviating math anxiety in students.

A Menace to Math: When Numbers Attack and Anxiety Strikes Back

In Mr. Golden's second-grade classroom, an interactive math activity was underway. As a service learner, I observed students engaged in various group tasks. At one table, a student was struggling to understand the concept of skipping numbers using labeled paper cups. His frustration mounted, culminating in tears. After noticing his frustration, I began to approach the student to see what I could do to help him. This is when Mr. Golden approached me and said not to help him because he was throwing a fit and just did not want to do the work. This made me feel uneasy as I could tell that these were not tears because he wanted to avoid doing work but because he could not understand it.

Despite Mr. Golden telling me not to approach the student, I could not ignore him and make him feel unnoticed or unimportant. I could tell he needed help as I noticed his behaviors were similar to mine when I was frustrated with content I could not understand when working on my own assignments. It took me sitting beside him, reassuring him that it's okay if he does not understand it, and asking if he wants help. He quickly calmed down and accepted the help being offered to him. All it took was the use of a numbered carpet in the classroom that allowed him to skip numbers by jumping over the numbers and saying them to learn how to skip count. At the time, I did not realize how big of an impact I could have made on this student's relationship with math especially considering Mr. Golden did not understand how his response could impact the student's future relationship with math.

This story highlights the potential origins of math anxiety in young students and the importance of fostering an empathetic learning environment. Misinterpreting a student's struggle, isolating them in their frustration, and employing inadequate teaching methods can fuel anxiety. However, by responding with empathy and tailoring instruction to individual needs, educators can help prevent math anxiety and empower students to approach mathematical concepts with confidence.

Literature Synthesis

Math is a part of our daily lives as we are expected to find a sufficient tip amount or split a bill when eating out or with a group of friends, measure the amount of ingredients in a recipe when cooking, or even budget money for groceries. When doing these day-to-day activities, we do not get anxious when math is involved. Researchers have defined math anxiety (MA) as tension and fear when put in situations involving math, leading to avoidance of the subject (Gearty, 2020; Doz & Doz, 2023; Christiansen, 2021). Not only that, but depending on the career path you choose, the mathematics involved will vary, but it remains important to know. Those who tend to have MA usually tend to be high math achievers; however, due to having MA will avoid mathematic-centered electives or careers in the future (Szucs, 2019; Doz & Doz, 2023). MA was also found to have negative effects on an individual's memory, which tends to be worsened in situations where they are being timed (Gearty, 2020; Doz & Doz, 2023). For this reason, it is important that MA be addressed as it can cause individuals to feel tension and fear when put in situations that involve math, whether in real life or academically. The issue of MA also relates to a student's environment. When it comes to a student's environment, how your parents and teachers perceive math will affect how the student experiences math at that time and in the future. It is known that educators who are math anxious themselves reflect those attitudes unnoticeably onto their students. It tends to happen to teachers just starting as well as they feel unprepared to teach content, especially mathematics. Parents are the most important asset in their child's education as they are their long-term role models. With teaching standards and methods changing, it has made it harder for parents to help their children struggling with math. The research throughout this synthesis will focus on MA during and after the COVID-19 pandemic, global studies on MA, and equity issues that could create an environment for MA to be developed and discuss what can be done to find a solution.

Why is it an Issue?

MA was first recognized as “number anxiety” around 1957 by Dreger and Aiken (Dowker, Sarkar, & Yen, 2016). This led to further research to understand why MA is prevalent

among individuals of various ages. MA has become an issue for individuals as it stems from differing environmental factors and has been shown to create an avoidance of math for individuals, even causing stress to the body when coming into contact with it. Due to findings indicating that females experience this anxiety more (Szücs, 2019; Gearty, 2020; Doz & Doz, 2023), we see math anxiety being pushed onto future generations of students, creating inequality in these STEM-based fields as well as shortages, because of these stereotypes we do not see as many women in some STEM-centered careers. This is especially problematic because those who tend to have math anxiety do not always tend to have poor math performance. Still, because of their personal anxieties, they believe they do not perform well (Van Mier, Schleepen, & Van den Berg, 2019). It has been found that when it comes to the school environment, newcomers tend to show higher levels of math anxiety; teaching methods and instructional approaches are another reason for MA development in young students (Aguas, 2013; Doz & Doz, 2023; Gearty, 2020; Nowakowski & Ruesch, 2021). Nowakowski & Ruesch (2021) found that going through a math lesson too fast or administering timed math tests builds math insecurity and affects math fluency. Studies on MA have also shown that it affects an individual's attention, memory, and processing speed; Gearty (2020) explains that this happens because the brain is more focused on relieving the stress you are feeling than engaging in what is causing the stress. The last reason it is important to focus on math anxiety students is because of the change in learning modalities that came with the COVID-19 pandemic. Di Pietro (2023) discussed how the pandemic required parents to get more involved in their children's education, which worried many parents whose lack of confidence and self-efficacy beliefs grew. Groups showing high levels of anxiety in a study by Mulenga & Marban (2020) taking place at an Italian middle school showed a decrease in anxiety because these students were not forced to learn in an

environment they associated with learning. Others who had anxiety not as severe did not suggest that their anxieties had decreased with the change to a fully online modality. This was compared to a study done in Minnesota, where similar results correlated with math anxiety during the pandemic. The results found that the students taking part in the study had decreased anxiety (10%), somewhat decreased (22%), somewhat worse (24%), and worse (22%) when moving to an online learning modality (Christiansen,2021). This raises concern about whether the pandemic increased the number of students experiencing math anxiety after having to experience online learning for some time.

What Should Be Done?

Some solutions include instilling a growth mindset in students (Lavallo, Lam, & Wong N.D.; Tut, 2023), understanding what MA looks like in students or teachers and how to help them (Gearty, 2020; Aguas, 2013), making math fun, creating life-like scenarios to teach new subjects in math (Tut, 2023), and lastly ensuring educators are confident in their math abilities (Aguas, 2013; Gearty, 2020). By instilling a fixed mindset, which is more often than not done unintentionally by the teacher, leading to psychological vulnerability (Gonzalez-DeHass et al., 2023). If they believe they are bad at math or unsuccessful because of this mindset and vulnerability, the pattern will continue when encountering new math-related topics. When it comes to everyday math use in an individual's life, such as budgeting how much they have left to spend on their groceries for the month or how much they can spend when going out to eat with friends, whether it is because it involves math in a way we do not realize or because its something that has to be done we do not hear people saying their bad at math when doing these mundane tasks. If we applied real-life scenarios when introducing new topics or made math fun

in mathematics, educators could create more engaging math lessons that would also create longer retention of the lessons in students' memory. An example is given by Tut (2023), where a school in Singapore has third to fifth-grade students use menus from real restaurants, role-play ordering food, and calculate how much they will have to pay in total, including a tip. Another example given by Nowakowski & Reusch Another way to ensure that students within the classroom are not anxious is by checking their level of understanding. Signs to look out for are students who say they are bad at math, shutting down in class when working on math-centered topics, avoiding eye contact, or using closed-off body language (Gearty, 2020). These signs are often avoidant behaviors, and it can be hard for an educator to identify these patterns. Hearing a student say they do not like math or are not good at it can be the most obvious; the teacher should use that statement and understand that when this is said, the student is struggling with something in the math content. Another proven method to help students is creating a survey that checks for understanding after or between lessons (Tut, 2023; Gearty, 2020; Furner & Duffy, 2022). The last way to ensure students do not develop MA is by making sure our educators are confident in the content they are teaching to their students. It has been found that educators struggle with confidence in their teaching abilities, especially at the beginning of their careers, as they are trying to learn classroom management, teaching a class on their own, and learning the standards of their school administration and faculty. Creating a support system for educators that allows them to ask for help or go to another educator when they do not feel confident in teaching a new topic can also benefit students (2013). Though this problem could be seen more in middle and high school levels, it happens at the elementary level as well, as it's common for teachers to prefer teaching a certain grade level because they are confident in the math involved with that grade level. Galeano et al. (2024) found that students with math-anxious educators exhibit lower

math achievement than teachers without MA. Ramirez et al. (2018) found that negative reactions to student questions were also associated with creating MA within students.

Conclusion

Math anxiety is a known issue among students and educators that can affect their relationship with math and career choices, whether it is choosing not to go into a STEM-centered field or not wanting to teach above a certain grade level due to a lack of confidence in math, the problem needs to be addressed. This can be due to environmental factors, stereotypes, or how the content is taught. Research has also shown that the COVID-19 pandemic can hold some responsibility for an increase in math anxiety. Proposed solutions for preventing math anxiety in the future include instilling a growth mindset in students, teaching them content in a way they can apply to the real world and is fun for them, understanding what MA can look like in a student, and lastly, making sure that educators have the confidence to teach their students math topics so that their students can feel that same confidence. Doing these things makes it possible to reverse MA in students and prevent it, which is important.

Method

For this Capstone Project, I investigated how educators viewed math anxiety, analyzed their experiences, and the best-proposed prevention methods. Based on the analysis of the data and the relevant research literature, I formulated an action that responds to students' math anxiety in a way that inspires, informs, and involves a particular audience.

Context

My study involved participants coming from three districts: located in "Monte¹," CA, "Pimento," CA, and the other in "Queens," CA. "Monte," CA, has an estimated total population of 430,723, with most of its population being Caucasian. District A, which will be referred to as

¹ All proper names have been replaced with pseudonyms.

Ocean Unified School District, is located in Monte and oversees 10 elementary, two middle, and four high schools. The district enrollment total is 9,809; out of those students, 2,584 are English Learners, 1,407 have a disability, 1,194 are homeless, and 6,336 are socioeconomically disadvantaged (California Department of Education, n.d.). Their ethnicity enrollment report shows that most students enrolled are Hispanic/Latino at (~62%), followed by Caucasian (~19%) and African American (~5%). When it comes to meeting state standards on the math portion of the CAASPP assessment, evidence shows that the majority of students not meeting the standard are those that are African American, Hispanic/Latino, socioeconomically disadvantaged, English learners, have a disability, or are homeless.

District B is located in "Pimento," CA, and will be referred to as Three Lakes Unified School District. Pimento has an estimated total population of 528,001, and 39% of that population is Caucasian, and the second most is Latino at 29.4%. Three Lakes Unified School District oversees about 39 schools in total, with over half (28) of them being elementary schools, 5 middle schools, 4 high schools, and one adult school. The district enrollment total is 37,651; out of those students, 9,254 are English Learners, 4,050 have a disability, 2,410 are homeless, and 33,303 are socioeconomically disadvantaged. When viewing the district enrollment by ethnicity, it shows that a majority of students enrolled are Hispanic/Latino at 37.5%, followed by Caucasian (30.6%), Asian (12.7%), and African American (9.6%)(California Department of Education, n.d.). When it comes to Three Lakes meeting state standards on the math portion of the CAASPP assessment, evidence shows that the majority of students not meeting the standard are those that are Indigenous(~57%), African American(~66%), Asian (~52%), Hispanic/Latino (~55%), socioeconomically disadvantaged(~56%), English learners (~70.49%), female (~71%), have a disability (~81%) or are homeless(~63%). After reviewing Shell Vaso Elementaries SARC report it shows that a majority of their students are Hispanic/Latino(~38%), Asian(~34%), and socioeconomically disadvantaged (~92%). When reviewing the math results for the CAASPP test, a majority of students not meeting the standard are those who have a disability (~79%), are socioeconomically disadvantaged (~55%), English learners (~68%), Indigenous (~68%), African American (~82%), Hispanic/Latino (~61%), and Caucasian (~53%).

District C is located in "Queens," CA, and has an estimated population of about 13,738, with a majority of the population being Hispanic/Latino (~85). It will be referred to as Kingston Unified School District, with a total of five schools, four of which are elementary schools and one middle school. When it comes to Kingston Unified's enrollment, there is a total of 2,578 students, with most of their students being Hispanic/Latino (95%), followed by Caucasian at 3.3%. Out of those students, 1,603 are English learners, 2,326 are socioeconomically disadvantaged, 392 have disabilities, 207 are migrants, and 373 are homeless (California Department of Education, n.d.). After reviewing the state standards on the math portion of the CAASPP assessment, it showed that students struggling most to meet the standard are students who have disabilities (~83%), or are socioeconomically disadvantaged (~61%), English learners (~74%), Hispanic/Latino (~60%), migrants (~73%), and/or homeless (~67%).

Participants and Participant Selection

Two participants for this study were recommended to the researcher as they all have expertise with mathematics and/or math anxiety; the third participant was previously known by the researcher and was asked to join the study and offer her experiences as she is newer to being an educator and works with students at differing grade levels.

M. Carey. A Caucasian female who has been an educator for 10 years in total. For the past three years, she has taken on the role of the math program coordinator for Ocean Unified School District. Her role as the program coordinator consists of development, implementation, and coordination for schools throughout the district. This is an important role because the coordinator is responsible for enhancing instruction and student learning. Growing up, she was homeschooled by her mother, who explained math as mysteries needing to be solved. She mentions being able to practice manipulating numbers on her home window with expo markers and practicing things such as long division. By doing this, she discovered shortcuts to solving equations by finding number patterns. This allowed her to create positive experiences with mathematics and helped her in her current position notice the importance of giving students low-risk assignments and practice to allow them to develop a number sense and feel comfortable

and confident in their math abilities. She mentions how this has helped her as an educator overall because she has become more aware of how students need low risk assignments that allow them to practice and experiment with math and differing methods to develop their number sense and recognize patterns.

C. Aguilera. A Latina female who has been an educator for a year in an after-school program at Shell Vaso Elementary School in the Three Lakes Unified School District. Her position title is Program Senior Team Lead and entails assisting other educators within the program when needed. An example provided by her is the host teacher having to use the bathroom, needing their class to be watched, having trouble with a student requiring them to be taken from the class to address the issue with the student and their guardian (if called for), taking charge when the program coordinator is not present and taking over classes when short-handed. An experience that stuck out to Aguilera during her time in school is the transition from elementary school to middle school, where she went from a school and teachers that would teach her multiple methods of accomplishing math-related content to a school where class sizes were larger, causing her to have trouble getting help especially because she was unable to get extra help after school due to her younger siblings having to be picked up at another school right after she got out of school she stated this led to her falling behind in math. She also mentioned a good experience with one of her elementary teachers who used songs or differing scenarios, enhancing her understanding of math while making it fun and engaging. She has taken both of her experiences with math and used them to shape others' experiences to make math fun and less daunting to her students.

L. Woods. A female educator who has been an educator for 29 years in total. Being a part of the Kingston Unified School District for 26 years, and became an instructional coach and tech teacher in 2020. Her role involves moving between different schools within the district and assisting teachers and students using new technological teaching tools. Her personal academic experiences with math included wanting to become a mathematician because of her love for math. She mentioned viewing math as a puzzle and her personal experience of learning to count to 100 in Kindergarten after telling a peer she could and being determined to learn after stating

she could. She also mentions a memory of her father placing coins on the table and asking her how much there was. She later used this experience when working in her family store without a calculator or the register to tell her how much change to return. She mentions the impact of her students on her and the resources she has created and provided within classrooms to help students retain their math knowledge and form connections within the subject matter. This led to increased student learning and satisfaction for educators because of the amount of help the technological resources provided. She mentions differing resources giving student feedback right away without the teacher having to check the work.

Researcher

This is an important topic because of my personal experiences of disliking and struggling with math, as well as seeing the effects of other students who struggle with math in different classrooms and analyzing the responses of the teachers teaching math. I am similar to my participants as we all want to see students succeed in mathematics and see students with more confidence when it comes to math-related topics. Ways that I differ from participants is their experience and/or ideas relating to how to improve math anxiety. I may need to be mindful of going into this project because some stakeholders may be unaware of what math anxiety entails or how to recognize it within the classroom. I also need to be mindful that the change and issue I bring to light cannot be fixed or understood by everyone overnight.

Semi-Structured Interview and Survey Questions

Semi-Structured Interview Questions

1. What do you know about math anxiety?
2. What is currently being done to address math anxiety - by whom - and what are the strengths and weaknesses of these efforts?
3. What do you think should be done about math anxiety?
4. What do you think are the challenges of helping students who have math anxiety?

5. Is there anything else you would like to say about math anxiety and/or helping students deal with it?

Survey Questions

1. When thinking about your K-12 experience, was there an experience you thought of in particular? What was it?
2. Was there a specific teacher that came to mind when you thought of your experience?
3. How have your experiences with mathematics and your teachers shaped you as an educator?
4. How long have/were you an educator? (total)
5. How long have you been an educator at your current school site?

Procedure

All participants were interviewed individually for this study. When it was not possible to interview participants in person, they were invited to complete a virtual interview or paper and pencil survey of the same questions. Interviews took less than an hour, were audio-recorded (with participant consent), and took place on the school site or via Zoom. The research also included written reflection questions to gather information on their experiences with mathematics, which they could complete before or during the scheduled interview time. A semi-structured interview format was used for interviews to allow for follow-up questions to unclear, interesting or unexpected responses. All interviews/surveys were scheduled at the convenience of the interviewee and took approximately 35 minutes to complete.

Data Analysis

Transcribed interviews were coded and analyzed for emergent themes.

Results

For this Capstone Project, educators were interviewed to see what they think could be done to improve math anxiety. This holds significant importance due to extensive research conducted on the subject. It's crucial to grasp methods of mitigating math anxiety in individuals, be they parents or educators, to foster a sense of confidence in our students regarding their mathematical skills, ultimately leading them to embrace rather than evade the subject. Based on an analysis of the data and the relevant research literature, three themes emerged (see Table 1). Evidence-based decision-making required evaluating each potential Action Option by the

following criteria: the probability of impact, potency, and visibility. The probability of impact is crucial because while all actions may offer benefits, some may be more achievable and impactful than others. This leads to the consideration of potency, where certain actions consistently emerge as effective solutions, enhancing students' and educators' confidence and comprehension of mathematics in the classroom. Visibility is also paramount, as it informs us about methods known to benefit educators and students, as well as the general awareness of these actions within the educational community. Based on the evaluation of each Action Option an action will be recommended and justified.

Table 1

Evaluation of Action Options

	Probability of Impact	Potency	Visibility
Making it fun for students	High	High	High
Phasing out timed tests	High	Medium	High
Ensuring educators are confident in their ability to teach math.	High	High	Low

Making Math Fun

Across all three participants, the biggest emphasis for helping students they worked with in varying grades is making it fun (M. Carey, personal communication, April 30, 2024)! Though their methods differed, they all came down to the same thing. When interviewing Carey about her actions for making math fun within school sites, family math nights and celebrating pi day with differing activities were what her school sites did to make math appealing to their students

and parents. Another way of making math fun, pointed out in the literature by Parikh (2007), Aguas (2013), and by interviewee Woods (L. Woods, personal communication, April, 2024), was creating real scenarios to make math content more engaging, like having students pretend they're at a restaurant with their peers and have to calculate the total amount for their food, including the tip (Tut, 2023). A different approach is making games out of math. This was proposed and is done by Aguilera, stating that when students are not working on math homework, they tend to find playing math games or projects that involve math fun and keep students engaged (C. Aguilera, personal communication, April, 2024). In research done by Bang et al. (2023) they said, "Since play has such a significant influence on children's development and thought processes, a key role of play in learning is the constantly evolving (Slutsky & DeShetler, [79]) zone of proximal development (ZPD, Vygotsky, [86]), the "sweet spot" where the learners are ready to learn, with tasks that are not too easy nor too hard, in which they can succeed with some struggle (Plass et al., [65])." She also mentioned that this allows her to see which students need more individual help and discussed having to explain it to them in different ways. A specific example given for a student she would check in with is one that is guessing when it is their turn to play and continuing to guess when given other opportunities to answer without thinking. Woods also discussed having students an EduProtocol called Fast and Curious. With this activity, students are given a quiz with math facts they need to learn and at the end of the quiz students go over the answers with the teacher before taking the quiz again the teacher keeps the class average as their score and their goal is to beat it the next time they take the quiz (Nowakowski & Ruesch, 2021). Due to this being found effective in helping students in both research and the interviewees the probability of making math fun and making an impact was high. Something that may be a struggle is doing this at the levels past the elementary school; Carey mentions we tend to see teachers that prefer to stand at the front of the room and teach the students rather than including them and making them engage in the lesson engagement is important for students even at this level because content gets more challenging as it incorporates multiple concepts learned at lower levels. A technique mentioned by Woods is having all students stand up and move around solving a problem on the problem to engage students. When it comes to potency it was ranked as high due to recommendation from research from Aguas (2013), Parikh (2007) and interviewees. Visibility was also ranked as high as two interviewees mentioned how they manage this issue

within their school sites as well as mentioned other schools across the country who used similar methods meaning that bringing awareness to this issue is on its way to being solved and with the right resources contribute to student success.

Phasing Out Timed Tests

The next action option mentioned by 2 of the 3 participants is phasing out timed tests or changing the concept of these tests. In the study done by Tsui and Mazzocco (2007), students with low levels on math anxiety had a decreased performance on timed tests, while students who had high levels performed the same with the untimed tests. Though this differed from the results in another study they compared to in their literature, it was still mentioned as something to avoid by Carey and Woods. Carey mentioned that many teachers use this method because it's what they were taught. Both Carey and Woods mentioned that these teachers do not understand that speed does not translate into fluency, which could be impacted by administering timed tests for some students and influence the idea that they are not good at math because they could not complete it in the given time. A similar approach suggested by Carey that could be more effective is starting at a time that you know is more than enough for them to complete to give them that confidence and then telling them the next time they do it to try and lower the amount of time they finish it. Another alternative method based on the fast and curious protocol in some of the classes Woods works with is using the same math facts for students to learn over three weeks in the first week, students take a multiple-choice test. In the second week, students will do a fill-in-the-blank test using an online platform like Quiziz. In the third week, they will do a paper and pencil test where educators give students plenty of time to finish, and if they are unable to, there's no consequence, and the student knows they need to practice more. Woods mentions that with this method, students tend to be excited and confident once getting to the paper-and-pencil format. When it comes to evaluating this option for the probability of impact, potency, and visibility, it was deemed high and medium for potency and visibility. The probability of impact was found to be high after it was mentioned that timed tests are a contributing factor to math anxiety for students. Though it seemed to be redacted by research mentioned earlier, it was not unanimous with other research, so getting rid of timed tests could be productive for preventing or lessening math anxiety in students. For this same reason, this may not be the strongest option for helping students, considering how much this will benefit

them. The issue's visibility seemed to be high as there has been research done to understand it and steps taken to remove them from classrooms; alternative approaches with the same idea of fluency, but it comes after mastery. The only problem that could come with ridding these tests could be getting veteran teachers to understand the importance of getting rid of timed tests in their classrooms because they believe their method works. However, this may not be common; the issue could and has arisen.

Ensuring Educators are Confident in Teaching Math

When it comes to the last action for decreasing math anxiety in students the next proposed solution is supporting the teachers responsible for teaching the future generations. Two of the three interviewees mentioned this during their interview. A line from Carey's interview that stuck out when understanding the influence educators have on their students when it comes to teaching mathematics was that some teachers will teach one way of solving a math problem that resembles the way they learned or they will teach multiple methods to solving a problem and not allow students to master one specific technique. This issue of going through a lesson too fast Carey also discussed the issue of first year teachers not struggling with the concept of teaching math because they're learning classroom management among other things while having to learn and teach math in a way probably not taught to them. Both contributing to their students lacking confidence in their math abilities. The issue with first year teachers lacking confidence when it comes to math was also mentioned by Szucs (2019) where they state it's been known for a while that primary school teachers in training tend to show high levels of math anxiety. Aguas (2013) also found that elementary school teachers tend to have math anxiety due to lack of training or education. They also mention that they're usually females which makes sense considering that educators many educators are female in comparison to male educators. Carey also discusses the issue of single-subject teachers who may struggle with specific math concepts or techniques and not ask for help from their fellow teachers due to fear of being seen as lacking knowledge in a subject they are there to teach. Woods mentioned a similar struggle with teachers, stating they are not good at math or a math person. Carey mentions that saying things similar to what Woods witnessed or hearing a teacher say that a certain math topic is easy or hard which alters the students perception of the material. The last thing emphasized by Carey is this "...if you've got anxious adults trying to teach anxious kids, we've got a never ending cycle and we've got to

break that cycle of anxiety and stress about math and see math as beautifully beautiful and joyful and something that's really relevant to their lives." When looking at this action option in relation to probability of impact, potency and visibility it scored high for probability of impact and potency but low when it came to visibility. It is believed that the probability of impact and potency are high because educators are one of the biggest contributors to students' interpretation of school and its subjects if a solution was found to create better outcomes for math lessons and interpretations that gives the student and teacher a better understanding and mastery of math while lessening math anxiety in our students for the future generation. Though this may not seem like a hard thing to do getting the resources to reverse anxieties in teachers can be difficult without help from school administrators. The text by Nowakowski & Ruesch (2021) wrote their book for teachers so they could learn how to learn math so that math learning is embraced in the future by educators while also reducing student stress.

Conclusion

Recommendation. Based on the information provided by both interviews, research and the criteria provided it could be most effective to make math fun for students as there are many methods to accomplishing that. By doing this the stigma of not being a math person or not being good at math could be removed for our schools teachers and students which could put a stop to the endless cycle of the belief that only some people are good at math. It also engages your students in a way that can help with retaining math content. With doing this an environment could be created where everyone is confident in their math abilities and want to learn more.

