# Math

## Toolkit and User Guide

21ST CCLC NTAC
National Technical Assistance Center

For out-of-school time and summer learning programs

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# Math Toolkit User Guide

The Math Toolkit consists of this user guide and the 19 tools described herein. The tools were developed for 21st Century Community Learning Centers (21st CCLC) programs, but any out-of-school time (OST) program can use them.

You may use these tools to:

- Support professional development.
- Help your program implement or improve a practice.
- Engage and inspire stakeholders.

### What's In This Guide

- The full set of tools and ways to use them
- Tips and strategies for supporting math learning in OST programs

## Tool Titles and Descriptions

This annotated list of the tools is organized into three categories: (1) Learn, (2) Plan and Implement, and (3) Assess and Reflect.

### Learn

**Building Math Confidence and Competence Research and Practice Brief** — Learn about the effects of math anxiety and about strategies from research and practice that can build students' confidence and competence in mathematics.

**How Thoughts and Emotions Affect Learning** — This guide provides information about how negativity can impede learning and gives useful strategies for overcoming the negativity.

**Math Anxiety and Four MUSTs for Addressing It** — Get basic information about math anxiety, its effects on students, and strategies for reducing it.

**Math Booklist for Staff and Students** — These books can spark new ideas and understanding, reinforce positive messages about math abilities, support math learning, and reduce math anxiety.

**Math Glossary** — Use this list of common math terms to help staff and students become familiar with them. Includes a link to an extensive glossary.

**Math Standards** — This document is intended to familiarize staff with what a standard is and what information it contains. Included is an overview of different standards in use across the U.S., with examples of conceptual standards across various grade levels.

**Science and Mathematics Vocabulary Builder** — Have staff use this checklist of key terms and guiding questions to help students build math and science vocabulary during program activities. Also useful as an observation tool.

### Math Anxiety and Why It Matters

Math anxiety is apprehension and tension associated with the performance of arithmetic and other mathematical tasks. This anxiety makes it hard to focus and remember and causes worry and stress. It can lead to harmful beliefs like "I'm not smart" and "I can't learn math." Students with math anxiety may avoid math, which can limit college and career options.

## Plan and Implement

**Activity Center Planner** — This tool includes considerations and ideas for K-12 activity centers, plus a planning template and an observation checklist.

**Financial Literacy Knowledge and Activities Across Age Groups** — This guide has examples of individual and group activities that engage students in real-world scenarios where they apply financial literacy and math skills.

**Math Messages That Build Confidence** — Promote these powerful messages to ward off math anxiety and build students' confidence.

**Math Moments at Home** — Share this information sheet with families to help them discover easy ways to help their child "bust" math myths and fears.

**Math Skills for Students to Learn and Practice** — Review the skills for learning and using math and for managing math anxiety to get concrete ways to help students put skills into practice.

**Math Thrills: Putting Fun Into the Equation** — Get math strategies that thrill and will keep students engaged and coming back for more, day after day.

**Math Understanding: Helping Students Think Conceptually** — Help students use three math concepts to clear away mental fog caused by confusion or anxiety and to increase math understanding and confidence.

**Nurture a Growth Mindset** — Learn what it means to have a "growth mindset" and get ideas for helping program staff and students develop this approach to learning.

**Simple Ways to Add Math to Program Activities** — A variety of easy-to-implement ideas and resources to make staff members aware of how math is embedded in things they're already doing.

**Strategies to Help Every Student Learn and Enjoy Math** — Explore a thorough discussion about meeting the individual math needs of students with demographic considerations such as English learner status or a disability.

**Ways to Help Students in Math if You're Not a Math Teacher** — Ask school-day staff to share their approaches for teaching math, and use the strategies in this tool to support students.

## Assess and Reflect

**Math Anxiety Self-Assessment and Autobiography** — Use the math anxiety self-assessment with staff or students and have them process the results by writing a short "math autobiography." Then, they can identify messages and strategies to help overcome any math anxiety.

Keep reading to learn about ways out-of-school time programs cans support students' math confidence and competence.

## Math and Its Importance to Student Success

Of all the classes students take in school, math can be the biggest hurdle for some students — and the hurdle is even higher if they have math anxiety. Even students with good math grades can experience math anxiety.

The OST environment is ideal for providing activities that connect math to real-world experiences and student interests. Enrichment activities can bring math concepts to life. For example:

- Cooking activities can build students' understanding of measurement.
- Design projects can build geometry skills.
- Predicting the outcome of a coin toss can help students see the relationship between data and probability.

Your OST program may be the place where "a lightbulb goes off" in a student's head or they taste math success for the first time.

## Tips for Out-of-School Time Programs

First, it's important to understand and address math anxiety because it affects people of all ages and ability levels and can hold them back.

You don't have to be a math whiz to help students bust harmful myths about math (like "making mistakes means I'm not smart") and help them break through fears. Here are some tips:

- **Learn about the Math MUSTs** (messages, understandings, skills, and thrills) and look for ways to use these strategies in your program.
- **Draw on your own life experiences** in using math for hobbies, personal goals, and everyday tasks like comparison shopping. You know more than you think you do!
- **Lead students to aha moments** by pointing out ways they already know and use math every day without realizing it.
- **Provide engaging activities** to help students and families experience math success and connect math to their goals and interests. Positive experiences with math can help rewire students' brains and short-circuit math anxiety.
- **Work with the school day** to provide targeted homework help and reinforce key concepts through games and other high-interest activities.
- **Enlist community volunteers and partners** who offer math enthusiasm and know-how.

### Did You Know …

Anyone can have performance anxiety or test anxiety in any school subject, but math's the only subject with its very own anxiety-related definition in the American Psychological Association's dictionary of terms.

Next, tap into these key ideas from research and practice:

- **Encourage problem-solving.** Problem-solving engages students in using math facts, skills, and strategies they know to solve a problem. Research indicates that inviting students to solve problems that are interesting to them — and encouraging them to ask questions and use critical thinking skills — is a good way to develop their problem-solving skills. Activity leaders can use guiding questions to facilitate discussion and to help students discover math strategies and solutions on their own.

- **Support "math talk."** Math talk is a structured format in which students are supported as they discuss their problem-solving strategies, the reasoning behind their work, questions they may have, and observations about different math approaches and applications. This helps students clarify their thinking, make connections to what they already know, uncover new questions, and develop curiosity.

> **Listen and Respond**
>
> Hearing students put their thoughts into words can help you identify misconceptions and provide useful feedback.

- **Emphasize group work.** Research indicates that having students work together to solve problems often supports higher levels of performance than working independently. When two to four students work together to discuss concepts, compare ideas, justify methods, and articulate thinking, they come to understand that there are many ways to approach a math problem. OST activities that combine social interaction and academic enrichment can help students learn and practice math concepts in a relaxed environment.

To implement high-quality math activities in OST programs, here are 10 suggested steps:

- **Get oriented.** Build your understanding of math anxiety (apprehension and tension associated with the performance of arithmetic and other mathematical tasks) and math education (most teachers follow State standards that address five strands of mathematical proficiency: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition). Talk with school-day math teachers or look online for information about your State's standards to get yourself up-to-date.
- **Start smart.** Create a small but mighty program advisory committee to help with planning, assessing the needs of students and families, and setting goals. Include stakeholders with various roles, perspectives, and expertise (e.g., site coordinator, math teacher, school counselor, local employer, family member, and student).
- **Map community assets and resources.** Identify people, organizations, and materials to help you provide engaging math experiences that students find interesting and relevant to their lives. Then prioritize your list of possibilities and decide which ones to engage.
- **Get real about logistics.** Coordinate details about the budget, schedule, materials, and professional development for program staff and volunteers.
- **Train staff to be math savvy.** The goal isn't to turn every frontline staff member into a math teacher. It's to build their confidence and enthusiasm for providing math enrichment and academic support and for working with school and community partners to design and deliver these experiences for students.
- **Use math strategies intentionally.** Enhance or design program activities that focus on a certain math message, understanding, skill, or "thrill," and make sure these activities match student needs and program goals.
- **Angle to attract and retain students.** Plan how you'll recruit students and keep them coming back.
- **Factor families into the equation.** Talk with families and provide information about simple things they can do and say to build their child's math skills and confidence. Assure them that their efforts can make a big difference.
- **Scan for impact.** Make adjustments as needed to stay on target.
- **Turn up the volume and celebrate!** Acknowledge successes, big and small.

## General Strategies

The following strategies help to provide high-quality OST learning experiences to support students' academic and nonacademic needs. These strategies are especially helpful for supporting students who've fallen behind and aren't meeting grade-level standards:

- **Align OST programs academically** with the school curriculum so OST educators can build on material and skills students are already learning.
- **Adapt instruction to individual and small group needs.** OST groups of more than 20 students per staff member are shown to be less effective.
- **Provide high-quality, engaging learning experiences** that offer academic support and enrichment activities that develop students' social skills.
- **Target student recruitment and retention efforts** to ensure that students with the most need for additional support have adequate opportunity to participate in OST programs.
- **Assess program performance** regularly using disaggregated results to improve or adjust the program as needed.
- **Partner with community-based organizations and local intermediary organizations** to provide a variety of high-quality enrichment opportunities and create opportunities for community engagement.
- **Support students with disabilities** by providing services that can accelerate learning. Students' Individualized Education Programs (IEPs) and Section 504 plans can provide OST program staff with helpful information about meeting individual student needs.

### Get Additional Tools and Resources for Your Out-of-School Time Program

Visit the 21st CCLC National Technical Assistance Center website to view the Math Toolkit as a flipbook and download the zip file. The zip file includes (a) a PDF version of the user guide and toolkit and (b) a Microsoft Word version of each tool for easy customization.

### Feel Free to Customize!

**If you add or revise content to "make it your own," please replace the text box at the end with the following statement:**

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# Activity Center Planner

**What to do:** Use the planning considerations, activity center ideas, and checklist in this tool to help you plan interesting, age-appropriate activity centers in your out-of-school time program.

**Why it matters:** Activity centers are a quick and comfortable way to ease staff and students into learning opportunities. Well-planned activity centers engage students in hands-on, independent exploration, collaborative experiences, and learning targeted to specific objectives.

## Planning Considerations

**Space:** A "center" can be as simple as a table or area where students can work on activities they choose by selecting from shoeboxes filled with activity-specific materials.

**Materials:** The materials needed will vary by activity. Start with free or low-cost materials that are easily available. As you add centers, you may decide to purchase some materials and ask businesses, organizations, and community members to donate materials as needed.

**Time:** Decide when centers will be available. On certain days, or daily at set times? During homework time for those who finish early or need a break?

**Student engagement:** Students can help develop ideas, organize materials, and manage centers.

**Purpose, objectives, and expectations:** Specify learning objectives in the planning stage. Make the purpose, objectives, and expectations clear. Include rules and procedures about behavior, safety, and clean-up.

**Variety:** Build a repertoire of activities for students to choose from. Experiment with making several different activities available at the same time.

**Assessment:** Watch centers in use. Note whether children are engaged, distracted, or bored. Talk to students to gauge outcomes. Discuss findings with staff, and revise activity centers as needed.

## Activity Center Ideas for Various Grade Levels

**Time:** Calendars to customize, daily and weekly schedules with dates and times, clocks and watches to play with and take apart, appointment books (K-3)

**Money:** Penny jar, pennies, play money, menus, catalogs, store items (K-3); balancing a checkbook and budgeting (Grade 5 and up)

**Measuring:** Measuring cups, measuring spoons, containers of different sizes, scale, sand, pebbles, liquids to measure (K-3); designing a garden or room (Grade 4 and up)

**Sorting:** Buttons or beads in a variety of colors, sizes, and shapes for sorting, estimating, and counting (K-2)

**Building, construction:** Blocks, Legos, paper cups, cardboard, straws, and twist-ties to construct two- and three-dimensional shapes (K-4); straws, tape, scissors, papers, graph paper, and paint with instructions for completing different challenges (Grades 3-6); plywood, wood scraps, tools, and electronics equipment (Grade 6 and up)

**Puzzles:** Various types of two- and three-dimensional puzzles, with increasing complexity (K-12)

**Shapes:** Posters with shapes, crayons, pencils, construction paper, graph paper, different sizes of triangles, squares, rectangles, and circles; two- and three-dimensional shapes and objects to trace, draw, cut out, and play with (K-3)

**Patterns and rhythms:** Rhythm instruments to beat out patterns, paper for students to write beat patterns in symbols for others to follow (e.g., a = short tap, b = long tap) (Grades 2-4)

**Experiments and building kits:** Use downloaded instructions and gather materials for experiments and make them available regularly. Include kits for things like building sun dials, paper airplanes, and boats, and mixing paint colors (Grades 2-6)

## Activity Center Planner

**Description/theme of center** _____

**Focus areas** (check all that apply)

___ Science ____ Technology ____ Engineering ____ the Arts ____ Mathematics

___ Other (specify): _____

**Learning objectives/purpose** _____

_____

**Number of users at one time** ___

**Primarily for** ___ Individual work ___ Pairs ___ Small groups ___ Any

**Instructions** ___ Clearly written

___ Needs verbal explanation or demonstration

___ Users can explain to each other

**Availability** ___ Always ___ Days/times _____

___ Homework ___ By request

**Supervision** ___ None, general only ___ Periodic check

___ Demonstrations and explanations needed

___ Active supervision required

**Extensions and support**

____ Additional resources ____ Expertise ____ Specialized support

**Supplies needed**

Instruction sheet _____

Materials, tools, equipment _____

_____

**Activity Center Observation Checklist**

Use this checklist to record observations and suggestions.

____ The center is actively used by all or most students

____ Most students can follow the written activity instructions

____ Students seem to enjoy the activities offered

____ Objectives are being met

____ Materials or supplies need to be updated or replenished

- For the center in general? Specify: _____
- For certain activities? Specify: _____

____ Positive outcomes are achieved

____ Possible improvements (Specify: _____)

____ Possible changes or extensions (Specify: _____)

Additional ideas or comments:

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# Building Math Confidence and Competence
# 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, self-confidence, and 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).

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 (NACE, 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 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). 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 they 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 meaningful opportunities for students to use mathematical language and to think about mathematical ideas.** For example, have them brainstorm possible ways to solve a problem, like how to figure the area of a rug, before teaching methods. Or challenge them to share a question they have that math can help answer, like how many colored pencils are needed to make sure each student has at least 5. (IES, 2024)
- **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. (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 more. These programs have the potential to support students academically and in other ways (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. 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 a variety of 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 misconceptions 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., overcoming the fear of "looking stupid" if their answer 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 helps to do 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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# Financial Literacy Knowledge and Activities Across Age Groups

**What to do:** Use these ideas to plan activities that build students' financial literacy. Adjust the activities to match students' ages, interests, developmental levels, background knowledge, and academic needs. You may also modify activities to include adults for a family math night or financial literacy event. See the resources on the last page for additional ideas.

**Why it matters:** Financial know-how helps young people make good decisions about money and provides knowledge and skills they can use throughout their lives (such as budgeting to achieve short- and long-term goals). It also helps them connect school-day math lessons to personal goals like paying for postsecondary education, buying a car, saving for a downpayment on a home, managing debt, and running a business.

## The Five Basic Concepts of Financial Literacy

| | |
|---|---|
| **Earning** | Thinking about the money that comes in (income) via work, chores, etc. |
| **Spending** | Planning for the money that goes out (expenses) for day-to-day necessities, optional purchases, etc. |
| **Credit and Debt** | Considering appropriate and inappropriate uses of credit cards, loans, and other types of debt, as well as managing one's debt and creditworthiness. |
| **Protecting and Insuring** | Anticipating and preparing for future needs in the event of losses or unexpected events (i.e., by purchasing car insurance, health insurance, property insurance and/or life insurance). |
| **Saving and Investing** | Building financial resources for the future for specific short-, mid-, and long-term goals. |

## Activity Ideas for Teaching Financial Literacy, by Grade Level

As you engage in the following activities with your students, remember that talking about finances can be sensitive for anyone. Encourage students to consider their real-world circumstances and opportunities within the activities you facilitate, but avoid asking students to share these personal details or implying that most students have a certain amount of disposable income.

| Grades | Suggested Activity | Knowledge/Skills Required | Concepts Covered |
|---|---|---|---|
| K-3 | Work with students to identify coins and bills. Then have them choose what can be purchased with certain amounts of money. | • Counting money<br>• Comparing<br>• Adding and subtracting | • Spending |
| | Have students identify two items they want to buy — one short- and one long-term goal — and have them explain why they want these items. Then, have students create two piggy banks and label one for short-term spending and one for long-term saving. Work with them to develop a savings plan for the items they want. | • Planning<br>• Counting money<br>• Exchanging money | • Spending<br>• Saving/investing |
| | Create a program task chart and develop responsibilities for which students can earn money to save and spend on fun extras (such as books they can take and keep or, with pooled earnings, a special snack for everyone). | • Communicating<br>• Collaborating<br>• Planning | • Earning<br>• Spending<br>• Saving/investing |
| | Have students pair up and take turns using a dollar to "pay" for an item that costs less than a dollar while their partner makes change. | • Making change<br>• Exchanging money | • Spending |

*An investment in knowledge pays the best interest.*

— Benjamin Franklin

| Grades | Suggested Activity | Knowledge/Skills Required | Concepts Covered |
|---|---|---|---|
| 4-8 | Develop a full-year or summer-long program such as My Classroom Economy: Students earn, save, and spend "classroom money" through simulated real-world tasks like shopping for insurance, depositing money in a bank, and paying bills. | • Planning<br>• Evaluating<br>• Collaborating<br>• Communicating | • Earning<br>• Spending<br>• Credit/debt<br>• Protecting/insuring<br>• Saving/investing |
| | Ask students to list items they hope to buy over a given period (in the next month or year, before the end of summer, etc.), then have them label each item as a "want" or a "need" and put the items in a priority order. | • Communicating<br>• Comparing<br>• Evaluating | • Spending<br>• Saving/investing |
| | Ask students to list items they buy often, such as food or clothing, then have them comparison shop for those items online or in print advertisements. | • Comparing<br>• Evaluating<br>• Discounts | • Spending |
| | Have students look at sales ads from various stores and calculate comparative costs. Then, have students investigate the ads to look for misleading offers, costs of ownership, and more affordable deals on certain products. | • Figuring percentages<br>• Discounts<br>• Using fractions<br>• Comparing<br>• Evaluating | • Spending |
| | Provide groups of students with a family profile, weekly budget, and grocery store sale paper. Each group can develop a grocery shopping list that fits the family's budget, food preferences, and nutritional needs. Alternatively, give students a budget for a family vacation, and have them plan travel, lodging, meals, and activities. | • Unit pricing<br>• Conversion<br>• Solving word problems<br>• Collaborating | • Spending |
| | Host a Student Business Fair, where teams develop a product or service, create a budget, set prices, and "sell" to peers and staff. Have a Shark Tank-style pitch session where students present their business ideas — prizes for creativity and profitability! | • Planning<br>• Collaborating<br>• Communicating | • Earning |

| Grades | Suggested Activity | Knowledge/Skills Required | Concepts Covered |
|---|---|---|---|
| 9-12 | Have students "shop" for credit cards, cars, or cell phone plans and calculate the true costs with different interest rates, fees, and monthly payments. Deepen the exercise by having them explore sample credit reports to identify good and bad credit habits or pairing them up to debate the pros and cons of different financial decisions—like leasing vs. buying a car. | • Calculating interest<br>• Figuring percentages<br>• Evaluating | • Credit/debt<br>• Spending |
| | Have students identify and explain information found on example paystubs. Have them calculate percentages put toward retirement savings, taxes, and insurance costs as they appear on the paystubs. Have them calculate the difference between gross pay and take-home pay, per pay period and per year. | • Taxation<br>• Figuring percentages<br>• Analyzing | • Earning<br>• Protecting/insuring<br>• Saving/investing |
| | Have students create a monthly budget to track expenses and plan savings. If students don't have a source of income, invite them to imagine they are taking on a weekend job and provide example jobs they could be eligible for and their salaries. Deepen the exercise by having students develop a savings plan for a long-term goal (such as buying a car) or create a meal plan (What will they eat? How often can they afford more expensive options or to eat out?). | • Multiplying and dividing<br>• Planning | • Spending<br>• Credit and debt<br>• Saving/investing |
| | Provide examples of restaurant receipts and have students identify tip amounts by figuring out 15 percent, 20 percent, and so on. Explore ways of making the calculations quicker, such as rounding the bill up to a whole dollar amount. | • Figuring percentages<br>• Problem-solving | • Spending |

**Bonus Idea:** Build a Financial Literacy Word Wall — add terms like "savings," "interest," "budget," and "credit" as students learn them. It's a great way to reinforce concepts and spark discussion for any grade! Also, see **Financial Literacy Lingo Bingo** in the 21st CCLC NTAC Financial Literacy Toolkit for a ready-made game to help students learn and review key terms.

## Resources

Check these online resources for additional activity ideas:

**Hands on Banking**
https://handsonbanking.org/
Introduce families to this online resource from Wells Fargo at your next Family Math Night or Resource Fair. Choose from categories such as preparing for a rainy day, managing day-to-day, and resources for youth.

**Jump$tart Coalition for Personal Financial Literacy**
https://jumpstartclearinghouse.org/
See the Jump$tart Clearinghouse for a searchable database of financial education resources, including many that are free.
Fun fact: Jump$tart is the original promoter of April as Financial Literacy Month.

**MoneyMath: Lessons for Life**
https://treasurydirect.gov/research-center/tools/moneymath-lessons-for-life/
Middle schoolers will enjoy activities like The Secret to Becoming a Millionaire (covers savings and interest), Wallpaper Woes (covers expenses, budget constraints, and trade-offs in a redecorating project), Math and Taxes (explores careers, human capital skills, salaries, and income tax), and Spreading the Budget (has them develop a budget for a college student).

**Money Smart for Young People**
https://www.fdic.gov/resources/consumers/money-smart/teach-money-smart/money-smart-for-young-people/index.html
This resource from the Federal Deposit Insurance Corporation includes a teaching guide, student handouts, real-life exercises, and links to financial education resources from other organizations. Follow the links for even more ideas!

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# How Thoughts and Emotions Affect Learning

**What to do:** As you read this information, highlight strategies you think might help your students. The examples focus on math, but you can use the strategies in other contexts, too. Try them the next time you encounter a stressful or unpleasant situation to see which ones work best for you. Once you're comfortable with the strategies, share them with your students so they can use them to interrupt negative thinking.

**Why it matters:** Stressful or unpleasant experiences can reinforce negative self-talk like "I must not be smart enough" or "I'm just not good at this" or "I hate doing this." When it comes to math, this internal dialogue can feed math anxiety and lead to math avoidance. This can lead to poor academic performance and students missing out on future career opportunities.

Scientists have used brain imaging to study what happens in your head if you have math anxiety. If you're taking a timed test and you have math anxiety, you may have trouble accessing math facts you already know. Being locked out of that stored knowledge causes you to feel stressed and frustrated. You might think, "What's wrong with me?" Your focus shifts from the math problem to the battle happening inside you. The buzzer sounds, and you know you performed poorly. Your confidence erodes each time this happens.

## Self-Talk

This is a way to replace negative internal chatter with positive messages to reset your brain and body so you can stay calm and focus.

***To use this strategy:***

Give yourself reassuring messages. For example, right now you can tell yourself, "Remember, no one expects me to be a math teacher when I finish reading these ideas. I'm doing this because I care about my students. If I remember and use just one good idea, it could make a difference. Plus, there are tools I can use if I need them." Teach your students about self-talk and provide opportunities for practice.

## Growth Mindset

This is the belief that people don't have a certain "fixed" amount of math ability that can't be changed. People can "grow" their abilities through effort and persistence.

***To use this strategy:***

Don't just tell students, "You can do it!" and assume this one-time message will result in a growth mindset. Instead, use words and actions every day to send the message "You can do it!" Also enlist school-day math teachers and local math enthusiasts to help students build conceptual understandings and grow their "math muscles" over time.

**Yes, I Can!**

See the Nurture a Growth Mindset tool for more about this strategy.

## Metacognition

This literally means "thinking about thinking." It's the ability to examine how you process thoughts and feelings, which leads to greater awareness of how you think and learn.

***To use this strategy:***

Don't just give a lesson on "how to think about your thinking" and assume students are now ready to do it. Instead, use direct instruction to teach students what science says about how people learn and how anxiety affects working memory. Also enlist school and community partners like psychologists and counselors to teach proven strategies students can use to influence their own thoughts and feelings.

During homework time and tutoring sessions, you can also use **math talks** — a structured format where students are supported as they discuss their problem-solving strategies, the reasoning behind their work, questions they may have, and various approaches to math and problem-solving.

## Sweet Spot

You've found the sweet spot when a math challenge, game, puzzle, or other task is neither too hard nor too easy, but "doable" with effort and the right kind of supports (for example, sufficient time and, in some cases, access to a calculator). Working in the sweet spot builds students' math muscles. It helps students deal with stress by providing the right conditions and support for success without lowering expectations, which deprives students of learning opportunities.

### Watch the Movie

Teaching Habits That Promote Productive Struggle in Math is a 2-minute video from the MIND Research Institute that explains productive struggle.

***To use this strategy:***

Don't give students the answer if they can't solve a challenge, game, or puzzle right away. It's OK for students to engage in **productive struggle**. That means they don't solve the challenge, game, or puzzle with ease, but they don't struggle to the point of extreme frustration and anxiety either. Struggle within the sweet spot, followed by success, produces new understandings and confidence. To find the sweet spot for each student, you may need to offer a variety of activities — or a single activity with various levels of difficulty.

*Let's not forget that the little emotions are the great captains of our lives and we obey them without realizing it.* — Vincent van Gogh

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# Math Anxiety and Four MUSTs for Addressing It

**What to do:** Review the information and strategies here to learn ways math anxiety can impact students and ways you can help. Then choose a few strategies to try with your students!

**Why it matters:** Math anxiety is an emotional reaction to math that produces feelings of tension, apprehension, and fear of situations involving math, regardless of one's math ability. It can impact performance and have long-term effects on education and career choices.

## Five Ways Math Anxiety Can Affect Students

| Learning | Feelings | Beliefs | Behaviors | Career |
|---|---|---|---|---|
| Disrupts working memory, which makes it hard to focus. | Causes worry and distress; may affect self-esteem. | Makes students believe they don't like math and can't learn it. | Leads learners to avoid math activities and advanced classes. | May limit education and career options. |

## Helping Students With Math Anxiety

Even if you're not a math teacher, you can use many of the "math MUST" strategies described below (MUST = messages, understanding, skills, and thrills) to help yourself and your students build math confidence and know-how.

## The Math MUSTs

| "M" is for Messages | "U" is for Understanding |
|---|---|
| **Messages About Math**<br>• Math builds mental muscle.<br>• Math's needed for most careers.<br>• Math can help you reach your goals. | **Understanding Math**<br>• Procedural fluency<br>• Conceptual understanding<br>• Problem-solving<br>• Number sense |
| **Messages About Math Ability**<br>• Effort and persistence matter more than natural ability when it comes to learning math.<br>• Boys and girls are capable of learning math.<br>• There are many ways to be good at math.<br>• You can be good at math even if you have trouble memorizing math facts, rules, and formulas.<br>• Faster isn't smarter, though mental math shortcuts are handy.<br>• Mistakes are learning opportunities. | **Understanding Math Anxiety**<br>• Self-talk<br>• Growth mindset<br>• Metacognition (thinking about thinking)<br>• Sweet spot (not too hard or too easy)<br>• Productive struggle (mental effort) |

| "S" is for Skills | "T" is for Thrills |
|---|---|
| **Skills for Learning and Using Math**<br>• Mental Math<br>• Move It *(manipulatives)*<br>• Picture It *(in your head/on paper)*<br>• Ask It *(get help/ask why)*<br>• Say It *(talk it through)*<br>• Read It *(reading skills and math vocabulary)*<br>• Sing It *(as a memory aid)* | **Thrills in Learning About Math**<br>• Discovering math can be interesting, relevant, and amazing (I-R-A)<br>• Gaining a new math skill or understanding |
| **Skills for Managing Math Anxiety**<br>• Breathing techniques<br>• Progressive muscle relaxation<br>• Walking meditation<br>• S.T.O.P. (**S**top, **T**ake a breath, **O**bserve, **P**roceed)<br>• Self-talk: Be your own coach<br>• Write it out<br>• Pomodoro Method (focus 25 minutes, break 5 minutes, repeat) | **Thrills in Overcoming Math Anxiety**<br>• Feeling more confident and less anxious about math<br>• Opening doors to academic success and career possibilities |

## Ways to Reduce Math Anxiety

**Use a three-pronged approach to reduce "brain fog":** To increase math understanding and confidence, focus on activities that build students' conceptual understanding, procedural knowledge, and problem-solving.

**Keep it relevant and amazing!** Positive experiences with math build students' curiosity and interest. You're investing in students to ensure real-life payoffs today and in the long run.

**Use math anxiety erasers:** These practices help students unload worries by recognizing and acknowledging them or even writing them down, and then telling themselves they're "excited" instead of "anxious" whenever nervousness begins to creep in.

### A Not-So-Fun Fact

You can have performance anxiety or test anxiety in any school subject, but math's the only subject with its own anxiety-related definition in the American Psychological Association dictionary.

**Employ math mindfulness:** Keep an eye out for signs that a student may be experiencing math anxiety and needing immediate attention and support. Help those students implement strategies that work for them.

**Avoid the math monster:** A math hurdle, mental block, or fear can have a negative influence on motivation and achievement. When adults feel frustrated while providing homework help or they somehow give negative messages about math, it can increase student anxiety.

**Look for math moments:** Stay alert for opportunities to create interesting, relevant, and amazing experiences in the moment or "on the fly." Look for math in the world around you and make students aware of it, too!

**Enlist people and resources:** People, places, and resources in the community and online can help you and your students find the fun and banish the fear when it comes to math!

To learn more about the math MUSTs, see these tools in the 21st CCLC NTAC Math Toolkit:

- **Math Messages That Build Confidence**
- **Math Understanding: Helping Students Think Conceptually**
- **Math Skills for Students to Learn and Practice**
- **Math Thrills: Putting Fun Into the Equation**

*Nothing in life is to be feared;*
*it is only to be understood.*

—Marie Curie

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# Math Anxiety Self-Assessment and Autobiography

**What to do:** Use this self-assessment to have students and staff members gauge their levels of math anxiety. For each question, circle the level of agreement. Then add up the circle numbers to get the score. See the "Results" section to see what the score might mean. (If you're using this self-assessment as an adult, think back to when you were a student.)

**Why it matters:** There are many benefits to self-assessment, including a better understanding of what triggers the anxiety, what motivates you to work through it, and discovering strategies that work for you to confront and overcome the anxiety.

| Statement | Level of Agreement<br>*1 = Disagree* | | | | *5 = Agree* |
|---|---|---|---|---|---|
| 1. I cringe whenever it's time for math class. | 1 | 2 | 3 | 4 | 5 |
| 2. I get the jitters if I have to go to the board in math class. | 1 | 2 | 3 | 4 | 5 |
| 3. I'm afraid to ask questions or ask for help in math. | 1 | 2 | 3 | 4 | 5 |
| 4. I constantly worry that the math teacher will call on me next. | 1 | 2 | 3 | 4 | 5 |
| 5. I'm pretty good at math, but I still worry about my abilities. | 1 | 2 | 3 | 4 | 5 |
| 6. I tend to zone out in math class. | 1 | 2 | 3 | 4 | 5 |
| 7. I fear math tests more than any other kind. | 1 | 2 | 3 | 4 | 5 |
| 8. I don't know how to study for math tests. | 1 | 2 | 3 | 4 | 5 |
| 9. Math is clear to me while in class, but when I go home it's like I was never there. | 1 | 2 | 3 | 4 | 5 |
| 10. I'm afraid I won't be able to keep up with the rest of the class. | 1 | 2 | 3 | 4 | 5 |
| **Score** *(total of all the numbers you circled)* | | | | | |

| Score | Level of Math Anxiety |
|---|---|
| 40-50 | You have math anxiety. |
| 30-39 | You're somewhat fearful about math. |
| 20-29 | Any fears you have are mostly under control. |
| 11-19 | Math is smooth sailing for you. |
| 10 | No math monsters in your closet! |

Follow these steps to help you process your self-assessment results and consider possible ways to reduce your math anxiety.

**Step 1: Write —** Use these sentence starters to write a short math autobiography:

- According to my math anxiety self-assessment, my level of math anxiety is:
- If you ask me how I feel about math, I'd use these words:
- Here's what I think about my ability to learn math:
- A good experience I had with math (in school or elsewhere) was:
- A bad experience I had with math (in school or elsewhere) was:
- One way my feelings about math (positive or negative) affect my life is:
- Here's what I think about my ability to learn math:

**Step 2: Reflect —** Use these questions to reflect on your math autobiography:

- Has the fear of math (or fear of making mistakes or failing a math class or test) held you back? If so, in what ways?
- What would you like to change about your relationship with math?

**Step 3: Discuss —** Talk with at least two other people about your math autobiographies. Tell each other which of these positive (and true!) messages about math you most need to hear, and which strategy you'd like to try.

| Which message about math ability do you most need to hear? | Which anxiety management strategy do you want to try? |
|---|---|
| • Effort and persistence matter more than natural ability when it comes to learning math.<br>• Boys and girls are equally capable of learning math.<br>• There are many ways to be good at math.<br>• You can be good at math even if you have trouble memorizing math facts, rules, and formulas.<br>• Faster isn't smarter (but mental math shortcuts are handy).<br>• Mistakes are learning opportunities. | • Breathing techniques<br>• Progressive muscle relaxation<br>• Walking meditation<br>• S.T.O.P. (**S**top, **T**ake a breath, **O**bserve, **P**roceed)<br>• Self-talk (be your own coach)<br>• Write it out (to "unload" your worries and concerns)<br>• Pomodoro Method (to beat procrastination caused by anxiety, work 25 minutes, break for 5 minutes) |

*The fears we don't face become our limits.* — Robin Sharma

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# Math Booklist for Staff and Students

**What to do:** Choose books for students or staff to support math learning and reduce math anxiety.

**Why it matters:** Books can spark new ideas and conversations. They can also reinforce positive messages like "Math is interesting" and "Mistakes are learning opportunities." Reducing anxiety and encouraging a growth mindset can help students persevere with math. It can also help staff members feel more prepared to lead math activities.

## Tips and Reminders

- Just because a book has a reading level or target audience that's at a lower grade level doesn't mean your students won't enjoy it or learn from it. People of all ages can access and enjoy picture books, and they make great conversation starters.
- If you find a book you really like, look for other books by the same author.
- This list is just a starting point!
    - Check with librarians and math teachers to get their recommendations.
    - You can also search online for booklists related to math and math anxiety.
    - See what's available in your school or local library.

## Picture Books to Build Math Interest and Enthusiasm

***Bean Thirteen*** by Matt McElligot — Ralph and Flora try to get rid of the unlucky thirteenth bean, but it keeps coming back! This story is a fun way to explore remainders and division. *Grades K-3.*

***Counting on Katherine: How Katherine Johnson Saved Apollo 13*** by Helaine Becker — This true story of Katherine Johnson, a mathematician who worked for NASA during the space race, was featured in the film *Hidden Figures*. *Grades 1-2.*

***Fractions in Disguise: A Math Adventure*** by Edward Einhorn — A valuable fraction goes missing. Knowing it's likely to be disguised, George Cornelius Factor invents a tool (the Reducer) to strip away disguises, reducing the fraction and revealing its true form. *Grades 2-5.*

***G is for Googol: A Math Alphabet Book*** by David M. Schwartz — This book presents interesting math concepts for every letter of the alphabet. It's also a painless way to build math vocabulary. *Grades 4-8.*

***How Much Is a Million?*** by David M. Schwartz and Steven Kellogg — This book's one in a series that uses stories and imagination to teach important math concepts like quantifying large numbers, grasping basic financial concepts, and understanding why and how people use standard measurements. *Grades K-3.*

***I'm Trying to Love Math*** by Bethany Barton — This book shows cool and amazing uses of math, whether you're making music, baking cookies, or blasting off into outer space. *Grades pre-K-3.*

***Nothing Stopped Sophie: The Story of Unshakable Mathematician Sophie Germain*** by Cheryl Bardoe — Sophie's parents took her candles so she wouldn't stay up late doing math. But one day she would develop a formula that laid the groundwork for modern architecture. *Grades pre-K-3.*

***The Art of Clean Up: Life Made Neat and Tidy*** by Ursus Wehrli — Bright photographs surprise and delight by showing everyday objects (like a bowl of alphabet soup, sunbathers, a spruce branch, and stars) sorted by color, shape, or size. *Grades 1-6.*

***Uno's Garden*** by Graeme Base — This book takes you on an adventure where you search for certain plants and animals in the forest where Uno lives. To complete the adventure, you have to complete skills, puzzles, and multiplication questions. *Grades pre-K-2.*

## Picture Books to Help With Math Anxiety

***Everything You Need to Ace Math in One Big Fat Notebook: The Complete Middle School Study Guide*** edited by Ouida Newton — This book presents strategies for dealing with math anxiety along with easy-to-understand explanations of math concepts like fractions, decimals, ratios, percentages, probability, geometry, and more. *Grades 6-9.*

***I am Peace*** by Susan Verde — This book addresses general moments of anxiety and ways to calm down and be in the moment. Includes mindfulness exercises. *Grades pre-K-3.*

***The Dot*** by Peter Reynolds — How do you overcome the fear of "I can't draw"? By starting with a simple dot and seeing where it takes you. This book has a powerful message about overcoming fear of any kind. *Grades K-4.*

***The Monster Who Did My Math*** by Danny Schnitzlein — A boy with math anxiety faces homework that involves multiplication when a monster appears in his room and offers easy answers. The consequences, however, aren't so great. *Grades pre-K-3.*

***When Sophie Thinks She Can't*** by Molly Bang — When Sophie feels frustrated because she can't solve a math puzzle, her teacher helps her find a different approach. "I can't do it" becomes "I can't do it — yet." *Grades pre-K-2.*

## Books That Show Math as Interesting, Relevant, Amazing, and "Doable"

***Mammoth Math: Everything You Need to Know About Numbers*** by David Macauley — In this illustrated book, mammoths help readers understand key math principles. Written with reluctant math students in mind, each chapter covers a different branch of math. *Grades 2-6.*

***Math Doesn't Suck*** and other books by Danica McKellar — This book covers fractions, decimals, and more. All of the author's math books aim to entertain, encourage, and explain. *Grades 4-7.* Her website shows her books by age group (including adults).

***The I Hate Mathematics! Book*** and other books by Marilyn Burns — This illustrated book shares math tips, tricks, and tidbits in a lively way. *Grades 4-adult.*

**Tip:** Check your library or check online for other books by this author for various age groups.

***This Book Thinks You're a Math Genius*** by Mike Goldsmith — This fill-in book uses entertaining activities to introduce key math concepts in a highly visual way. It helps children think like mathematicians by inviting them to experiment and investigate for themselves. Covers geometry, space and volume, statistics, numbers and number patterns, codes and ciphers, and the concept of infinity. *Grades 2-8.*

***Unbuilding*** by David Macauley — This is a fictional account of selling the Empire State Building and dismantling it to move it to the new owner's country. The book features drawings and discussion about the math and engineering involved in building. *Grades 5-7.*

*Anyone who has never made a mistake has never tried anything new.*

– Albert Einstein

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# Math Glossary

**What to do:** Use this glossary to familiarize yourself with math terms you may have heard but aren't completely familiar with. Refer to it as needed when you communicate with school-day math teachers about student needs and concerns.

**Why it matters:** Understanding the terminology can reduce your anxiety, help you communicate more effectively, and be more successful when working with students.

This glossary would be huge if it included every math-related term that exists! So, this includes just a sample of terms you might hear if you talk with math teachers. It also includes terms related to math anxiety.

## Tips for Expanding Your Math Vocabulary and Understanding

Talk with a math teacher.

Look in a dictionary or textbook.

Check reputable online sources. For example, see the Common Core State Standards Initiative Math Glossary at https://www.thecorestandards.org/Math/Content/mathematics-glossary/.

**100 chart:** A 10-by-10 grid with the numbers 1 to 100 printed in the squares.

**Adaptive reasoning:** The capacity for logical thought, reflection, explanation, and justification; one of the National Research Council's five strands of mathematical proficiency.

**Algebra:** A branch of mathematics that deals with symbols or variables and uses arithmetic operations (+, –, ×, ÷) to find the unknown quantities represented by these variables.

**Algebraic thinking:** Particular ways of thinking, including analyzing relationships between quantities, noticing structure, studying change, generalizing, problem-solving, modeling, justifying, proving, and predicting.

**Anxious reappraisal:** An anxiety management strategy where you tell yourself you're "excited" instead of "anxious" whenever you feel nervous. Researchers say it works because anxiety and excitement are similar; in both cases, the heart beats faster and the hypothalamus releases cortisol (the "fight or flight" hormone). The difference? Anxiety is a negative emotion that increases awareness of potential threats while excitement is a positive emotion that increases awareness of opportunities.

**Arithmetic:** A branch of mathematics that deals with the properties and manipulation of numbers.

**Array:** A visual arrangement of objects in rows and columns. Math teachers use arrays to help students visualize numbers and operations, like addition, subtraction, multiplication, and division.

**Calculus:** A branch of mathematics that deals with the study of rates of change.

**Conceptual understanding:** An integrated and functional grasp of mathematical ideas that enables students to learn new ideas by connecting them to what they already know. Conceptual understanding supports retention and prevents common errors. It's one of the National Research Council's five strands of mathematical proficiency.

**Embedded instruction:** Providing opportunities for students to learn or practice a **math concept or skill** or a **learning strategy** in the context of an academic enrichment activity. Embedded instruction can be interdisciplinary and fits well in out-of-school time environments.

**Explicit instruction:** Direct teaching of **math concepts and skills** as well as **learning strategies** such as visual representations, verbalization of thought processes, reflection on problem-solving strategies, and interleaving — alternating between different types of math problems, which improves learning and retention.

**Fibonacci Sequence:** A set of whole numbers formed by adding the last two numbers to get the next number in the sequence: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so on. Related to the Golden Ratio, examples of which may be found in the petals of flowers like lilies, daisies, and sunflowers; the spirals of shells, galaxies, weather patterns, and animal flight patterns; faces, bodies, and DNA.

**Fractal:** A geometric shape that repeats with a complex structure. Examples found in nature are snowflakes, ferns, pine cones, pineapples, and branching trees.

**Geometry:** A branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.

**Graphing calculator:** An advanced calculator that can solve equations, plot graphs, and perform other tasks with variables.

**Growth mindset:** The belief that one's skills, character, intelligence, and creative ability can be developed with practice over time. Opposite of "fixed mindset."

**Interleaving:** A study strategy where you alternate between two or more related concepts or skills instead of focusing on only one at a time. For example, instead of doing addition problems first, then multiplication problems, you'd go back and forth. This strategy can help learning and retention.

**Math MUSTs:** A set of ideas and strategies to help dispel myths, fears, and stereotypes about math and your ability to learn it. "MUST" is an acronym for **m**essages, **u**nderstanding, **s**kills, and **t**hrills. **Note:** This term is specific to the 21st CCLC NTAC Math Toolkit.

**Mathematics:** The study and use of numbers and their operations to describe, measure, predict, and explain occurrences and relationships in the physical world. Branches of mathematics include algebra, arithmetic, calculus, geometry, and trigonometry.

**Math anxiety:** Feelings of tension, apprehension, and fear of situations involving math, regardless of one's math ability.

**Math circle:** A meeting of K-12 students or teachers to work on problem-solving. The lead instructor or facilitator may be a university professor, graduate student, or someone else who is knowledgeable and passionate about math.

**Math talk:** A structured format in which students are supported as they discuss their problem-solving strategies, the reasoning behind their work, questions they may have, and observations about different math approaches and applications.

**Mental math:** The use of various skills and strategies to do math in your head, without pencil and paper or a calculator. Skills that help you do mental math are being able to recall math facts, estimating, and rounding. Strategies include breaking problems down into steps or breaking numbers down into their components. For example, to add 43 and 52, you could add 40 and 50 to get 90, add 3 and 2 to get 5, then add 90 and 5 to get the answer: 95.

**Metacognition:** This literally means "thinking about thinking." It's the ability to examine how you process thoughts and feelings, which leads to greater awareness of how you think and learn.

**Mindfulness development:** Development of skills that promote a state of active, open attention on the present.

**Number bonds:** Pairs of numbers that you can add to make another number. For example, number bonds for 5 are 1 + 4 and 2 + 3.

**Number line:** A line on which numbers are marked at intervals. On a number line, any numbers to the right of the zero are positive, and any numbers to the left of the zero are negative. Rulers and thermometers are examples of number lines.

**Number sense:** The ability to understand, connect, and relate numbers. Examples are understanding quantities and making comparisons.

**Number talk:** A short, structured activity where the teacher poses an addition or multiplication problem (like 95 + 95 or 19 x 5), asks students to solve it in their heads, then asks them to share how they did it. Students practice mental math, learn about different problem-solving approaches, rehearse math facts, and develop number sense.

**Order of operations:** A set of rules for the sequence you follow to solve a math expression: (1) perform all operations inside parentheses, brackets, or above and below a fraction bar in the order specified in steps 3 and 4; (2) find the value of any powers or roots; (3) multiply and divide from left to right; (4) add and subtract from left to right.

**Pi:** The ratio between the circumference of a circle and its diameter. As a fraction, it's expressed as 22 over 7, but the actual number is unknowable. To find the area of a circle, multiply Pi by the radius squared.

**Pomodoro technique:** A time management strategy to overcome procrastination and make a task seem less overwhelming. To use this technique, set a timer and work on a task for 25 minutes, take a 5-minute break, and do another 25 minutes. After four times, take a longer break (20 or 30 minutes).

**Problem-solving:** Applying your math knowledge, skills, and understanding, along with critical thinking and creativity, to solve a problem.

**Procedural fluency:** Skill in carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately. It's one of the National Research Council's five strands of mathematical proficiency.

**Productive disposition:** The inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy. It's one of the National Research Council's five strands of mathematical proficiency.

**Productive struggle:** The level of effort required to successfully complete a task that's in the "sweet spot" of being neither too easy nor too hard to achieve. Sometimes called *beneficial difficulty* or *zone of proximal development*. This kind of struggle, followed by success, produces new understandings and confidence.

**Self-talk:** Internal dialogue; studies show negative and positive self-talk can affect one's psychological state and performance.

**Strategic competence:** The ability to formulate, represent, and solve mathematical problems. It's one of the National Research Council's five strands of mathematical proficiency.

**Sweet spot:** A level of difficulty that engages students in productive struggle by providing a task that's neither too hard nor too easy, but "doable" with effort and the right conditions (e.g., sufficient time) or supports (e.g., a calculator), depending on the task. Also called the *zone of proximal development*.

**Trigonometry:** A branch of mathematics; a subset of geometry that's concerned with the length, height, and angles of a triangle.

**Universal design for learning:** A framework, based on brain science and evidence-based practices, that guides the design of learning experiences to proactively meet the needs of all learners.

**Variable:** In math, a variable is a symbol or letter (like $x$ or $y$) that represents a value you don't know yet. Variables can be *dependent* (which means their value depends on other variables) or *independent* (which means their value doesn't change even if other variables change).

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*Arithmetic is being able to count up to twenty without taking off your shoes.*

—Mickey Mouse

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# Math Messages That Build Confidence

**What to do:** Promote these messages about math and your students' ability to learn it.

**Why it matters:** All of us encounter messages about math in our schools, homes, workplaces, and popular culture. They can be spoken, written, or conveyed through attitudes and behaviors. Some are positive, true, and empowering. Others are negative, untrue, and harmful. Either way, they are a powerful influence. The messages below can build students' confidence in their abilities and reduce math anxiety.

## Messages About Math

- **Math builds mental muscle.** It gives your brain a workout and sharpens your thinking skills.
- **Math's needed for most careers.** It's not just for scientists and engineers. Hundreds of careers require math skills, like animation, construction, fashion design, food services, marketing, nursing, stockbroking, and more.
- **Math can help you reach your goals.** People use math at home, work, school, and in everyday life in a variety of ways, like planning a trip, cooking a meal, doing tax returns, or creating a budget for the boss. Help students see how math can help them reach their goals and do things that matter to them.

## Messages About Math Ability

- **Effort and persistence matter more than natural ability when it comes to learning math.** That doesn't mean you should just tell students to "try harder." Instead, provide specific strategies and supports to help them see they can influence their own learning through effective study habits, focus, persistence, participation in group work, asking questions, and seeking help when they need it.
- **Boys and girls are equally capable of learning math.** Individual differences in math performance mostly depend on the age of the student, their existing math skills and knowledge, and what kind of math they're doing. But all students are capable of learning math. Messages like "maybe you're just not good at math" or "boys are always better at math than girls" can diminish confidence and motivation.
- **There are many ways to be good at math.** Data analysis, visualization, mental math, logical arguments, critical thinking, and spatial reasoning (like imagining how two objects will fit together) are just a few examples of ways to be good at math. There are many ways to build on what you already know to develop these abilities.
- **You can be good at math even if you have trouble memorizing math facts, rules, and formulas.** You might be surprised to learn that the students who score the lowest on international math tests are those who use memorization as their main strategy. Those who score highest have a conceptual understanding of math as a set of connected, big ideas. It's helpful to know math facts, but many successful people with degrees in science and engineering never memorized the "times table."

- **Faster isn't smarter, though mental math shortcuts can be handy.** Some of the most successful mathematicians, scientists, and thinkers aren't fast at arithmetic. While timed tasks and competition bring out the best in some students, they bring out anxiety in others. Former National Council of Teachers of Mathematics (NCTM) president Cathy Seeley says overemphasizing speed can do more harm than good. Being fast doesn't mean you're better at math.
- **Mistakes are learning opportunities.** Mistakes can be powerful teachers if you help students see them as a normal part of learning. Encourage students to share and discuss mistakes, to unravel what went wrong, and to build new understandings. When you wrestle with a mistake and learn from it, your brain grows new dendrites, and you gain confidence. Mistakes don't mean you have poor math ability.

## Math Messages and Math MUSTs

MUST is an acronym for four tools that fight math anxiety and nurture a can-do attitude:

- **M** is for the **messages** students get about math and their ability to learn it.
- **U** is for **understanding** math concepts and how thoughts and emotions affect learning.
- **S** is for **skills** that help you learn and use math — and manage anxiety, if it's an issue.
- **T** is for **thrills** because students need positive experiences to help them discover the magic and satisfaction of math in a way that's meaningful to them.

For more about the math MUSTs, see the 21st CCLC NTAC Math Toolkit for these tools:

- **Math Anxiety and Four MUSTs for Addressing It**
- **Math Understanding: Helping Students Think Conceptually**
- **Math Skills for Students to Learn and Practice**
- **Math Thrills: Putting Fun Into the Equation**

*In mathematics the art of proposing a question must be held of higher value than solving it.*

— Georg Cantor

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# Math Moments at Home

**What to do:** Find ways to share math experiences with your child as a part of your daily activities. This will help them to see that math is part of their everyday experiences.

**Why it matters:** Sharing math experiences helps you connect with your child and create positive math moments! These moments add up to help your child overcome fears and negative ideas like "Math is boring" and "It's too hard." They also help your child:

- **Build life skills** like sticking to it, trying different things, and seeking help if they need it.
- **Discover** that math can be interesting, useful, and fun!
- **Feel good** about math and their ability to learn it.
- **See the purpose** of math in daily experiences.
- **Build confidence** with positive math experiences that help to overcome anxiety and "rewire" their brain to more proactive thoughts.

## To Encourage and Support Your Child …

### Say This

- Math builds mental muscle!
- There are many ways to be good at math.
- Boys and girls are capable of learning math.
- How did you figure that out?
- Mistakes are learning opportunities.
- Faster isn't smarter.

### Do This

- Connect math with your child's interests.
- Play math games.
- Estimate the number of pennies and their value.
- Praise effort.
- Model positive math attitudes.
- Make a favorite recipe.
- Tell how math helps you at home and at work.
- Play "I Spy" to spot everyday math.

## Opportunities to Share Math With Your Child

**Cooking and baking:** Think of cooking and baking as a tasty math lab! Children learn to measure, get exposure to fractions, and learn equivalences such as 2/4 = 1/2. They might also use multiplication if they need to double a recipe, or division if a recipe needs to be cut down.

**Food:** Once the cooking or baking is completed, it's time to eat! Grouping skills and division come into focus as children figure out how many pieces of pizza per person, or separate a dozen cookies into equal groups.

**Measurement:** In addition to measuring in the kitchen, children can measure things around the house. And they don't even need a ruler or a yardstick — paper clips, pennies, pencils, hands, feet — almost any object can be used. Older children can try measuring the square footage of their room, the yard, or other areas around the house.

**Gardening:** Measurement shows up here, too! Seeds are often planted in evenly spaced rows. In math these are called arrays, and they help to visualize a number in different ways (2 rows of 10, 10 columns of 2, and so on).

**Estimation:** This can be done in lots of ways. Estimate how many steps you take on your walk, how many people are at the pool, or how many jellybeans are in the package.

**Telling time:** Children must get up at a certain time and need a certain number of minutes to get ready for the bus. The ride to school takes a specified time, and so on. Knowing how much time it takes for dance class or baseball practice, and estimating the time for other activities, are important skills to develop. Encourage your children to use a calendar so they know how many days until their birthday or how many weeks until school is out!

**Money, budgeting, and finance:** If your children get an allowance or earn money for chores, help them make responsible decisions about saving and spending. Involve older children in family financial discussions as appropriate (the cost-benefit calculation of a new TV vs. a new couch, or the best value for a family activity). Shopping is a great way to expose younger children to the value of various coins, as well as counting money and making change.

**Traveling:** Children can calculate mileage, distance traveled, traveling speed, or arrival time.

**Patterns and shapes:** Look for these everywhere in nature, at the store, and in your neighborhood.

**Playing sports and games:** Most games involve some type of math. Keeping score, counting to move a certain number of spaces, adding two dice, recognizing the numbers on cards, and counting Monopoly money all build math skills.

## What If Your Child Avoids Math?

Does your child …

- Avoid math-related activities?
- Dread math class?
- Say things like "I hate math" and "I'm no good at math"?
- Seem especially nervous when doing math homework?
- Get a stomachache or beg to stay home on days when there's a math test?

If so, it's possible that your child has math anxiety.

**What is math anxiety?**

Math anxiety is a negative emotional reaction to math.

**Who gets math anxiety?**

People of all ages and abilities can have math anxiety. Even students with good math grades can have it.

**How can I tell if my child has math anxiety?**

If your child is struggling, the American Psychological Association recommends talking with your child and also talking with your child's teacher. The school may recommend an evaluation for learning disabilities such as dyscalculia, which impairs math ability. Math anxiety is more common than dyscalculia, but if your child does have a learning disability, knowing about it is the first step in making sure they get the support they need. Understanding, supporting, and advocating for your child is important to their success.

### Math Anxiety: Five Ways It Can Affect Your Child

| Learning | Feelings | Beliefs | Behaviors | Career |
|---|---|---|---|---|
| Disrupts working memory, which makes it hard to focus. | Causes worry and distress; may affect self-esteem. | Makes children believe they don't like math and can't learn it. | Leads to your child avoiding math activities and advanced classes. | May limit education and career options. |

*Success is the sum of small efforts, repeated day in and day out.*

— Robert Collier

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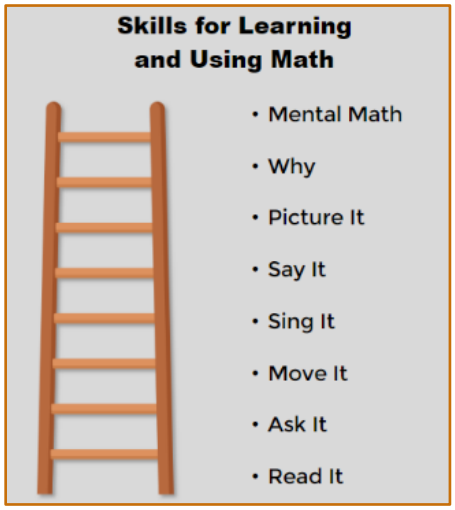
# Math Skills for Students to Learn and Practice

**What to do:** Review the skills for learning and using math, and the skills for managing math anxiety, to get concrete ways to help students put skills into practice.

**Why it matters:** Students who develop and implement these skills become more confident in their math abilities, cultivate a growth mindset, and have positive learning experiences and outcomes.

## Skills for Learning and Using Math

Try out these skills for learning and using math. Then share them with your students.




### Mental Math

Doing math in your head without a pencil, paper, or calculator is called "mental math." Helpful skills for mental math include being able to recall math facts, estimating, and rounding. Useful strategies are breaking problems down into steps or breaking numbers down into their components. For example, to add 43 and 52, you could add 40 and 50 to get 90, add 3 and 2 to get 5, then add 90 and 5 to get the answer: 95. *(If memorizing math facts isn't your superpower, don't worry: You can develop other powers to help with mental math, like rounding and regrouping numbers or visualizing patterns and relationships.)*

### Picture It

Create a visual representation of a math problem or concept, either on paper or in your head. Some examples are number lines, strip diagrams, pictures of concrete objects, charts/graphs, arrays, and graphic organizers. *(A pizza is a pie chart you can eat!)*

### Say It

Talking out loud about what you're doing as you work on a math problem can help. For one thing, it keeps your attention on your work. For another, it helps to clarify your thinking when you put it into words. *(Try this at home, not in the library, so you won't interrupt others.)*

### Sing It

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. *(Not only does music help you access stored memories and create new ones, but it can also boost your mood.)*

### Move It

Use manipulatives (solid objects you can move with your fingers, like wood blocks or coins) to help you see numbers, relationships, and patterns, or to perform number operations like addition and subtraction. Eventually you might be able to see the objects in your head without using

physical objects, but don't worry if this takes a while or doesn't happen. Research shows that small motor movements or gestures can help improve problem-solving ability and memory, whether you're doing or watching the gestures. *(Don't forget: Exercise builds brains as well as muscles.)*

**Read It**

Reading skills (including vocabulary) matter just as much as math skills when you're in math class. So, when you're building literacy skills, include word problems and share "insider tips" on reading math problems, like paying attention to instructions, thinking carefully about what the words and numbers represent, and making sure you understand math vocabulary terms. English learners may need support in learning "math words" (for example, they might think a "right angle" in math means a "correct angle").

**Ask It**

If you don't understand something in math, don't be afraid to ask someone for help, like a teacher, another student, or a family member. If you do a math problem and the answer doesn't make sense, check your arithmetic and your logic, or try a different method to see if you get the same answer. Thinking about whether an answer makes sense *always* makes sense. Follow up on those hunches. And if you're curious about something, investigate. Math isn't just about answering someone else's questions. *(Millions saw the apple fall, but Newton asked why.)*

### Why the Most Valuable Question May Be "Why?"

**This true story from Sarah W. explains why it can be especially important in math:**

"I never did well in math because I wanted to understand WHY we had to do things a certain way, and teachers didn't like being asked that. In graduate school, though, I had a statistics professor who was great about explaining why. He also didn't make us memorize formulas or anything because "you can look those up. If you don't know how and when to use it, it doesn't matter if you have it memorized." I appreciated that mentality so much! Around the same time, the TV show *Numb3rs* was out. A large part of it was a character using applied mathematics to solve crime. It really made things click for me — here were these math concepts I had heard of before but seemed pointless, being used in real life!"

**Here are two "why" questions to explore with your students:**

- **Why are there two different ways to express a number that's part of a whole — fractions and decimals?** Students may find it interesting to know that fractions came first, and decimals later. Decimals gained wider use partly because they were easier for printing presses to set in type. This is a centuries-old example of the relationship between technology and numbers! Bonus fact: Did you realize that the metric system uses decimals, while the customary system of measurement in the U.S. is primarily based on fractions?
- **Why do I need to know how to multiply and divide fractions?** It's useful in everyday situations like doubling a recipe or cutting it in half or deciding how much pizza to order for a party if someone says, "Only ⅔ of the people we invited are coming."

## Skills for Managing Math Anxiety

Here are some anxiety management skills you can use anytime stress and worry make you feel anxious, whether it's in math class or elsewhere. Many of them include mindfulness practices.

### Breathing Techniques

The most basic technique is to simply pay attention to your breath without trying to control it. Your mind will try to wander. That's OK. Just bring your focus back to your breath with each inhale and exhale. Another technique some people use for anxiety is 4-7-8 breathing: Close your mouth and breathe in through your nose for a count of four. Hold your breath and count to seven. Exhale through your mouth for a count of eight. Repeat up to three more times.

### Build Students' Math Vocabulary

The **Science and Mathematics Vocabulary Builder** in the 21st CCLC NTAC Math Toolkit has ideas for using math-related words and questions during snack time, recreation, and other program activities — not just during math activities or homework time. For example: Count your raisins by twos. Divide into teams of three. What's the repeating pattern in this piece of art?

### Progressive Muscle Relaxation

Tense your toes for 5 seconds, then relax and notice the difference. Next do the same with your calf muscles, thigh muscles, and other muscle groups, one at a time, until you progress all the way up to your forehead. You can do one side of your body at a time, or both sides at once. Bring your focus to the difference you feel in that body part each time you relax.

### Walking Meditation

You don't have to sit still to meditate. You can walk or do other movements while bringing your attention to your feet, your body, and the ground and focusing on what it feels like to walk. If you're outdoors, your focus might be on sights, sounds, and sensations — the changing sky, birdsong, the rhythm of traffic, and what the sun or wind feels like on your face.

### S.T.O.P.

**S**top what you're doing. **T**ake a deep breath. **O**bserve what's happening around you and inside you. **P**roceed mindfully (either go back to what you were doing or change course and do something different).

### Self-Talk: Be Your Own Coach

Remind yourself that you're ready: "I've studied this material, so I'm ready for the test." Recall past successes: "I thought I'd fail the last test, but I passed it with room to spare!" Reframe your anxiety: "This state of heightened alertness feels uncomfortable, but I can actually take advantage of this extra energy to improve my performance." Reassure yourself with calming words like "It's OK" or use an energizing mantra like "I'll give it my all. Let's go!"

### Write It Out

Write out any worries and negative thoughts about math before a math test or performance task. This might seem like an odd idea, but it works because writing is a form of action. So instead of your negative thoughts continuing to run in circles inside your brain, they're rounded up, directed into your writing hand (or fingertips), and "released" onto paper. Give it a try!

**Pomodoro Method**

If anxiety causes you to avoid doing math homework or studying for a test, try the Pomodoro Method. This time management strategy can help you overcome procrastination and make the task less overwhelming. Set a timer and work for 25 minutes, take a 5-minute break, and do another 25 minutes. After four times, take a longer break (20 or 30 minutes). You can adjust the times. Experiment and do what works best for you!

## Math Messages and Math MUSTs

MUST is an acronym for four tools that fight math anxiety and nurture a can-do attitude:

- **M** is for the **messages** students get about math and their ability to learn it.
- **U** is for **understanding** math concepts and how thoughts and emotions affect learning.
- **S** is for **skills** that help you learn and use math — and manage anxiety, if it's an issue.
- **T** is for **thrills** because students need positive experiences to help them discover the magic and satisfaction of math in a way that's meaningful to them.

For more about the math MUSTs, see the 21st CCLC NTAC Math Toolkit for these tools:

- **Math Anxiety and Four MUSTs for Addressing It**
- **Math Messages That Build Confidence**
- **Math Understanding: Helping Students Think Conceptually**
- **Math Thrills: Putting Fun Into the Equation**

*Mathematics rightly viewed possesses not only truth but supreme beauty.*

— Bertrand Russell

This resource was developed in 2024, and revised in 2025, by the Nita M. Lowey 21st Century Community Learning Centers (21st CCLC) National Technical Assistance Center (NTAC), funded under a grant from the U.S. Department of Education (Department) and administered by Synergy Enterprises, Inc. under Cooperative Agreement No. 287E230009 with the Department's Office of Elementary and Secondary Education. Opinions expressed herein do not necessarily reflect the position or policy of the Department, nor does mention of trade names, commercial products, or organizations imply endorsement by the Department or the federal government. This resource is in the public domain and is available at 21stcclcntac.org. Authorization to reproduce it in whole or in part is granted.

# Math Standards

**What to do:** Talk with a math teacher or a school district math specialist. Ask for a copy of the learning standards for your State or look them up on your State educational agency's website. The chart below highlights key elements.

**Why it matters:** Each State establishes its own standards. State standards and practices draw on an established body of knowledge for math education. Knowing what's expected of the students in your program will help guide decisions about enrichment activities.

| National Research Council | Common Core State Standards | National Council of Teachers of Mathematics | |
|---|---|---|---|
| **Five Strands of Mathematical Proficiency** | **Eight Mathematical Practices** | **Five Process Standards** | **Eight Mathematical Teaching and Learning Practices** |
| Conceptual understanding<br>Procedural fluency<br>Strategic competence<br>Adaptive reasoning<br>Productive disposition | Make sense of problems and persevere in solving them<br>Reason abstractly and quantitatively<br>Construct viable arguments and critique the reasoning of others<br>Model with mathematics<br>Use appropriate tools strategically<br>Attend to precision<br>Look for and make use of structure<br>Look for and express regularity in repeated reasoning | Problem-solving<br>Reasoning and proof<br>Communications<br>Connections<br>Representations | Establish mathematics goals to focus learning<br>Implement tasks that promote reasoning and problem-solving<br>Use and connect mathematical representations<br>Facilitate meaningful mathematical discourse<br>Pose purposeful questions<br>Build procedural fluency from conceptual understanding<br>Support productive struggle in learning mathematics<br>Elicit and use evidence of student thinking |

### Tips to Learn More About Math Standards in Your State

Many States use the Common Core State Standards for math. You can find information about those standards at Mathematics Standards | Common Core State Standards Initiative (thecorestandards.org). But remember: States often revise or add to these standards, so school-day math teachers and your State educational agency's website are the best sources for up-to-date information about what your students are learning in school.

## Examples of Math Standards at Different Grade Levels

These examples aren't comprehensive. They're meant to give you a "quick peek" into math classes so you can see some things students are expected to learn at different grade levels. As you read, notice how later knowledge builds on earlier understandings and goes to a deeper level.

**Kindergarten**

- Count and compare: The tall stack has 8 blocks and the short one has 3.
- Identify and name shapes: There's a circle, a triangle, and a square.

**Grade 1**

- Number families: 6 + 3 = 9, and 9 – 6 = 3
- In a dozen eggs, there's one group of 10 eggs with 2 eggs left over.

**Grade 2**

- The number 23 means there are 2 tens and 3 ones.
- I measured this table, and it's 6 feet long and 3 feet wide.

**Grade 3**

- 8 x 10 = 80, and 80/10 = 8.
- For this recipe you need 1/2 cup of berries and 1/3 cup of nuts.

**Grade 4**

- Hey, 3/6 is the same as 1/2! Also 1/2 x 10 = 5.
- This rectangle has parallel and perpendicular sides, four 90-degree angles, and symmetry.

**Grade 5**

- You can write the fraction 1/2 as a decimal number: .5.
- How many 2-inch cubes fit into this 6-inch cube?

**Grade 6**

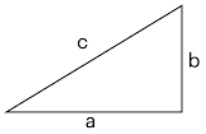
- What's the ratio of apples to oranges on this snack tray?
- Variables: These expressions mean the same thing: 3 x $y$, 3 • $y$, and 3($y$).

**Grade 7**

- Let's figure out the surface area of this basketball.
- Based on a survey of 50 people where 28 said they loved chocolate, how many people in our school probably love chocolate?

**Grade 8**

- An example of using functions in everyday life is when you figure what it costs to fill your gas tank based on the price per gallon and how many gallons it takes.
- I'll explain the Pythagorean Theorem and its uses.




$c^2 = a^2 + b^2$

*Pythagorean Theorem*

**High School**

In U.S. high schools, students typically complete Algebra I, Geometry, and Algebra II before taking higher-level math classes like Precalculus, Calculus, Advanced Statistics, Discrete Mathematics, Advanced Quantitative Reasoning, or courses designed for certain fields in career and technical education. (Many other countries teach "the maths" in a more integrated way.) Here are examples of six domains usually covered in U.S. high school math, with examples of real-world applications.

**High School: Number and Quantity**

- High school math extends students' understanding of "number" beyond real numbers to include imaginary numbers and complex numbers. Students reason quantitively and use units to solve problems.
- **Application:** Deciding which measures (e.g., fatalities per year, fatalities per year per driver, or fatalities per vehicle-mile traveled) might be a good indicator of overall highway safety.

**High School: Algebra**

- Algebra is part of all higher math classes. It involves seeing structure in expressions, doing arithmetic with polynomials and rational functions, creating equations that describe numbers or relationships, and reasoning with equations and inequalities.
- **Application:** Using letters, numbers, and symbols to express a problem so that you can solve it (e.g., If $3x = 6$, $x = 2$).

**High School: Functions**

- Functions describe situations where one quantity determines another.
- **Application:** Estimating when to leave for a soccer game 20 miles away if you drive the speed limit and traffic flow is normal.

**High School: Modeling**

- Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions.
- **Application:** Planning a table tennis tournament for seven players at a club with four tables, where each player plays against each other player.

**High School: Geometry**

- Geometry is a branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.
- **Application:** Designing a stairway.

**High School: Statistics and Probability**

- Statistics provides tools for describing variability in data and for making informed decisions that take it into account. Probability rules can help you interpret data to make a judgment or decision.
- **Application:** Forecasting the weather.

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# Math Thrills: Putting Fun Into the Equation

**What to do:** As you review these math activity ideas, highlight the ones you'd like to try. Consider your students' needs, interests, and grade levels. Start with one or two activities that you can easily implement and already have the resources to do. Then look for ways to use these ideas throughout the program year.

**Why it matters:** If you work in an out-of-school time program, you know thrills aren't frills. They're a MUST, not just for math, but for keeping students engaged and coming back for more, day after day.

## Math Thrills are a Math MUST!

MUST is an acronym for four ways to nurture students' competence and confidence in math:

- **M** is for the **messages** students get about math and their ability to learn it.
- **U** is for **understanding** math concepts and how thoughts and emotions affect learning.
- **S** is for **skills** that help you learn and use math — and manage anxiety, if it's an issue.
- **T** is for **thrills** because students need positive experiences to help them discover the magic and satisfaction of math in a way that's meaningful to them.

Here are some ways to bring "math thrills, not drills" to your program and get those endorphins going!

## The Thrill of Positive Experiences With Math

To help every student have positive experiences with math, provide I-R-A experiences. In this context, the letters I-R-A don't stand for Investment Retirement Account. They stand for interesting, relevant, and amazing. Providing I-R-A experiences is a way to invest in students by grabbing their attention and getting them to focus on math in a positive way.

## Creating Interesting Math Experiences

Here are some ways to create student interest in math:

- **Student Interest Survey:** Students are interested in music. Let them pick a favorite song, show them the sheet music, and teach the relationship between the song's rhythm and quarter notes, half notes, and so on.
- **Student Choice:** If you present a "problem of the day," a read-aloud, or a math project, provide options and let students choose.
- **Mystery:** "The Mystery of the Missing Numerator" is more interesting than "solve for the missing number."

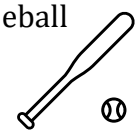
- **Games:** Try the **Pepperoni Pizza Game**: Students roll a die twice. The first roll tells how many pizzas to draw. The second roll tells how many pepperonis to put on *each* pizza. How many pepperonis in all? Students write sentences to help them answer. For example: *I roll a die and get three, so I draw three big pizzas. I roll again and get five, so I draw five pepperonis on each pizza. I know 3 x 5 = 15, so there are 15 pepperonis in all.*

- **Movement:** Have student teams use various units of measure (e.g., feet, yards, meters, steps, pencils) to describe the length of a wall or fence line. Challenge them to invent a new measure and explain its pros and cons.

## Creating Relevant Math Experiences

To make an activity relevant to students, pay attention to the four spheres of relevance: self, community, culture, and the real world. Here's an example:

- **Self:** You learn that several students love baseball.
- **Community:** With the correct approval from your 21st CCLC SEA Coordinator, you arrange for students to watch a local baseball game virtually or in person and collect game statistics. You also invite speakers to discuss math in baseball (e.g., personal and team statistics, dimensions of the field).
- **Culture:** You invite student groups to do an interdisciplinary mini project on baseball to explore its historical development, social and economic aspects, influence on national and global culture, design of uniforms and equipment, how the rules have or haven't changed, and what kinds of data marketers consider when they're deciding how to maintain and grow the audience.



- **The real world:** The interdisciplinary mini project includes intersections with real-world use of data and statistics. So, you use these connections to help students "get their head in the game" of math and its real-world applications. For example: Given the distance between bases, and the average time it takes to throw someone out, how fast do you need to run to have a good chance of making it to first base if you hit a ball to center field? Knowing this info helps you set your target for training and increasing your speed.

## Creating Amazing Math Experiences

Challenge yourself and your program team to create amazing moments for your students. The best ones happen when they're amazed at their own ability to learn or do something new, or when a mathematical fact, game, or concept provides a sense of wonder. Here are some ideas for you and your students to explore together:

- **Fractals:** These are geometric shapes that repeat with a complex structure. When you zoom in on a fractal, you often see the same structures appearing again and again. Examples include snowflakes, ferns, pine cones, and branching trees. If you search online, you can find many amazing images of fractals to share with students. Better yet, invite them to come up with examples, both online and in real life.
- **Pi:** The ratio between the circumference of a circle and its diameter. As a fraction, it's expressed as about 22/7, or 3.14, but as an actual number, Pi is unknowable, and it's called an irrational number. To find the area of a round pizza, you multiply Pi by the radius

squared, and multiply area by height to find the volume. So, the volume of a pizza with a radius of "z" and a height of "a" can be expressed in the formula **Pi** x **z** x **z** x **a**. Also, if you enter Pi (3.14) in a calculator, then look at the calculator in a mirror, it spells "pie."

- **Palindromic numbers:** A palindromic number is a number that's the same whether you read it forward or backward, like 121 and 12321. Multiplying 1's always gives you palindromic numbers. For example:

1 x 1 = 1

11 x 11 = 121

111 x 111 = 12,321

1,111 x 1,111 = 1,234,321

11,111 x 11,111 = 123,454,321

- **Jiffy:** If you tell someone you'll finish something in a jiffy, it means you'll do it in a very short amount of time. But in physics, "jiffy" is an actual measurement for the time it takes for light to travel across 1 centimeter, and there's a formula for it: $33.3564 \times 10^{-12}$ seconds.

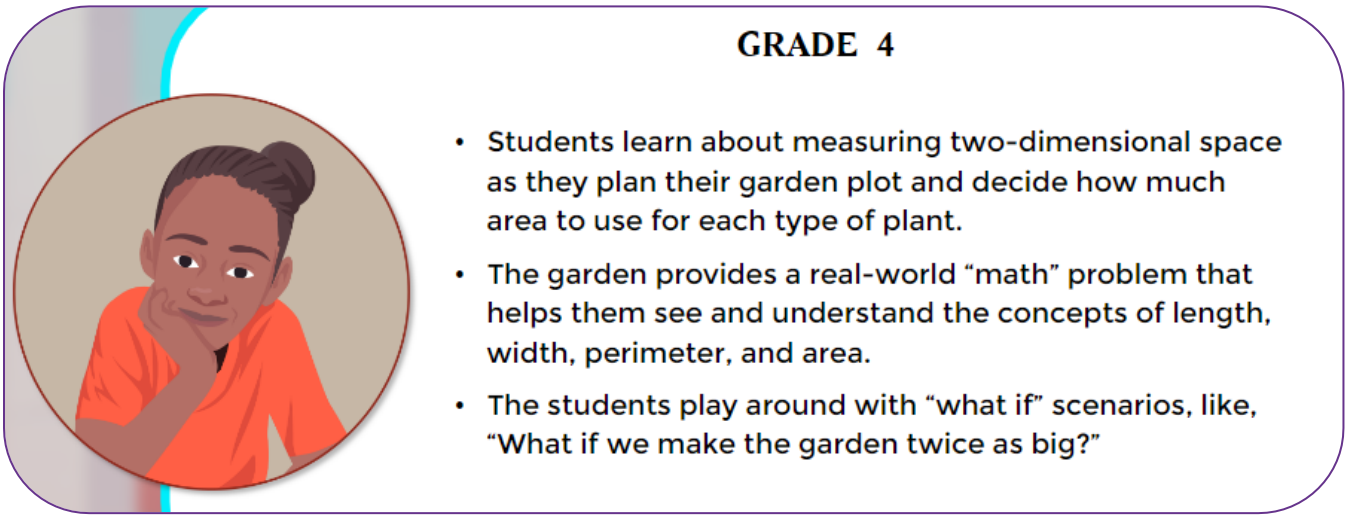
## More Activity Ideas

Here are a few more ideas to spark your creativity!

**Gardening Activity (Example of Math Standards in Action for Grades 4 and 8)**

This example shows how the five strands of mathematical proficiency in geometry can connect to a gardening activity at the fourth- and eighth-grade levels. By working with school-day teachers, you can use engaging academic enrichment activities like this to combat math anxiety while building students' understanding of key math concepts to help them master State math standards.

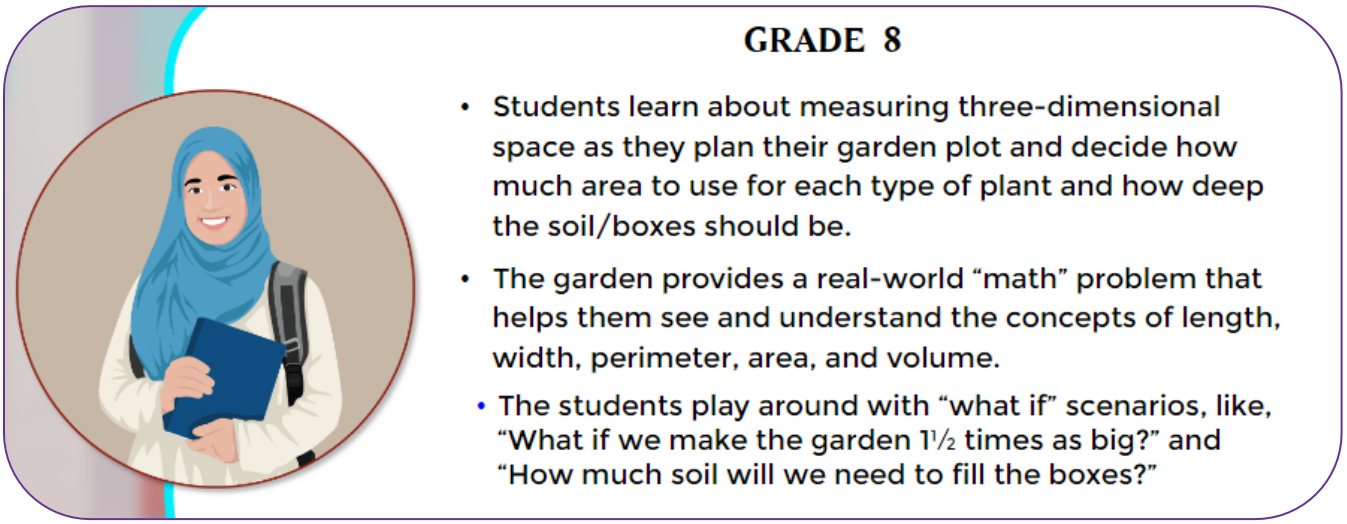
**Grade 4 – Geometry: Area and Perimeter**




Students have been engaging in academic intervention activities to help them build knowledge and skills related to geometry. They've also been participating in a school gardening activity to practice and master the new skills and knowledge in real-life, relevant ways. This table shows some things fourth-graders will be able to say once they master each strand of proficiency:

| Conceptual Understanding | Procedural Fluency | Strategic Competence | Adaptive Reasoning | Productive Disposition |
|---|---|---|---|---|
| I know the definitions of area and perimeter, and I understand the relationship between area and perimeter. | I know that to find the area of the garden, I need to measure the length and width, then multiply length times width. | I can use an array to represent the area and draw a square around the array to represent the perimeter. | I can adapt this knowledge to a new problem (e.g., if the garden area doubles). | I feel confident in explaining the relationship between area and perimeter, and I think it's a helpful thing to know. |

**Grade 8 – Geometry: Area, Perimeter, Volume**




The gardening activity for eighth-graders differs from the one for fourth-graders since the types of skills they need to master are different. This table shows what eighth-graders will be able to say once they master each strand of proficiency:

| Conceptual Understanding | Procedural Fluency | Strategic Competence | Adaptive Reasoning | Productive Disposition |
|---|---|---|---|---|
| I can connect the concepts of area and perimeter to volume by adding a third measurement (height) to the measurements used for area (length and width). | I know that to find the volume of the rectangular garden boxes, I need to multiply the measurements of length times width times height, using number sense. | I can use three-dimensional figures to model the rectangular boxes and find any of the values (length, width, height, or volume) to solve the problem. | I can adapt this knowledge to a new problem (e.g., if the width doubles). | I feel confident in explaining the relationships and differences between finding the area, perimeter, and volume. |

**Infographics**

Infographics help students visualize patterns, trends, and relationships. A fun project might be to challenge students to find infographics on topics that interest them, then choose one to explain or interpret to their classmates. Maybe they'll be inspired to create their own infographics.

**Interdisciplinary Connections**

Challenge students to work in teams to create a list of 50 (or 100!) ways math connects to other disciplines and interest areas like these:

- Art
- Baking
- Careers
- Financial literacy
- Health
- Literature (including poetry)

**Math Scavenger Hunt**

Scavenger hunts are fun and can help students see that "math is everywhere." Your list might include "something that comes in sets of 12" and "a street name with a number in it." Or it could include the numbers 1 through 10. You can find many ready-made scavenger hunt lists online. Look for one that matches the grade levels and concepts you want to teach.

**Math Talks**

Math teachers and tutors sometimes use a structured format called "math talks" to help students think and learn about math. Students get supported as they discuss their problem-solving strategies, the reasoning behind their work, questions they may have, and observations about different approaches to math and problem-solving. Here are some informal ways to get students talking and thinking about math in your program:

- **Sentence starters:** Display some sentence starters and a short list of terms for students to use during discussions. For example, if you ask, "How long do you think it takes to get from here to Juno, Alaska?," you might display the following sentence starters and key words:

  **Sentence starters:**

  - Something I need to know before I can answer is …
  - Some factors that might affect it are …
  - The way I'd figure that out is …

  **Key words:** time, distance, speed, measurement

- **Cartoon-inspired thought bubbles:** Show a picture or cartoon with an empty thought bubble. (If you're using an existing cartoon, you can cover current thought bubbles with a paper cutout.) It might show a team working on a science project, someone shopping in a grocery store, or people working out in a gym, for example. Ask students to suggest math-related ideas for the thought bubble (or bubbles). For example, if a team is working on a project, various team members' thought bubbles might say, "I wish I'd paid more attention in math class" or "I love using my math skills to solve problems."

- **Word sorts:** English language arts teachers use word sorts to teach vocabulary. They might give students a list of words and ask them to identify ways the words are similar or different, or to categorize the words in some other way. You can use this method to teach

math vocabulary. For example, if you're starting a project that will require students to measure various things, your word list might include *mile, hour, inch, pound, minute, feet, yards, second, meter, ounce, kilogram, and quart.* In groups, students could sort the words in various ways — for example, U.S. customary units vs. metric system, or distance vs. weight vs. time vs. volume.

**Math Stations**

If you use math stations, be sure they reinforce positive messages, and train staff and volunteers to use the Math MUSTs as they set up the stations and support students.

- **Guided Learning or Reciprocal Learning Station:** This station allows the teacher to interact with each student. Keeping the station to only a few students allows for individualized instruction and opportunities for students to interact. This would involve explicit instruction on specific math skills and concepts.
- **Interactive Whiteboard:** Games can be loaded or developed to allow students to work together to solve and learn in a fun and engaging way.
- **Computer Station:** Load skill-specific math software onto a computer, add headphones, and allow students to work on their skills. Generally, this type of software allows teachers to run reports on student progress and set lessons so that students are working on specific areas of need.
- **Game Station:** This can include math games that focus on students' specific needs. Strive for "hands-on, minds-on" activities, and remember: this station may be indoors or outside!
- **Homework Station:** This station can include print and online resources, access to virtual or in-person homework helpers, and visual reminders of effective homework completion strategies.
- **Music**
- **Technology**
- **Other** _____

**Math High-Q Cards**

Start a "question bank" of index cards or slips of paper with intriguing questions you can pull out and use during just about any activity (whether it's related to math or something else) to develop students' curiosity, question-asking ability, and critical thinking. Here's a starter set:

| | |
|---|---|
| Why do you say that? | What are some other possibilities? |
| How are those things connected or related? | What do you predict will happen? |
| What if … ? | What's another strategy you could try? |
| Can you give an example? | How could you prove or confirm your answer? |
| How are they alike? How are they different? | Can you create a rule for when to use one approach instead of another? |

| | |
|---|---|
| If you wrote a book about it, what would the title be? | What conditions or variables might change the outcome? |
| Would you explain how you did that? | What would the world be like without _____? |
| What's something you know now that you didn't know then? | Have you ever experienced anything like that? |
| What do you think should be done? | What questions do you have? |

**Numbers in Stories, Legends, and History**

Talk about stories and legends that involve numbers or mathematics. For example:

- Goldilocks and the Three Bears
- The Three Little Pigs
- Mount Rushmore was originally called the Six Grandfathers Mountain by the Lakota after a vision of the six sacred directions: west, east, north, south, above, and below. It was a place for prayer and devotion for the Native people of the Great Plains.

**Posters About Math**

Coordinate with school-day staff to have your students create posters about math to use in school classrooms or common areas. Provide quotes about math or have students find or create a quote to include on a poster they create.

**Read-Alouds**

See the **Math Booklist** for picture books to read aloud and talk about.

**Stories About People Who've Played a Role in Mathematics**

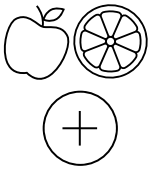
Share stories about people who've contributed to math or used math to accomplish something. Here are some ideas to get you started:

- Five Famous Scientists Who Struggled With Mathematics: https://interestingengineering.com/lists/5-famous-scientists-who-struggled-with-mathematics
- NASA: Women in Science: https://chandra.si.edu/women/index.html
- BookAuthority's List of the 20 Best Mathematician Biographies of All Time: https://bookauthority.org/books/best-mathematician-biography-books

**Wait — What's Math Got to Do With It?**

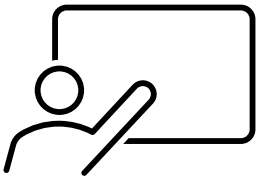
Have students guess the meaning of idioms that use mathematical terms or concepts. Teaching about these idioms can also help students who are English learners.

*Back to square one — Catch 40 winks — Comparing apples to oranges — It's part of the equation — Put two and two together — That's a plus — That doesn't add up — They're a dime a dozen — Zero in on it*



You can find more idioms, including illustrated examples and videos, in The Free Dictionary's Idioms dictionary: https://idioms.thefreedictionary.com/.

**What Number Am I?**



Select a student to be the first player. The student stands in front of the class with their back to the board. You write a number on the board so that the other students can see the number, but the player can't. Students raise their hands if they want to give the player a clue (like "You're the answer to 7 x 8") to help the player guess the number. They must wait until the player calls on them to give their clue. When the player guesses the number that's on the board, the player selects the next player to come to the board. This game is a fun way for students to learn math facts.

## Itching to Know More or to Try a New Idea?

Here are some possible next steps:

- Talk to the math teachers at school about what students are learning in school and what math standards they're meeting and not meeting.
- Find out what program staff, students, and families think and feel about math. Maybe you can do an activity where you share the **Math Anxiety Self-Assessment and Autobiography** tool.
- Assess what program staff, homework helpers, and tutors know (and need to know) about math anxiety and the Math MUSTs.

For more about the math MUSTs, see the 21st CCLC NTAC Math Toolkit for these tools:

- **Math Anxiety and Four MUSTs for Addressing It**
- **Math Messages That Build Confidence**
- **Math Understanding: Helping Students Think Conceptually**
- **Math Skills for Students to Learn and Practice**

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# Math Understanding: Helping Students Think Conceptually

**What to do:** Read this guide to learn about ways to build students' conceptual understanding of math. Consider ways to use your current math knowledge and life experiences to help them grasp some of math's big ideas, like estimation and measurement. Ask your students' school-day math teachers what concepts students are learning so that you can reinforce those ideas.

**Why it matters:** It's important for students to know how to solve math problems. That's called procedural knowledge. But it also helps if they understand *why* those procedures work. That's called conceptual understanding, and it can increase their math understanding and confidence.

## The Math MUSTs

MUST is an acronym for four tools you can use to build students' confidence in math and nurture a can-do attitude:

- **M** is for the **messages** students get about math and their ability to learn it.
- **U** is for **understanding** math concepts and how thoughts and emotions affect learning.
- **S** is for **skills** that help you learn and use math — and manage anxiety, if it's an issue.
- **T** is for **thrills** because students need positive experiences to help them discover the magic and satisfaction of math in a way that's meaningful to them.

## Understanding Math Concepts

Students need these three kinds of knowledge to learn math and to apply what they learn:

**Procedural fluency:** Knowing about math formulas and how to use them to solve a math problem.

**Conceptual understanding:** This helps students to go beyond memorizing math procedures to understand why and how those procedures work. Once you have conceptual understanding, math starts to make sense, and you can apply what you know about math to different problems and situations.

**Problem solving:** This is the ability to apply procedural fluency and conceptual understanding in flexible ways to solve problems.

## Why Conceptual Understanding Is So Important

Math today puts more emphasis on conceptual understanding than it did in the past. Here are three reasons why conceptual understanding is so important:

- **Reason #1:** It gives you the **insight to apply what you know** about math procedures (like the procedure for dividing fractions) to new problems and situations.
- **Reason #2:** It helps you **understand why a math procedure works**, and math makes sense. This can boost confidence and decrease anxiety.

- **Reason #3:** It's part of **number sense** (the ability to understand, connect, and relate numbers) so you can find ways to solve the problem even if you can't recall the procedure for dividing fractions.

### Example: Clearing the Mental Fog to Solve a Math Problem

**Problem:** Divide a dozen eggs evenly into three baskets and tell how many eggs are in each basket.

**Procedural fluency:** Translate the word problem into a math equation where x shows the unknown value: A dozen means 12, so the equation for this word problem is
12 ÷ 3 = x

**Conceptual understanding:** Explain the idea behind the word problem or math equation: You're really saying, "How many 3's are there in 12?"

**Problem solving:** Use knowledge of math procedures and concepts to solve the problem and justify your answer: "Put four eggs in each basket because 12 ÷ 3 = 4."

## Examples of Important Math Concepts Used in Everyday Life

You likely already know and use some big math concepts in your everyday life. You can use that knowledge to enrich your current program activities while helping students understand big ideas that are part of math at every grade level. Here are some examples:

**Equivalence**

- **Definition:** There are infinite ways to represent any number, measure, numerical or algebraic expression, or equation.
- **In a math activity:** All the following numbers and expressions are equivalent to the number two: 2, 2.0, 2/1, square root of 4, 1/6 of a dozen, 4 ÷ 2, 100 ÷ 50. These are just a few examples. I bet you can think of more! Try this with other numbers too, especially 10 and 100: *How many ways can you write an expression that equals 10? How many number combinations can you come up with that equal 100?* **Also:** Help students understand the "equals" sign is a way to show that what's on each side of the "=" are equivalent. Many students think the sign means "put the answer on the right side of the sign." This can cause confusion as they take more advanced math classes. Give them experience filling in the blank or box or question mark on the *left* side of the equals sign, like this: ? + 3 = 17. Or, use a balance scale with cubes to give students a physical example of equivalence.
- **In daily life:** At the grocery store, if you pay in cash and they give you 50 cents change, you might get two quarters, or a quarter + two dimes + a nickel, or some other combination of coins equivalent to 50 cents.

**Comparison**

- **Definition:** You can examine the differences between numbers, quantities, or values and compare them to decide if one is greater than, smaller than, or equal to another.

- **In a math activity:** Which number is larger, 10 or 100? Which cup holds more liquid, the pint cup or the quart cup? How does a fluid ounce compare to a dry ounce? A fluid ounce refers to volume (how much space the fluid takes up), while dry ounces refer to weight (how much something weighs).
- **In daily life:** Which shoes are longer from heel to toe, U.S. men's size 6 or U.S. women's size 10? How do "medium" and "large" drinks compare at a single restaurant? At different restaurants?

**Estimation**

- **Definition:** You can replace numbers in an equation with other numbers that are close but easier to compute mentally.
- **In a math activity:** For 250 + 298, since 298 is almost 300, add 250 + 300 to get an estimate of 550. For 19 + 23 + 21 + 24 + 18, since all the numbers "cluster" around 20, multiply 5 x 20 to get an estimate of 100.
- **In daily life:** Sometimes an estimate is all you need to solve a problem (*About how many hot dogs should we order for the picnic?*), and sometimes an estimate can help you make sure your answer to a problem makes sense (*Is my answer close to what I estimated?*).

**Measurement**

- **Definition:** Some things in the physical world can be measured and quantified. There are measurement systems for length, weight, time, substance, temperature, luminosity (intensity of light), and electric current.
- **In a math activity:** Experiment with a variety of instruments to measure length, distance, mass, time, and temperature. For example: A football field is 100 yards long. The area of a room is given in square feet. The volume of a box, tube, or other three-dimensional object can be measured in cubic feet, or sometimes in liquid measures like liters or quarts. Time can be measured in seconds, minutes, hours, days, years, centuries, and so on. Temperature is measured in degrees, whether on the Celsius or Fahrenheit scale. Most of the world uses the metric system, not the U.S. customary system of weights and measures. Various professions have established measures to meet their needs — for example, carats to measure jewels, Kilowatts to measure energy, and the Richter scale to measure the magnitude of an earthquake.
- **In daily life:** When cooking or baking, it's important to know the difference between dry measures and liquid measures. If you're buying a house, the size (area) is usually given in square feet. The windchill index takes air temperature and wind speed into consideration. If your airline ticket indicates a 6 a.m. Eastern Time departure from Washington, DC, and a 10 a.m. Pacific Time arrival in Los Angeles, CA, the actual flight time is 7 hours (not 4 hours) because you're traveling across time zones. Construction crews need to know about sandpaper weights, standard drill bit sizes, lumber sizes, wood screw sizing, and more. Mechanics need to know about standard tire measurements, wrench and socket sizes, revolutions per minute (RPM), and more.

**Patterns**

- **Definition:** Relationships between numbers or objects that repeat in predictable ways, according to a certain rule.

- **In a math activity:** Any number multiplied by 2 is twice as large as the original number, and any number multiplied by ½ gets smaller. In the following number sequence, all the numbers are odd: 1, 3, 5, 7, 9, 11, 13, 15. In this sequence, the numbers are sequential and in ascending order: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Noticing patterns can help you make generalizations about numbers, properties, shapes, and so forth.
- **In daily life:** Pattern recognition is part of every aspect of your day, from matching your socks in the morning to searching the night sky for star patterns known as constellations. Patterns are evident in other ways too: When you learn to read, you recognize letter combinations as words, and word combinations as sentences. Scientists classify plants and animals based on certain common characteristics. Economists predict the impact of economic trends by looking for patterns in data. Artists create patterns with color, line, texture, and shape.

**Variables**

- **Definition:** A variable is a symbol or letter (like $x$ or $y$) that represents a value you don't know yet. (Sometimes it helps to remind students that it's no different than the ___ in the number sentences they did when they were younger.) A letter can also represent a *constant* (something that doesn't change).
- **In a math activity:** In the equation $3 + 4 = x$, you need to add 3 + 4 to determine the value of $x$. In this equation, the value of the letter $x$ is 7. But $x$ doesn't always mean 7. The letter $x$ doesn't have a fixed value, so in a different equation (like $4 + 4 = x$), the value of $x$ is 8.
- **In daily life:** If someone asks, "How many days are in 10 weeks?" you already know there are 7 days in 1 week, so you could write this problem as an equation and use an $x$ to represent the unknown value, like this: $7 \times 10 = x$.

To learn more about the math MUSTs, see these tools in the 21st CCLC NTAC Math Toolkit:

- **Math Anxiety and Four MUSTs for Addressing It**
- **Math Messages That Build Confidence**
- **Math Skills for Students to Learn and Practice**
- **Math Thrills: Putting Fun Into the Equation**

*To not know math is a severe limitation to knowing the world.*

— Richard P. Feynman

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# Nurture a Growth Mindset

**What to do:** Review these ways to nurture a growth mindset and use them to build a can-do attitude for yourself, staff members, and students.

**Why it matters:** People with a growth mindset believe they can grow their abilities through effort and persistence. Fostering a growth mindset in your program supports learning and nurtures hope and confidence. Making this mindset part of your program culture — and intentionally designing activities that build on what students already know — encourages students to tackle new tasks and persist rather than giving up when the work feels too hard.

## Be a facilitator of student learning rather than a sage on the stage.

You can do this by using guiding questions rather than revealing the answers. You can also try using think-pair-share activities or math talks to help students take charge of the discussion.

## Use games instead of timed tests.

Games can be a low-stress way for students to self-test. Solo games allow them to compete only with themselves. Team games allow them to learn from peers. Both kinds of games can help them identify what they've learned — and what they still need to learn.

## Give specific feedback instead of generic praise.

Hearing "Great job!" feels good but it isn't specific enough to move learning forward. Try feedback like this instead: "The way you double-checked your reasoning with others in the group is a strategy that will help you succeed in the workplace."

## Use heterogeneous grouping instead of homogenous grouping.

Grouping students by similar math achievement scores can reinforce the notion that "some people are just better at math than others," even if that's not your intention. It also deprives students of opportunities to hear different approaches and perspectives on problem-solving.

## Increase deep-level questioning and reduce surface-level questions.

*What's the answer?* isn't the only question students should hear (or ask) during program activities or homework help. Prompt higher-level thinking with questions that go beyond simple recall.

## Emphasize effort and progress over outcomes.

Sometimes this is called "normalizing struggle." Help students to understand that struggling and working hard to master new concepts is a normal part of the learning process.

### Be aware of your verbal messaging.

Don't inadvertently send fixed mindset messages like, "It's OK, you did your best. Maybe algebra just isn't your thing." Instead, say something like, "You don't have to get it right the first time. The goal is to improve step by step."

### Embrace the word "yet."

Consistently using "yet" reminds students that learning is an ongoing process.

**Tip:** For information about how negative thoughts, anxiety, and a fixed mindset can affect learning, see **How Thoughts and Emotions Affect Learning** in the 21st CCLC NTAC Math Toolkit.

*The mind is like a muscle — the more you exercise it, the stronger it gets and the more it can expand.*

— Idowu Koyenikan

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# Science and Mathematics Vocabulary Builder

**What to do:** Use this tip sheet to remind you of ways you can help students become comfortable and familiar with words related to math and science. You can customize this tool to match your students' ages and needs. Consider asking their school-day math and science teachers to send you a list of vocabulary terms students need to know. Also, you can use this tool during activity observations to "catch" staff and students using the processes, questions, and vocabulary terms listed below.

**Why it matters:** All students can benefit from explicit instruction and repeated exposure to the language of mathematics and science. It's especially helpful for English learners. Often, they can pick up on conversational English on the playground, but they may have limited opportunities to learn and use academic language.

## Talking Science

**Tip:** Use science-related vocabulary and questions in all activities, not just during science activities or homework time.

| Scientific Process | Guiding Questions | Related Vocabulary | Activity | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | Y | N | Y | N | |
| **Questioning and hypothesizing** Forming questions and coming up with possible explanations or answers (hypotheses). | • Why is that?<br>• How does it work? or How does it happen?<br>• What might happen if…?<br>• What might you see? | Curious<br>Hypothesis<br>Inquire<br>Inquiry<br>Question<br>Theory<br>Wonder | **Example:** Take a walk in the woods or in a park to explore plant life. | | | | | |

| Scientific Process | Guiding Questions | Related Vocabulary | Activity | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | Y | N | Y | N | |
| **Observation**<br>Using the senses to gather information. | • What do you see, hear, smell, or taste? How does it feel when you touch it?<br>• What's going on? How do you know?<br>• Does this seem like anything else you know about? | Describe<br>Experiment<br>Observation<br>Observe<br>Senses<br><br>**Tip:** Include observation tools like microscopes and telescopes.<br><br>**Tip:** Include terms related to the metric and U.S. customary measurement systems as appropriate. | **Example:** Notice and talk about different plants and seeds. | | | | | |
| **Classification**<br>Ordering and grouping data based on observations. | • Which are the same, similar or different?<br>• How are they similar or different? | Characteristics<br>Classification<br>Classify<br>Differ<br>Different<br>Features<br>Group<br>Same<br>Similar<br>Sort | **Example:** Collect samples of different seeds and leaves. Group them by characteristics (e.g., size, shape, color, texture, where they were found). | | | | | |

| Scientific Process | Guiding Questions | Related Vocabulary | Activity | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | Y | N | Y | N | |
| **Recording and communicating** Explaining and presenting to others. | • How do you describe this? What did you do? How did that happen?<br>• What were you looking for? | Explain<br>Justify<br>Justification<br>Reason<br>Reasoning<br>Report | **Example:** Ask students to explain what they found, where, and why they grouped the seeds and leaves the way they did. | | | | | |
| **Using data (e.g., numbers and measurement) to represent and explain.** | • How many?<br>• How often? How much?<br>• How long did it take?<br>• When?<br>• How big? What shapes?<br>• How many different…? | Area<br>Calculate<br>Circumference<br>Count<br>Data<br>Diameter<br>Length<br>Quantity<br>Represent<br>Width | **Example:** How many types of seeds and leaves? How many of each? Which are the most common? | | | | | |

| Scientific Process | Guiding Questions | Related Vocabulary | Activity | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | Y | N | Y | N | |
| **Form conclusions, question further, predict, and revise hypotheses.** | • What did you find out?<br>• What do you wonder about? What else do you want to know?<br>• Is there another explanation?<br>• What do you think will happen if… | Conclude<br>Conclusion<br>Explain<br>Explanation<br>Findings<br>Predict<br>Prediction<br>Revise<br>Revision | **Example:** Which seeds grow into which plants and leaves? Who eats these seeds and leaves? Do people eat seeds and leaves? What makes a seed or leaf edible or not? For whom? | | | | | |

## Talking Mathematics

**Tip:** Use math-related vocabulary and questions in all activities, not just during math activities or homework time.

| During… | Ask and talk about… | Related Vocabulary | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|
| | | | Y | N | Y | N | |
| Snack time | • How many will you need?<br>• How many more? About how many? Estimate. Approximately how much?<br>• How many extra are there?<br>• Count these out by twos.<br>• What percentage is sugar? | Add/Addition<br>Approximate/Approximately<br>Divide<br>Estimate<br>Less than/More than<br>Minus/Take away<br>Multiply/Times<br>Percent/Percentage<br>Plus<br>Subtract/Subtraction | | | | | |
| Forming teams, playing games, music, art | • Divide into groups of two (or five, or three)<br>• Count off by twos, or odds and evens, or A's and B's<br>• How many points? How many more? What's the total?<br>• What's the rhythm? Tap it out.<br>• What proportion of which color? What's the pattern? | Divide<br>Odd, even<br>Pattern<br>Proportion<br>Represent<br>Shapes<br>Total | | | | | |
| Dismissal, schedules, events | • What time will that happen? Later or earlier? Before or after? In how long (minutes, hours, days, weeks)? | Location and position words<br>Measurement words<br>Time vocabulary | | | | | |

| During… | Ask and talk about… | Related Vocabulary | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|
| | | | Y | N | Y | N | |
| General conversation, family, pets, friends, making plans | • Is he or she bigger or smaller? Older or younger? Taller or shorter?<br>• How much will that cost? Do you have enough? Is that more or less?<br>• How many pairs do you have?<br>• Can you make a list? Can you put the items in order? How do you rank them? Same or different? Straight or curved? Equal or unequal?<br>• How else can you say that? | Add/Addition<br>Compare/Comparison<br>Distance<br>Divide/Division<br>Fraction<br>Half<br>Measure/Measurement<br>Minus<br>Order/Organize<br>Plus<br>Prioritize<br>Rank<br>Subtract/Subtraction<br>Sum/Total<br>Whole/Part/Piece | | | | | |
| Going places, finding things, cleaning up, neighborhood | • Is that closer or farther?<br>• Near or far? How far?<br>• How long does it take?<br>• Right or left?<br>• Above, below, next to, between?<br>• Where is it? How do you get there? | Directions/Compass terms<br>Distance (measurements)<br>Location and position terms<br>Maps and mapping terms<br>Relationship words | | | | | |

| During… | Ask and talk about… | Related Vocabulary | Staff use | | Student use | | Notes |
|---|---|---|---|---|---|---|---|
| | | | Y | N | Y | N | |
| Describing things, looking at things, ranking things | • What shape is that? What size? Bigger or smaller?<br>• Which are the same; different? How are they the same or different?<br>• Is that two-dimensional or three-dimensional? | Angle<br>Circle<br>Corner<br>Cube<br>Curved/Straight<br>Equal/Unequal<br>Ordinal/Cardinal<br>Point<br>Pyramid<br>Rectangle<br>Round<br>Square<br>Triangle<br>**Tip:** Include measurement tools like rulers, protractors, and T-squares. | | | | | |

*Mathematics is the door and key to the sciences.* — Roger Bacon

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# Simple Ways to Add Math to Program Activities

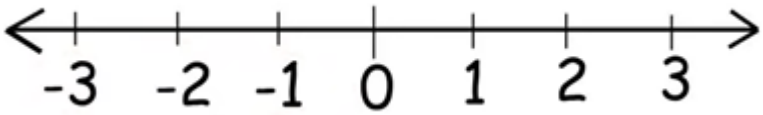
**What to do:** Review these examples to see how to use what you already know to create math moments "on the fly." Stay alert for ways to bring interesting, relevant, and amazing math experiences into what's happening in your program *right now.* Providing activities that engage students and increase math understanding and confidence may not require elaborate planning.

**Why it matters:** When you embed math into routine activities, students see math as a useful, everyday tool rather than an abstract concept. These strategies can help staff members make math an integral, enjoyable part of your program and can encourage students to embrace math concepts as a natural part of their daily experiences.

## Math Moment #1

**Math Concept: Number Lines.** Students learn and apply this concept to different situations in math classes (and everyday life), beginning as early as third grade.

- A "real number" is any number that can be plotted on a number line. It can be a whole number or a fraction, and either positive or negative (or zero). Every real number can be associated with its own point on the number line. Here's what a number line looks like:




- **What you already know:** You use number lines every day, but you might not call them that. Examples are measuring tools like rulers, tape measures, some bathroom scales, thermometers, barometers, and measuring cups. Number lines don't have to be horizontal. For example, the number line on a measuring cup is vertical — and the measurement marks show only the positive numbers, not the negative numbers. The bottom of the cup is the "zero" on this number line.
- **What you can do:** Explain the concept of "number lines" the next time you use a measuring device during an activity, like:
  - A measuring cup when you're cooking
  - A ruler during an art project
  - A thermometer to see if it's warm enough to sprout seeds in your classroom window. **Note:** The negative numbers are visible on a thermometer (to indicate "below zero") but not on a measuring cup.
- **Make it relevant:** If a student says, "Our family's going on a road trip," here's some interesting information you can share:
  - Watch for the green mile markers the next time you travel on an interstate. They show the number of miles from where the interstate route enters the State you're traveling in.

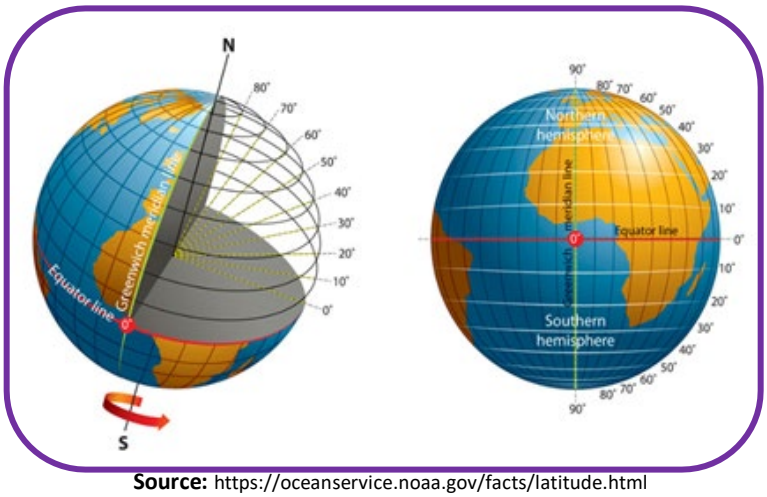
- The counting always starts at the State line in the south (for north-south routes like I-95) and in the west (for east-west routes like I-90). So the mile marker numbers always get larger as you travel east or north.
- In most States, each interstate exit is numbered according to the nearest mile marker.
- The interstates that run east and west are assigned even numbers, and most end in zero, from I-10 in the south to I-90 in the north. The interstates that run north to south have odd numbers, and most end in 5, from I-5 in the west to I-95 in the east.

## Math Moment #2

**Math Concept: Orientation and Location.** Objects in space can be oriented in an infinite number of ways, and an object's location in space can be described quantitatively (using numbers).

- **What you already know:** You use the concept of orientation and location every time you use a GPS map or give directions to help someone get from one place to another. For example, you might say, "Walk 2 blocks north on Elm Street, then turn left and walk 1 block west on Second Avenue." Maps have a "compass" symbol to help with orientation. The "crosshairs" of the compass work like two intersecting number lines, one going east to west (left to right) and the other going north to south (top to bottom).
- **Make it relevant:** The next time students mention someplace they'd like to go, help them find the location on a map. Point out the compass icon and discuss how it works. Talk about directions (east-west and north-south). Wherever you are, see if you can figure out which direction is north. Use a real compass, if you have one, or the one on your smartphone, or use the sun's location and time of day to estimate where north is. Explain that if you're facing north and have a map in front of you with north on top, the west will always be to your left, the east to your right, and the south directly behind you.
- **Cool fact to share:** If your students have smartphones or tablets, they can download a compass app, but they might not know how to use it or how to read the coordinates displayed for their location. They don't have to do any math to find their coordinates because the Global Positioning System (GPS) uses satellites and computers to do the calculations and provide the exact coordinates through the app on their smartphone or tablet.

- **Explanation of how GPS works:** You can pinpoint any location on Earth by finding its latitude and longitude. That's an imaginary grid of lines that run east to west and north to south.




**Source:** https://oceanservice.noaa.gov/facts/latitude.html

The horizontal lines running east and west are lines of latitude, called parallels. The most recognizable one is the equator, which represents 0° latitude. The vertical lines running north and south from pole to pole are lines of longitude, called meridians. The most recognizable is the prime meridian, which represents 0° longitude and runs through Greenwich in London, England.

These lines are further divided into degrees (°), minutes (′) and seconds (″). There are 60 minutes in a degree and 60 seconds in a minute (similar to measuring time). Each degree of latitude corresponds with 60 nautical miles, or 111.1 kilometers, on the Earth's surface.

When giving a coordinate, latitude (north or south) always precedes longitude (east or west). For the Sydney Opera House in Australia, the latitude and longitude are given as 33° 51′ 30″ S, 151° 12′ 53″ E — meaning it lies 33 degrees, 51 minutes, and 30 seconds south of the equator and 151 degrees, 12 minutes, and 53 seconds east of Greenwich.

You and your students might enjoy this 2.5-minute video from the Australian National Maritime Museum, which provides a helpful explanation: https://www.youtube.com/watch?v=-8gg98ws2Eo.

## Additional Math Moments for Younger Students

- **Game-Based Learning:** Staff members can design or use games that require counting, sorting, or pattern recognition. Games with scoring systems encourage basic arithmetic operations such as addition or subtraction. Students use math without being aware of it.
- **Manipulatives and Hands-On Activities:** Using objects like counters, blocks, beads, or even paper clips can provide a concrete visual example of mathematical ideas to help students gain understanding. Manipulatives can be used to teach counting, addition, subtraction, and even early multiplication, division, and fraction ideas.
- **Storytelling With Math:** Creating stories around numbers and mathematical operations can give meaning and substance to abstract concepts. It also acquaints students with word problems and helps them to solve mathematical problems in a different manner.
- **Integrating Math and Music:** Students can learn mathematical concepts directly through the words of a song, as would be the case with a counting song. Clapping to a beat or following the rhythm of a song is more indirect, but can also teach counting, along with patterns and sequencing.

- **Integrating Math Into Daily Routines:** There are many opportunities for mathematical learning during daily routines.
    - Ordinal numbers can be taught when students line up or are dismissed in a specific order.
    - More than, less than, and equal to concepts can be taught just by looking at various groups of students working on different things at a given time.
    - Counting skills are taught as students pass out papers, pencils, or other supplies.
    - Students learn division as they divide snacks equally among the group.
    - Understanding 1:1 correlation occurs as students set a table for snack time, matching the number of plates and cups to the number of chairs.

## People and Resources to Help With Math

Here are some ideas about people and resources in your community that may help you provide interesting, relevant, and amazing math activities:

### Not Sure Where to Start?

To prevent being overwhelmed, use these criteria to help you identify and prioritize which people and resources to engage:

- Relevant to program goals
- Meets student needs
- Proven to get results
- Easy to use
- Free or within budget

- **Bank official:** May be willing to provide financial literacy activities.
- **Bus driver**: Can share with students how fast they are traveling, and students can calculate how far they'll go in a given amount of time.
- **Coach:** Can share how geometry can be used to build skills when playing basketball. For example, to make a basket, gauge the angle and speed of your shot to create the perfect arc.
- **District math specialist**: Can provide grade-level guidance on student learning and can possibly help recruit math teachers.
- **Family members:** Can provide valuable math support at home, especially if you train them.
- **Librarian:** Can help you find math-related books students will enjoy and may loan resources like graphing calculators and measuring devices. Some libraries may offer financial literacy workshops for teens and families, too.
- **Math hobbyist**: Your students may be amazed to hear directly from someone who does math "just for the fun of it."
- **Math teacher:** Can tell you what students are learning in school and areas where they need help.
- **Office support staff:** Show students how they collect and analyze data to track attendance. (But don't share personally identifiable information, like student names.)
- **School counselor:** Share simple techniques to manage stress and focus attention. They can also talk about careers that use math.
- **Science museum director:** May offer enrichment activities.
- **Special education teacher or advocate:** Can share teaching strategies and provide insights into how dyslexia, dyscalculia, attention-deficit/hyperactivity disorder, and various

learning differences and disabilities may affect how students learn and process information.

- **Statistician from a State agency or university:** May be able to share interesting insights about statistics to grab students' interest.
- **Students:** Can tell you about their interest areas, serve as "math buddies" for immigrant students or other students who could use some friendly support.

## Free Online Resources (Don't Reinvent the Wheel)

Here are just a few examples of online resources you can use to create interesting math activities or provide homework help:

- Global Math Project is a worldwide movement of teachers committed to igniting and sustaining a love of mathematics in their students. There's something for every grade level. Check out the Exploding Dots videos and interactions.
- Khan Academy offers math videos/tutorials that walk you through each step. Also check out the searchable Khan Academy Math Playlist on YouTube.
- NCTM's Illuminations provides lessons, games, brain teasers, and simulators.
- Numberphile has interesting videos about math and numbers.
- PHet offers math simulations.
- Statistics in Schools helps you connect real-world Census Bureau data to student interests at every grade level.
- youcubed has many resources for math anxiety as well as math videos, activities, lesson plans, individual and group tasks, research articles, and resources to help teachers, parents, and students experience math as fun and engaging. Its Fluency Without Fear page includes activities to help children learn math facts and develop number sense.
- visualpatterns.org is a website that shows the beginning of a pattern — several groupings of puppies, for example — and asks students to figure out an equation to fit the pattern.

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# Strategies to Help Every Student Learn and Enjoy Math

**What to do:** Carefully consider the strengths and challenges of the students who participate in your program. Then use this tool to discover ways to target their needs more specifically.

**Why it matters:** Each of us learns a bit differently, so traditional methods of presenting material may not work for every student. Some may have a learning disability while others are still acquiring the necessary English vocabulary. Being aware of these differences and knowing strategies to address them will help students succeed.

You can help all children learn and enjoy math by using what educators call "universal design for learning." For example, the National Council of Teachers of Mathematics identified four evidence-based strategies that can help students who are having difficulties in math, but these strategies can work with all students: (1) structured, peer-assisted learning activities, (2) visual representations, (3) modifying instruction based on formative assessment of students, and (4) providing opportunities for students to think aloud as they work. Here are some ideas that can work with various student groups, along with suggestions for putting them into practice.

## Supporting English Learners

Students who aren't native English speakers:

- May need help with math words (e.g., *figure* and *volume* have multiple meanings).
- May need help with English in general to explain how they solved a math problem.
- Need opportunities to discuss strategies, approaches, and assumptions about math.
- Need visuals to support understanding the context of a problem and instructions.
- May need to build background knowledge to understand the context of a problem.

## Recognizing Special Needs of Immigrants Who Learned Math in Another Country

Many people say, "Math is a universal language." But that's not really true. Students from another country:

- May or may not be English learners.
- May use different mathematical symbols (e.g., decimal comma instead of a period).
- May write numerals differently (e.g., draw a horizontal line through the numeral 7).
- May know the metric system but not the U.S. systems of weights and measurements.
- May recognize the numbers in a word problem, but not grasp the context of the situation presented, and thus be unable to solve the problem.

## Appealing to Various Play Personalities

Make math learning spontaneous and playful. Math treasure hunts, games, riddles, jokes, stories, and creations are ways to bring a sense of play to activities involving math. Creating a fun, relaxed environment can be especially important for students with math anxiety.

Keep in mind that "play" can mean different things to different people. Dr. Stuart Brown says there are eight different "play personalities." You can learn more by visiting the National Institute for Play website. Here are the eight play personalities and examples of activities each type might enjoy:

**Play Personalities**

| | |
|---|---|
| Collector | Explorer |
| Competitor | Joker |
| Creator/Artist | Kinesthete |
| Director | Storyteller |

*"Play" can mean different things to different people.*

1. **Collector:** Collect measuring devices or collect statistics about a sports team, the weather, or another interest area, or do a math treasure hunt.
2. **Competitor:** Do math puzzles or play math games (alone or with others).
3. **Creator/artist:** Create abstract art using geometric shapes.
4. **Director:** Plan a trip, including the number of miles per day, number of stops, and the budget.
5. **Explorer:** Visit a new science museum or try out different virtual math tools.
6. **Joker**: Create or share math jokes. *(Why did the student do multiplication problems on the floor? Because the teacher told him not to use tables.)*
7. **Kinesthete (someone who likes to move):** Roll two dice and add the numbers to decide how many jumping jacks to do.
8. **Storyteller**: Tell a story, read a book, or watch a video that involves math or mathematicians.

## Supporting Students With Learning Disabilities

**Learning disabilities (in general):** Use specific strategies suggested in the child's Individualized Education Program or IEP (if one exists) and by the child's school-day teacher and family; focus on the child's strengths and interests; engage multiple senses, not just sight.

**ADHD and autism spectrum disorders:** Pick a quiet spot for homework or study time; alternate short "learning bursts" and movement; establish a routine; make it fun; point to specific words, numbers, or objects as you talk about them during a math activity; celebrate "little victories."

**Speech and language difficulties:** Talk about new words before you use them during an activity. Provide safe opportunities for students to learn and practice reading and pronouncing math terms.

**Dyslexia:** This is a learning difference that mainly involves difficulty with reading. Dyslexia can affect writing and spelling, too. It can also impact math. Students with dyslexia may struggle with reading and try to avoid reading aloud, have trouble sounding out words and memorizing sight words, confuse the order of letters, have poor spelling and grammar, and have trouble remembering phone numbers or items in a short list. Here are some strategies to use:

- Use simplified oral and written instructions, with pictures of directions or schedules.
- Provide response options that involve little or no writing (e.g., thumbs up or down).
- Engage multiple senses.

**Dyscalculia:** This is a learning difference that causes trouble with making sense of numbers and math concepts. Here are some signs of dyscalculia:

- Has trouble learning to count and doing basic computation.
- Doesn't understand math concepts like greater than, less than, and equal to.

- Struggles to make sense of graphs and charts.
- Doesn't remember phone numbers or items in a short list.
- Tries to avoid games and activities that involve numbers.
- Struggles to make change or figure out a tip.

Here are some strategies to help students with dyscalculia:

- Use graph paper to line up numbers and problems.
- Highlight key words and numbers in word problems.
- Break homework down into small chunks with breaks in between.
- When possible, provide a calculator and a table of simple math facts and formulas needed to do the work.
- Use multisensory, hands-on activities; tutoring; and direct instruction in problem-solving strategies and ways to learn and retrieve math facts.

## Using Technology Wisely

- Use technology to help students **practice** math in fun ways. See the *Teacher Digital Learning Guide* from the Office of Educational Technology at the U.S. Department of Education. The section titled Personalize Learning for Students suggests evidence-based technology tools and strategies.
- Help students make **real-life connections** to math by having them research a product or service they want (like online movie and music platforms) and create a short video discussing which are the best deals, and why.
- Show students where and how to find short online **videos that explain various math** concepts. Invite each student to find a video they think is especially helpful in explaining a math concept they're learning about in school.
- Let students use a **calculator** instead of pulling them out of stimulating math activities and using "drill-and-kill" forms of remediation that may deprive students of experiencing math success and developing conceptual understandings.

## Working With the School Day

- Check with school-day teachers to see if they have math software they'd like students to use but don't have time in class to offer, or students don't have available at home. Your 21st CCLC program can provide opportunities and support.
- Make academic and interdisciplinary connections by having students explore interesting or practical connections between math and other topics like history, music, the arts, science, and various career fields (including the trades).
- Intentionally design activities to provide support in math areas students need to master.

## Motivating and Supporting Students Who've "Given Up" on Math

These students may benefit from:

- Messaging
- Coaching
- Encouragement
- Direct instruction to build knowledge, understanding, strategies, and skills
- Stress-free experiences where they can have success with math

Try using these "hooks" to snag student interest in math:

- **Life skills:** Teach and practice life skills related to math (like understanding credit cards, savings, and compound interest), self-regulation (like breaking large tasks into "doable" chunks and taking breaks), and anxiety management (like self-talk, exercise, and breathing techniques). Emphasize that these are skills they can use throughout their lives.
- **Patterns:** Look for connections and patterns. Point them out, and encourage students to do the same. Encourage them to use all five senses: *What connections or patterns do you see, hear, smell, taste, or feel?*
- **I-R-A experiences:** Support school-day learning by planning interesting, relevant, and amazing (I-R-A) enrichment experiences related to the math your students are learning in school.
- **Quick wins:** Use downtime to bring math to life with math-related games, riddles, questions, stories, demonstrations, and fun facts. Keep them light and fun — and connect them to the needs and goals you've identified for your students.
- **The thrill of success:** When you provide activities that hit a student's "sweet spot," meaning the activity is challenging enough to be intriguing but not so hard that it's frustrating, you have your end goal in sight! When you do that, it starts a chain reaction:
    - When students put forth effort, stretch, and succeed, they experience the thrill of success.
    - That feeling of personal victory releases endorphins, whether the success involves solving a math problem or calming their own anxiety.
    - The thrill of one success, even a small one, reinforces the idea that success is within reach and worth the effort. It's a powerful motivator. That's why it's called "productive struggle." That's also why they say, "Nothing breeds success like success."

## Engaging Families in Math Awareness and Activities

Research shows that family members' frustration while providing homework help can feed math negativity and reduce a child's motivation and achievement. Here are some ideas for supporting families:

- Host events where families can learn math terms and concepts and ideas for providing or getting appropriate homework help for their child.
- Share tips in your program newsletter or in take-home sheets to help families learn about math concepts, teaching methods, and ways to support their child. Make these materials available in families' home language if possible.
- Create or share short instructional videos for families on your program's social media page. Or you could create a downloadable set of cards tips families can use to help their child learn or practice a basic math skill, messages they can use to build confidence in their child's ability to learn new things with effort, everyday ways to build "math muscles" at home, and links to websites that offer a daily math problem or other useful tools at no cost.
- Share positive personal messages about their child, either in person or (if the family gives permission) by phone or text. For example, you might say, "Chris said your family used to play 'I Spy' with numbers on road trips, and it made him aware of numbers in everyday life. Great idea! We never know when little things can make a big difference for kids."

## Celebrating Progress, Achievements, and Successes

When it comes to learning math and overcoming math anxiety, those little victories along the way add up. Some students are motivated by internal rewards like more confidence, while others need external rewards to spur them on. Be sure to recognize and celebrate successes, large and small.

**Along the way:**

- As students make progress, provide small incentives such as pencils or stickers for younger students, or certificates of achievement for older students.
- Highlight student projects, growth, and achievements in your newsletter or on social media.
- Recognize students' effort and persistence in front of their peers and family members.
- Build in time for students to "chill out" after they've been working hard.

**At the end of a project, semester, or school year:**

- Have an awards ceremony to honor all students and staff. Students can share how staff have helped them as an added bonus.
- Provide awards for different kinds of student progress and achievements.
- Make a presentation to the school board.
- Have a family event like a picnic or barbeque where students can share the skills and strategies they've learned.

*Differentiation is simply a teacher attending to the learning needs of a particular student or small groups of students, rather than teaching a class as though all individuals in it were basically alike.*

*— Carol Ann Tomlinson*

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# Ways to Help Students in Math if You're Not a Math Teacher

**What to do:** Work with school-day staff to familiarize yourself with current approaches for teaching math as well as strategies for helping students with their math assignments. You want to make sure you understand terminology and concepts. Then, use these strategies and tips to support students.

**Why it matters:** Students pick up on our verbal and nonverbal clues more readily than we think. We don't want to pass along any uncertainty or anxiety to them. Having strategies and resources ready to meet math challenges is a significant first step to success.

### Methods to Reduce Math Anxiety

Here are some ideas you can use to confront math myths, fears, and stereotypes to help you and your students manage math anxiety and build confidence in their ability to learn math. Anyone can use these strategies. It just takes awareness and time to put them into action.

### Do You Have Math Anxiety? Find Out!

If you have math fears, you'll want to make sure you don't pass them on to your students. Use the **Math Anxiety Self-Assessment and Autobiography** to gauge your level of math anxiety.

### But I'm Not a Math Teacher!

You don't have to be a math whiz to help students! If you work or volunteer in an out-of-school time program, here are some things you can do:

- Be prepared for the math concepts you'll work on with students. Your confidence (or anxiety) will carry over to them.
- Work with school-day teachers to provide targeted homework help and reinforce key concepts through games and other high-interest activities.
- Learn about the Math MUSTs (an acronym for messages, understandings, skills, and thrills) and look for ways to use these strategies in your program.
- Use specific ideas and resources that can help, such as the Khan Academy's free online courses, lessons, and practice tests and strategies suggested by understood.org.
- Draw on your life experiences in using math for hobbies, personal goals, and everyday tasks like comparison shopping and cooking. You know more than you think you do!
- Help students see ways they already know and use math every day, without realizing it.
- Help students make connections between concepts such as the link between addition and multiplication or the relationship between fractions, decimals, percents, and ratios.
- Look for patterns in math — they may be in shapes, colors, and numbers. Seeing the patterns can sometimes make solving problems much easier.
- Provide fun activities to help students and families experience math success and connect math to their goals and interests. Positive experiences with math can help rewire students' brains and short-circuit math anxiety.

- Encourage students to explain how they arrived at a correct response. The other students are likely to learn something, and you might, too!
- Enlist the enthusiasm and know-how of community volunteers and partners to provide support for math.
- Give yourself a pat on the back for seeking additional guidance. Two pats if you discuss what you learn about math anxiety with a colleague!

## 10 Common Sense Things Your Math Teacher Probably Forgot to Tell You

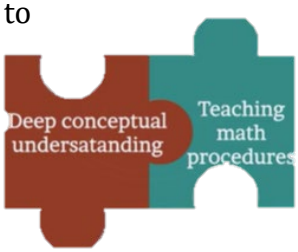
Share one of these ideas with students when the time is right and see how they react.

- Math is supposed to make sense.
- There's often more than one way to solve a problem.
- Creative people use math.
- Math is about finding patterns and making connections.
- Math symbols are a shorthand way to communicate ideas (e.g., fire + hand = burn).
- Using manipulatives, pictures, and drawings helps you visualize quantities and relationships.
- People use math ideas in a variety of ways at school, at work, and in everyday life.
- Mistakes are learning opportunities.
- Discussing and collaborating with others on math isn't "cheating." It's a way to learn, and it prepares you for the workplace, where teamwork is expected.
- In real life, there's no "answer key" with the correct answer to every question.

## Three Things to Know About Math Education Today

Maybe it's been years since you took algebra and you've heard that math instruction has changed, but you're not sure what's different. You don't need a crash course in math education to help students with math anxiety, but your uncertainty might make you anxious or hesitant to talk with teachers and others about math. Don't worry. Here are the main things to know:

1. **There's more focus these days on teaching math concepts ("how math works") along with formulas ("how to work math problems").** Memorizing formulas isn't a bad thing, of course! But researchers and educators have found that students are better able to tackle new problems — whether in daily life or in math class — if they have a conceptual understanding of math rather than relying mostly on memorized formulas without understanding why and how those formulas work. Math teachers try to help students go beyond learning math *procedures* like division to also understanding the *concept* of division. They encourage students to talk and write about their problem-solving approach as a way to clarify their thinking, learn from mistakes, consider various problem-solving methods, and build conceptual understanding.




2. **Each State decides what math standards to use, and these standards guide teaching and assessments.** State math standards tell teachers what students should understand and be able to do at each grade level. Schools use the State standards when they decide

what to teach, and State math assessments are aligned with the standards. You don't have to memorize the standards to help students. But it does help to be familiar with the standards so you know what school-day math teachers mean if they say a student is "not meeting standards."

3. **Math (and math education) has its own vocabulary.** