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Description automatically generated with medium confidenceBuilding Math Confidence and Competence Research and Practice Brief

**Research and Practice Brief**



**What to do:** Read this brief for insights into how out-of-school time programs can support students’ math confidence and competence. Consider how math anxiety can interfere with student learning and engagement. Highlight strategies you can use during enrichment activities and homework time to help students overcome self-doubt and build their math skills and understanding.

**Why it matters:** Math anxiety can affect people of all ages and ability levels — even those who are good at math. “A majority of adolescents report worry and tension in math classes and when doing math,” according to assessments of the Programme for International Student Assessment (PISA) studies (Luttenberger, Wimmer, & Paechter, 2018). And it’s not just adolescents. Math anxiety affects academic performance, impacts self-confidence, and can ultimately limit career options.

The American Psychological Association (APA) defines math anxiety as “apprehensiveness and tension associated with the performance of arithmetic and other mathematical tasks.” This brief explains why math anxiety matters to student learning and success. It also gives ideas from research and practice that out-of-school time programs can use to build K-12 students’ confidence and competence in mathematics.

# Math Anxiety Affects Student Learning and Success

Math anxiety is more than sweaty palms during a math test. Anxiety interferes with working memory, which makes it hard to focus on a task (Ashcraft & Krause, 2007). Many people feel nervous when approaching a test or performing a skill, regardless of the subject matter, but math anxiety may be more severe and have a greater effect on performance than anxiety about other subjects (Dowker et al., 2016).

Math anxiety can negatively affect student performance, achievement scores, and motivation — and may lead to “dislike and avoidance of all math-related activities” (APA, n.d.). Negative experiences with math can contribute to developing math anxiety, as can lack of confidence, perfectionism, low self-esteem, lack of self-efficacy, and how prone you are to anxiety in general.

# Proficiency in Mathematics Can Affect Academic, Economic, and Life Success

In a synthesis of funded mathematics education research (Rittle-Johnson & Jordan, 2016), the U.S. Department of Education notes:

Proficiency in mathematics promotes academic, economic, and life success. Academically, the level of mathematics a student completes is a strong predictor of entering college and earning a bachelor’s degree (Adelman, 2006). Economically, annual income is 65 percent higher among adults who have taken calculus in high school than among adults who have completed only basic mathematics (Altonji, Blom, and Meghir, 2012; Rose and Betts, 2001). Further, mathematics knowledge at age 7 is a stronger predictor of socioeconomic status (SES) in adulthood than is childhood SES, over and above the effects of IQ, reading achievement, and intelligence (Ritchie and Bates, 2013). In part, these trends arise because many careers in promising, well-paying jobs require advanced mathematics for job success. Outside of economic success, mathematics knowledge affects the quality of daily life. For example, many people have insufficient mathematics knowledge to make appropriate health decisions, such as taking appropriate drug dosages and understanding risks and benefits of screenings and treatment (Reyna et al., 2009).

Math appears to be the school subject that sets up the most barriers for students in terms of graduation and college and career options. This math barrier exists across demographics, but it’s even more noticeable in some schools. Students from low-income families and communities of color are “less likely to attend schools with quality math courses or skilled teachers, they are more likely to be assessed into lower math pathways, and they are not expected to excel. Their math education effectively shuts them out of college” (College Futures Foundation, 2019).

Poor math abilities limit career opportunities. The Job Outlook 2024 survey results showed that two of the five top skills employers look for on resumes (problem-solving skills and analytical/quantitative skills) are related to mathematics; the others are teamwork, a strong work ethic, and written and verbal communication skills (National Association of Colleges and Employers, 2024).

# Strategies to Reduce Math Anxiety and Build Confidence

Research points to several strategies that can help reduce math anxiety:

**Create a positive, relaxed environment for talking and learning about math.** Express confidence in students’ abilities. Use age-appropriate games, math riddles, picture books, stories, video clips, and statistics about sports or other areas of interest to spark curiosity and provide fun, positive experiences with math. Cooperative learning and computer-assisted instruction can also make learning more relaxed and effective (APA, 2022). Design high-interest activities that are responsive to students’ backgrounds, experiences, cultural perspectives, traditions, and knowledge (National Council of Teachers of Mathematics [NCTM], 2014). Use technological tools to support mathematics exploration, visualization, and learning — for example, calculators (numerical and graphing), geometric construction software, and computer algebra systems (CAS). Avoid shifting into “serious mode” when it’s time for math so that you don’t reinforce anxiety-producing ideas about math.

**Normalize mistakes.** Some math teachers have a poster on their wall as a reminder that mistakes offer important learning opportunities that should be “expected, respected, and inspected” (Barlow et al., 2018). Talk with students about this idea and how it applies to math — and to other areas of life.

**Encourage student effort.** Productive struggle builds “math muscles.” If students struggle with a math problem that they can solve with effort, avoid the temptation to console students or “give away” the answer. Instead, provide encouragement and support as they work through the problem, and use questions to activate critical thinking (Lewis, 2018). Teach learning strategies that can relieve stress and support learning, like *take a 5-minute break and move around, then come back to it* or *talk through your process with another student* (Oakley, 2014).

**Use and teach strategies to help students manage anxiety.** Researchers who examined 60 years of research on math anxiety found evidence to support several potential treatments: telling students that the state of arousal they feel can actually improve performance; having students “write out” their worries and negative thoughts about math before a math test or performance; and providing short, intensive, one-on-one cognitive tutoring during which students get feedback and coaching as the work through problems (three 40- to 50-minute sessions a week for eight weeks in the study) (Dowker et al., 2016). Mindfulness practices may also help (Terada, 2017). Some examples are breathing techniques, progressive muscle relaxation, and self-talk.

# Strategies to Improve Math Knowledge, Skills, and Understanding

Here are some evidence-based strategies to keep in mind as you design math-related enrichment activities and homework help:

## Young Children

* **Connect math to other subjects.** Highlight math within various subject areas, like literature and science. (Fuchs et al., 2021)
* **Use games to teach math skills and concepts.** (Fuchs et al., 2021)
* **Help children recognize, name, and compare shapes.** (Fuchs et al., 2021)
* **Encourage children to look for and identify patterns.** (Fuchs et al., 2021)
* **Show different ways to make comparisons.** To help children understand measurement, teach them to make direct comparisons and to use both informal (e.g., the child’s hand or foot) and formal (e.g., a ruler) units and measures. (Fuchs et al., 2021)
* **Sometimes a picture’s worth 1,000 words.** Help children collect and organize information and teach them to represent that information graphically. (Fuchs et al., 2021)

## Elementary School

* **Provide opportunities for students to think intuitively about math.** Encourage them to brainstorm possible ways to solve a problem, like how to figure the area of a rug, before teaching methods. (Boaler, 2022)
* **Offer meaningful tasks.** Self-selected projects that involve math as a “means to an end” are more likely to engage and benefit students than worksheets presented as opportunities to practice. (Boaler, 2022)
* **Focus on one problem or step at a time.** Use activities that focus students’ attention and keep them from feeling overwhelmed. (Fuchs et al., 2021)
* **Treat math like a team sport.** Have students work as a group to “meet or beat” their previous collective score. (Fuchs et al., 2021)

## Middle and High School

* **Use everyday situations to help students understand fractions.** Adolescents with math difficulties benefit from fractions instruction that builds fractions skills and concepts alongside problems anchored in everyday contexts. (Rittle-Johnson & Jordan, 2016)
* **Get physical.** Producing physical movements and gestures may improve students’ mathematical learning. (Rittle-Jordon & Johnson, 2016)

## All Grade Levels

* **Teach problem-solving strategies.** Share general strategies (like breaking a problem down into steps, talking it through, and asking for help if you’re stuck) as well as math-specific strategies like estimating and drawing pictures or diagrams to help visualize a problem or potential solution. (APA, 2022)
* **Teach study strategies to improve focus, memory, and deep learning.** If you’re having trouble remembering a math fact or theorem, try singing it to the tune of a favorite song. Music activates the parts of your brain associated with memory, reasoning, speech, emotion, and reward. It helps you access stored memories and create new ones, and it can also elevate your mood. (Fabiny, 2015)
* **Use technology strategically.** Teachers and students alike need “regular access to technologies that support and advance mathematical sense making, reasoning, problem solving, and communication.” For example, Desmos is a free online graphing calculator and teaching tool that helps students visualize mathematical expressions. Students can enter an expression and see the results graphed on the page. Effective teachers optimize technology to develop students’ understanding, stimulate their interest, and increase their proficiency in mathematics. When teachers use technology strategically, they can provide greater access to mathematics for all students. (NCTM, 2011)
* **Provide opportunities to develop mental math skills.** Mental math is “a critical component in students’ tool kits of mathematical knowledge. Mental math is often associated with the ability to do computations quickly, but in its broadest sense, mental math also involves conceptual understanding and problem solving.” (Seeley, 2015, p. 158)

# The Role and Potential Impact of Out-of-School Time Programs

The federal government created the Nita M. Lowey 21st Century Community Learning Centers (21st CCLC) program to give children — especially students from high-poverty, low-performing schools — academic enrichment during nonschool hours. Nationwide, 21st CCLC sites help students meet State and local standards in reading and math, offer activities to complement school programs, and provide participants’ families with literacy classes and other education. These programs have the potential to support students academically, socially, and emotionally (McCombs, Whitaker, & Yoo, 2017). There are several ways out-of-school time programs can help students prepare for mathematics success:

**Examine and change incorrect or unhelpful attitudes, beliefs, and language about math.** “I think I can” is a powerful idea. When students believe they can succeed at math, they’re more willing to keep trying, even when they struggle, and this effort results in better performance (Chang & Beilock, 2016). “Research shows that teachers unintentionally transmit their own attitudes about math to their students” (Beilock et al., 2010). In other words, math anxiety is contagious. Like a virus, it can attack students’ belief in their ability to succeed with effort. Teachers who were taught during their own years in school that “some people have the math gene and others don’t” — and there’s not much you can do about it — may unintentionally pass that false belief (and limited mindset) along to their students. The good news is, the growth mindset (“I think I can, if I make the effort”) is also contagious (Boaler, 2022). You and your colleagues can make a conscious effort to replace unhelpful messages like “You have to be smart to get an A in math” with helpful ones like “It’s challenging, but you can do it” and “It’s OK to make mistakes. That’s how we learn!” While both males and females can suffer from math anxiety, it can be a particular problem with girls, especially during their teenage years. Avoid reinforcing ideas like “Girls aren’t good at math” (APA, 2022).

**Integrate math awareness, skills, and concepts into your program’s enrichment activities** **where possible.** The low-stakes environment of out-of-school time is well suited to helping students experience math as something that’s doable, fun, and useful — for example, to keep score during game play, to double a favorite snack recipe for a party, to chart progress toward a personal goal, or to calculate the average score per game for a favorite sports team. Provide opportunities to use math for authentic purposes, connect it to personal goals, and help students experience success. Invite diverse community members to “show and tell” how they use math in their careers and in everyday life, or to share strategies they use for managing anxiety (Pattison, Rubin, & Wright, 2017).

**Show families ways to help children succeed at math.** Some family members might have math anxiety themselves. Reassure them that they don’t have to be a math expert to support their child’s success. They can praise effort, hard work, and persistence; model positive attitudes about math; confront stereotypes about who’s good at math; and encourage their child to ask for help and try new strategies when they’re stuck (Cox & Friedman, 2019). Help families understand that their own reactions to math while helping their children with homework can play a big role in shaping their children’s motivation and achievement (Wu et al., 2022). Family engagement activities like math nights can be a good way for educators, students, and families to share math ideas and experiences, learn and have fun together, build trust, and practice anxiety-reducing strategies like mindfulness and breaking big tasks into doable chunks (Seeley, 2014).

**Work with school-day math teachers and special educators to intentionally design and deliver the supports your students need.** Your students’ math teachers can tell you about grade-level standards and what math concepts students are learning in school. They can also alert you when a student is struggling to master a key skill or concept. Special education teachers can tell you which students have Individualized Education Programs (IEPs) or Section 504 plans, and what supports, accommodations, and strategies can help them succeed. These teachers, as well as the school counselor, can often provide ideas and strategies for helping students manage math anxiety. This information from the school day can help you prepare math tutors and homework helpers — and intentionally design enrichment activities to meet student needs. Tutors and homework helpers, along with program staff, can provide opportunities for students to practice what they’re learning in school. This can happen during enrichment activities or, in a more focused way, during homework time. Also, your program can provide individualized encouragement and support for students who are struggling with math.

**Support positive teacher-student relationships and interactions.** Instructor-child relations are a key aspect of program quality. A study of an academic afterschool program found substantial variation in academic outcomes by site (McCombs, Whitaker, & Yoo, 2017). The researchers identified a key factor as instructor-child relations — meaning staff reacting positively to youth, speaking in warm and respectful tones, engaging with them, and being enthusiastic. Positive relationships build trust, which enables students to take risks that are essential to learning (e.g., estimating the number of jelly beans in a jar) and to social and emotional development (e.g., overcoming the fear of “looking stupid” if their estimate is wildly wrong).

# Challenges and Implications

**Adults may have math anxiety, too.** It’s not just students who experience math anxiety. Many adults also suffer from math anxiety, so it’s quite possible that some program staff and students’ adult family members may have negative feelings about math and their ability to do it. This may lead to avoidance and affect their willingness to engage in program activities that involve math. Also, they may unintentionally pass along negative attitudes about math to students. Acknowledging and addressing math anxiety as something that affects people of all ages is an important first step.

**Staff may believe they lack the knowledge or resources to help students with math and math anxiety.** Engage school and community partnerships to expand your program’s capacity and expertise. Have partners help you identify specific ways staff and families with little or no math expertise can help students build confidence and competence in math. Provide opportunities and support for staff to learn and practice developmentally appropriate strategies.

**Students with learning disabilities may need differentiated support.** What works for one student might not work for another. Consult with the school day to identify students’ specific challenges and possible solutions. For example, students with dyscalculia (a learning difference that impairs the ability to make sense of numbers and math concepts) find it helpful to do pencil-and-paper computations on graph paper because the grid helps them line up the numbers (Morin, n.d.).

**High turnover among staff and volunteers can make it hard to maintain momentum.** Recruitment and retention are ongoing challenges for out-of-school time programs. High turnover among staff and volunteers can disrupt efforts to build positive, trusting relationships with students and families, and to ensure that staff have the awareness and training to appropriately support students with math anxiety.

# Conclusion

Out-of-school time programs that are aware of math anxiety and its potential negative effects on students’ academic and personal lives can provide valuable support. They can draw on promising strategies that don’t require staff members to become “math experts” but may have a positive influence on factors that affect students’ math attitudes and performance.

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