Concessions. One strength of choosing to get rid of timed tests is that it would be another great preventative to decrease anxiety in students when taking those tests. It could also be beneficial because students would focus on mastering the content you are teaching them rather than just memorizing the information and forgetting it once moving on to something else. Not choosing this option would not have the largest effect on students because, based on the interviews, timed tests are not a tool used in the classes they oversee. Ensuring educators are confident in their ability to teach math could be the strongest option. Showing students that their teachers are unafraid of math and understand ways of solving varied forms of math could give

them the example they need to understand that math is not scary and could even be fun when learned in a variety of ways, which could also lead to an overall increase in math fluency.

Limitations. The choice of making math fun could be limited to schools that lack resources. Many recommendations made to making math fun in research displayed the use of digital math games to engage students and give automatic feedback to increase student retention of the problem. I could also see this being hard for first-year teachers as they're learning the best classroom management methods. Adjusting lessons for them in a way that may help them and their students could be a challenge unless they have a mentor to guide them in some way with the hurdles of first-year teaching or making math fun. Another limitation might be making it fun for students above the elementary level. Research suggests that a math club would be a great solution to this however the fear of societal standards may keep some students from joining a club that focuses on math unless the perception of math being fun was changed for everyone.

Potential negative outcomes. A possible negative outcome would be that educators would not be able to create lessons that make math fun while also helping students develop fluency in math. If this were to happen, we will still see students struggling in math and, in turn, making the subject not fun even if the activity is engaging. It could also become problematic to do this if a teacher has trouble managing their class when it comes to doing activities that may involve working together as a class or in small groups. I can not see this being a problem for many teachers except for possibly teachers just starting their career.

Conclusion. Despite the concessions, limitations, and potential negative outcomes making math fun is still believed to be the best method to decreasing math anxiety in students. It could contribute to the generational cycle of disliking math due to negative associations made with it. When you make math fun it engages your students and makes them forget that the game they are playing is contributing to their academic success while also forming positive associations with the subject and drawing students towards math electives or careers in the future. This option is universal for any math class at any level which makes this option even better for students with math anxiety now and later.

Action Documentation

Math anxiety is a term that has been researched and understood for quite some time; however, we are still seeing our new-coming educators and students avoidant and fearful when it

comes to math, leading to avoidance of math in the future. Whether it is inequality in the STEM field, poor math performance, or an educator unsure of how their personal anxieties affect their interpretation of the subject, math anxiety is a prevalent issue that needs action to decrease. This is especially true for schools with an increase in students with MA after the COVID-19 pandemic. This was found based on the literature and interviews conducted during this project, which led to the three emerging action options of making math fun, ensuring educators are confident in their ability to teach math, and phasing out timed tests. Of those options making math fun was the action that was believed to make the greatest impact at decreasing math anxiety in a way more achievable and effective than the other two options this conclusion was made based on the proposed action's probability of impact, visibility, and potency. Creating a way for educators and even parents to understand what math anxiety is, habits to break, and methods to teach and understand ways of preventing it could significantly impact their students. By doing this, we will see an improvement in math comprehension and our future generations' math ability, hopefully translating to more choosing to go into STEM-centered careers and confident educators to end the cycle of math-avoidant students. To put these into action, I decided to create a website that will help educators find techniques to make math fun and sections that touch on what math anxiety is and how to become a positive educator. I posted the website link on X to spread awareness around the issue to hopefully see other educators taking action.

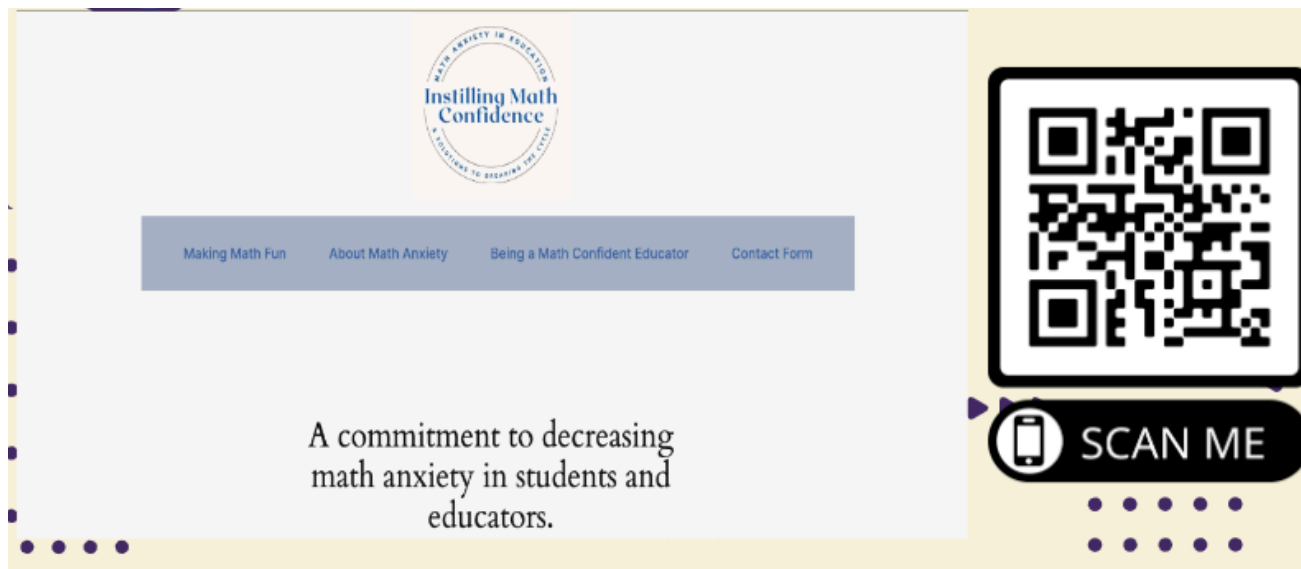


Image 1. Screenshot of website home page and scannable QR code with information on what math anxiety is, how to instill confidence as an educator, and how to make math fun. Also included is a contact form for inquiries from site visitors.

Critical Reflection

When I first started my LS 400: Senior Capstone I was unsure of what to focus on or what had mattered most to me when it came to improving our current education system. It was not until it was explained that topics that tend to make the biggest impact tend to be topics you resonated with or experienced at one point. Math has always been something that I struggled with and avoided into my college years. My service learning experience also inspired me to educate myself and others on what math anxiety is and posed solutions. Something that I found most interesting from my research on this topic is how severe some cases of math anxiety can be, having physical effects on individuals and affecting their memory. This was stated in both interview and research, and though I understood that this is an effect that comes with general anxiety, I never understood how severe it could be. In my interviews, it was not mentioned that the COVID-19 pandemic led to increased math anxiety in students; however, research has implied otherwise in some cases, which leads me to believe the schools used in this data understand what needs to be done and have used the implied actions to improve teaching methods. A problem mentioned that was implied not to prevent math anxiety or, in some cases,

increase it was standardized testing. Due to school funds being dependent on these test results, many educators focus on the school curriculum rather than teaching content for mastery and fluency. On the other hand, students are being taught a variety of topics that they were not taught to mastery in preparation for this exam, and then when it comes to taking the test, not only is this a computerized and timed test, but they are not confident in their skills leading to doubt and in some cases MA. For these reasons, I felt spreading awareness to educators and parents in an accessible and resourceful way would be the best choice for decreasing and preventing MA, leading to the site's creation, as I feared any other action might not make a large enough impact. Though I realize that the site is not going to be something an educator looks for when they're unsure what to do to help their students' I hope that by spreading awareness with other educators I come in contact with, they can share this site and the information provided. With this experience, I learned the importance of voicing my opinion and now expertise on math anxiety even when it is not considered a prevalent issue in our education system. Moving forward, I hope to help students and educators I work with instill confidence in themselves when working on math-related content.

Synthesis and Integration

My time at California State University, Monterey Bay, has been responsible for the growth I have made and contributed to my beliefs as a person and future educator. The required coursework, Liberal Studies MLOs, and this action research project positively impacted me as they prepared me for my professional development. The first MLO focuses on Developing Educators, skills to think, write, and speak critically, demonstrated throughout this project and in my personal life as I shared the project's content with those around me who were not considered educators to bring more awareness to the issue. Not only that, but I was able to speak with educators who have more experience and knowledge of the topic, which allowed me to develop new ideas and solutions related to it. Another outcome applied was MLO 3, which focuses on Innovative Technology Practices where technology is used to investigate, express, design, and collaborate. Not only were interviews conducted virtually with a Google form questionnaire to assist with collaboration, but a website was designed to express the issue and pose solutions to resolve the issue. Lastly, finding research related to my topic would have been difficult without using online resources such as OneSearch, Google Scholar, and Pi.ai. These learning outcomes,

along with others not mentioned here, will be applied in the future as my job as a future educator is to continue to educate myself to create a positive learning environment for future students and colleagues.

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