Math Is Like a Scary Movie?

Helping Young People Overcome Math Anxiety

Margaret Kulkin

One day, as I was working with a student after school on a problem involving division with decimals, I told him which number goes in the "division house." Suddenly the student blurted out, "That is not what my teacher told me, and I hate math!" I knew I had not yet found the key to helping this student. Was I addressing how he felt about math? Should I put the problem away and start over with the beauty of decimals, those smaller-than-one numbers that enable us to measure the speed of an Olympic athlete, the diameter of a pinhead, or the exact length of a ladybug? Teaching afterschool allows for such inner dialogues. As a learning support specialist providing academic support services both during school time and after school, I had the opportunity to dig deep.

I decided to find out how my other students felt about math. The emotional worry in some of their statements surprised me. They voiced intense, passionate feelings: "Math is boring … slow … hard for me." "Fractions are hard. They burn like lava!" "Math is like a scary movie."

My background as a certified classroom teacher and my work with students after school inspired me to explore new ways to help students learn math. Despite my lack of background in STEM (science, technology, engineering, and math), I have always been fascinated by the myths that plague the teaching and learning of math.

I want my students to make the meaningful connection to math that I myself was able to make only as an adult. In school, I struggled to remember complex math procedures. As my attention slipped away, the teacher at the front of the classroom became a blur, like a prolonged fade in a movie. Math started to make sense to me only later, when I went back to school as an adult and drew on my experience as a dancer. I noted that balancing equations was similar to feeling balanced physically in the studio. Math and dance also share other common

MARGARET KULKIN is a Washington State certified teacher. After teaching fifth grade, she created Northwest K–8 Learning Support, which serves students in a variety of settings. Her practice focuses on work with students diagnosed with dyslexia and language learning differences. She participated in the Afterschool Matters Practitioner Research Fellowship through School's Out Washington.

ingredients, such as steps and patterns. Just as I would close my eyes to visualize myself completing a particularly hard set of dance steps, so I could visualize steps and recognize patterns in math. I treasure these connections. When I sense student attention slipping away, I return to the recognition that math ideas are connected to problems that students are naturally interested in solving.

Afterschool teachers who tutor students or provide homework help have a unique opportunity to help students overcome the social or emotional barriers that so often block learning. We can embrace a creative and investigative approach to math learning. My interest in being a math attitude "myth-buster" led me to apply to a STEM-focused National Afterschool Matters Practitioner Fellowship, an 18-month professional development opportunity offered by the National Institute on Out-of-School Time. During that fellowship, I developed and administered a student survey, developed new student-centered curriculum, and conducted the case studies that inform this article.

My quest was to chip away at the "math is hard" idea to show students that math is accessible to all. Jung, Kloosterman, and McMullen (2007) suggest that children have an inborn sense of how to solve problems: "Mathematics is a science of patterns and relationships, and young children have far more ability to see those patterns than we may think" (p. 50). Math learning starts early, as children discover quantity and measurement by filling up and pouring out containers, create patterns by drawing pictures, or explore numbers by counting days on a calendar. We need to continue to nurture this math potential, grounded in real-life experience, as children grow older. My research with my own students helped me find ways to help them overcome math anxiety by creating learning opportunities based on their interests.

When I sense student attention slipping away, I return to the recognition that math ideas are connected to problems that students are naturally interested in solving.

Where Does Math Anxiety Come From?

Buckley and Ribordy (1982) define math anxiety as an "inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (p. 1). Common characteristics of math anxiety include "rigid thinking, lack of perseverance, poor or inconsistent performance, avoidance, and a resistance to monitoring one's thinking about math" (Furner & Gonzalez-De Hass, 2011, p. 228). Recognizing math anxiety as a problem, the National Council of Teachers of Mathematics (NCTM, 1989) recommended that teachers assess their students' mathematical dispositions.

The need is urgent, as Furner and Gonzalez-DeHass (2011) point out: "Clearly, mathematics anxiety is not the sole reason for low math achievement in this country; nevertheless, it is a critical academic problem" (p. 227). Furthermore, NCTM (2000) emphasizes as a "first principle" the importance of keeping opportunities to excel in math open to all students, including those who struggle with it.

Much of the research on math anxiety focuses on causes. Jackson and Leffingwell (1999) list causes including "[c]ommunication and language barriers, quality of instruction, evaluation methods, and difficulty of materials" (p. 88). Other causes of math anxiety include the negative attitudes that can be inadvertently communicated by teachers and parents who are themselves afraid of math (Kutner, 1992). An *Education Week* blog (Heitin, 2015) even suggests that "the beginnings of math anxiety in students can often be traced to the day they go to school and learn about fractions." After all, fractions (like decimals) are much harder to visualize or find in real life than are whole numbers (Heitin, 2015).

My own practice suggests that strict emphasis on procedures and facts reinforces math anxiety. When teachers focus on performance, emphasizing grades or acquisition of specific skills, students come to believe that their performance depends on their ability—and that their ability is not sufficient (Furner & Gonzalez-De Hass, 2011). Instead of setting performance goals, Furner and Gonzalez-DeHass (2011) suggest, teachers can better serve their students by focusing on mastery goals. "In a mastery goal classroom, success is defined by improvement, value is placed on effort and the process of learning, satisfaction is gained from working hard and learning something new" (p. 236). Performance goals are often met in a climate of competition that prizes speed, memorization of facts, and acquisition of specific skills. In contrast, mastery goals emphasize real-world application and problem solving. Though students do need to perform procedures and understand concepts, they have achieved mastery when they can successfully apply concepts to such tasks as solving problems and predicting outcomes.

In the real world, the heart of math is problem solving. Artists consider proportion in composing their creations. Carpenters take exact measurements to ensure that their final products come out straight and solid. Setting up math problems in such everyday contexts motivates students to develop their mastery. Driven by the desire to answer meaningful questions, students can overcome math anxiety.

Inquiry: How Do Students Feel About Math?

I often wondered how I could align real-life experience to student mastery of specific math concepts and procedures. To find out, I started by gathering data from my students. Drawing on work on measuring math attitudes by Tapia and Marsh (2004), I developed a survey and gave it to five of my students, grades 4–6, who struggled with math. The survey asked students to respond to a set of statements on a scale of 1 to 5, with 5 indicating complete agreement and 1 indicating total disagreement. For example, one statement was "When I hear the word *math*, I feel excited." Two students gave this statement a 1, two gave it a 2 or 3, and one gave it a 4. By contrast, three students agreed or strongly agreed with the statement, "Math stresses me out," though two students rated this statement 1 or 2. Perhaps these students weren't aware of their stress or simply weren't stressed despite their struggle.

Three students out of the five disagreed with the statement, "I like solving math problems in a group." These same students disagreed with the statement that they could see themselves doing math their whole lives. I wondered whether these students were reluctant to solve math problems in a group because they were not confident in their ability to communicate with peers about increasingly hard-to-picture concepts such as decimals or fractions.

My survey also included open-ended questions, which elicited the comments I cite in the introduction of this article. For case studies of my new approach to math instruction based on real-life problem solving, I chose students who clearly had a high degree of math anxiety: "Terry," who said that math "is like a scary movie," and "Avery," who said that math "burns like lava." (The names are pseudonyms.)

> Performance goals are often met in a climate of competition that prizes speed, memorization of facts, and acquisition of specific skills. In contrast, mastery goals emphasize real-world application and problem solving. Though students do need to perform procedures and understand concepts, they have achieved mastery when they can successfully apply concepts to such tasks as solving problems and predicting outcomes.

Case Studies in Mastery Through Problem Solving

Since I work with students individually, I already understood a great deal about these two students' math confusions, but I knew I could learn more. For both students, I intentionally created open-ended problem-solving activities that would require them to use math concepts to make or construct something. Each project took two to four of our once-a-week sessions. The problems I chose were based on the preferences and interests that the students had listed on intake forms or that I had observed.

Parachutes and Decimals

Terry was a sixth-grader with a definite inner intensity. He loved speed, including finishing his homework in record time, and liked sports. He needed to work on decimals, so I designed activities, based on his interests, that would require calculating with decimals and finding averages.

One day, when Terry arrived for his session, I sprang the news: "We are going to do an experiment today, and one of us will need to stand on my giant stool." Terry look puzzled, which was perfect. "First, though," I said, "you need to make some parachutes."

Terry seemed pleased that my usual mantra about "diving into decimals" had been back-burnered for the day. He was a ball of action and words. "Where's the stool? Where are the parachutes? What will be attached? A Lego man? Cool! How about a hippo? Let's try a giraffe! Which one will hit the ground faster? Let's just tie them all together and watch them all crash into the ground at once!" The experiment began with a flurry of materials: tape, yarn, Lego characters, hole punch, and plastic bags. Terry was moving at the speed he loves most: fast!

The math investigation would require Terry to calculate the average time it took for two different kinds of parachutes to reach the ground with the courageous Lego man. I was the one who got to stand on the giant stool. (I didn't want to explain to his parents how Terry sprained his ankle while learning math.) I dropped the parachutes while Terry timed the drops to the thousandth of a second, using a computer-generated stopwatch, and then recorded the times. Finally, he computed average times for the two different parachutes.

In another session, I challenged Terry to continue exploring decimals with an investigation based on another of his expressed interests: baseball. I found an activity on the Exploratorium website—a wonderful resource for creative, hands-on science and math activities—in which the student "hits" the ball thrown by a virtual pitcher and then records the reaction time to a hundredth of a second. Terry hit four times and calculated his average. His times were 0.25, 0.26, 0.20, and 0.21, so his average was 0.23 second. Then he asked, "What do I need to do the next time I'm up to bat to get an average reaction time of 0.22 second?" He wrote his answer: "My average is 0.23 of a second, so my average reaction time will need to improve by 0.01. My next hit will need to be 0.18 to improve my average by 0.01."

As Terry worked on this second investigation, he took the reins and displayed real confidence, apparently fueled by his success with the parachutes. He was less worried about his performance and more focused on mastering the core math ideas.

As Terry worked on this second investigation, he took the reins and displayed real confidence, apparently fueled by his success with the parachutes. He was less worried about his performance and more focused on mastering the core math ideas. He completed his decimal calculations with a sense of purpose. I let him work without comment, hoping that this shift would stick. I loved the way he had a dialogue going, asking and answering his own questions. Terry had learned a new math equation: an unsolved but achievable math challenge equals creativity, questioning, and discovery.

Fractions and Fabric Design

When I first started working with Avery, her teacher emailed me, "I've noticed Avery's biggest problem is self-confidence in math.... She also does not have a firm grasp with naming fractions using diagrams. For example, if you have a circle with 15 parts and three are missing, she'll say the fraction is 3/12." (personal communication, April 2013).

Avery had shared her love of design on many occasions; she was interested in patterns in clothes and jewelry. Based on the teacher's comments and my own observations, I thought Avery might learn about fractions by solving problems based on quilt squares. I wanted to demonstrate how math is often embedded in design, especially when decomposing patterns and shapes into smaller, fractional parts.

I showed Avery some quilt designs. Then we looked at a quilt template I downloaded from the Riverbend Community Math Center (www.riverbendmath.org). I pre-cut shapes of different sizes for Avery to arrange on the quilt block. The problem was to design a quilt square, divided into nine parts, and then use varying shapes and sizes to cover all nine parts so they add up to one whole square. I showed Avery the shapes: triangles, rectangles, and trapezoids of various sizes. We classified them on a chart by their fractional proportion of a whole square: 1/2, 1/3, 1/6, 1/9, or 1/18. The next step was arranging the shapes on a square template. Then Avery added all of the fractional pieces by converting all the fractions to a denominator of 18 to make sure that they added up to 18/18 or 1. I noticed that Avery was engaged with the activity, and her conceptual grasp of fractions was already improving.

The next problem was the Quilt Square Challenge from the Mathwire website (Kawas, n.d.). The challenge is to match a complex black and white quilt square design using only black and white triangles that are all the same size. Avery wrote how she found the solution: "Figure out that the triangles were in the rectangle and to match up the triangles with the pattern." We extended this challenge to create fraction problems comparing the number of black triangles with the number of white triangles.

This kind of spatial awareness, seeing how bigger shapes were made up of smaller pieces, enabled Avery to see the beauty of the whole as well as the pattern created by the smaller parts. These activities addressed Avery's struggle with spatial organization and fractions. The combination of math and design allowed her to begin to overcome her math anxiety. Like Terry, she became more interested in understanding the underlying concepts and less worried about simply getting the problem right. She was shifting her focus away from performance and toward mastery. Her teacher emailed about Avery's progress: "She is finally asking questions in class. She is at least able to voice her concerns. Before she didn't even know where to begin to ask for help" (personal communication, May 2013).

Changes in Attitudes About Math

There was never an "Aha!" moment with either of these students. However, the experience of success and the exhilaration of completing their math investigations mitigated their fear. As Terry and Avery shifted their focus from performance to mastery, the undercurrent of anxiety that had governed their relationship with math was lessened.

I confirmed this finding when I administered my survey a second time. Terry, who had previously compared math to a "scary movie," now compared math to a "book with many surprises." He agreed that he enjoyed discussing math with peers and that he could see himself doing math his whole life. Similarly, Avery no longer thought that math "burns like lava." After her quilt investigations, she said that, although math was difficult, it could also be "fun or easy like pie."

I have continued to work with Avery. She still has difficulty putting math concepts into words. However, one day when I asked her to compare two fractions, she surprised me by drawing a beautiful picture that clearly depicted a well-grounded understanding. When we moved into area and perimeter, Avery cheerfully suggested designing a zombie park!

Implications for Practice

Terry and Avery have not finished their stories. Someday, they may find that challenging their fear of math helped them develop some of their greatest strengths, such as curiosity, confidence, and initiative. Any teacher or youth leader, in or out of school, knows that our best moments come when our "unreachable" participants get back in the game, building confidence with each new success. When students formerly blocked by fear change their trajectory, obstacles become stepping stones.

To achieve this result, we have to appreciate the role of emotions in learning. The point is not just to present students with fun activities. We have to address their anxiety to help them find their inner mathematicians. Once their emotional block is addressed, students are less likely to impose self-limiting beliefs that they don't "fit the math mold" or can't learn math. Using real-world experiences to teach math concepts will help them shift their focus away from anxiety about their performance so they can engage in learning. As Furner and Berman (2003) have said, "Educators can play an instrumental role in fostering an environment that focuses on numeracy, and help reduce students' feelings of inadequacy and lack of confidence when working with mathematical ideas" (p. 173).

I recently team-taught a workshop on the benefits of STEM learning after school. I cannot describe the fun I had watching the teachers design the "perfect" carrier to bring a Lego character down a zip line. Some of the carriers failed, but we all laughed when the Lego people spilled to the floor. This activity had many embedded math problems: How fast were the carriers traveling? How did their size affect their speed and the distance they traveled? Adults who want to help students with math will be richly rewarded if they choose to entice students with problems that relate to everyday life. The excitement generated by even one positive math experience may turn some of our math-shy participants into the creators, designers, and problem solvers of the future.

References

Buckley, P. A., & Ribordy, S. C. (1982, May). *Mathematics anxiety and the effects of evaluative instructions on math performance.* Minneapolis, MN: Midwestern Psychological Association.

Furner, J. M., & Berman, B. T. (2003). Math anxiety: Overcoming a major obstacle to the improvement of student math performance. *Childhood Education, 79*(3), 170–174.

Furner, J. M., & Gonzalez-DeHass, A. (2011). How do students' mastery and performance goals relate to math anxiety? *Eurasia Journal of Mathematics, Science & Technology Education*, *7*(4), 227–242.

Heitin, L. (2015, February 10). "Fraction phobia": The root of math anxiety? [Blog post]. Retrieved from http://blogs.edweek.org/edweek/curriculum/2015/02/fraction phobia_the_root_of_mat.html

Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *Mathematics Teacher, 92*(7), 583–586.

Jung, M., Kloosterman, P., & McMullen, B. (2007, September). Young children's intuition for solving problems in mathematics. *Young Children*, *62*(5), 50–57.

Kawas, T. (n.d.). Quilt square challenge. Retrieved from http://mathwire.com/quilts/qschallenge.html

Kutner, L. (1992, August 13). Teachers and parents who are afraid of math can pass that anxiety to the next generation. *New York Times,* pp. B4, C12.

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly, 8*(2), 16–21.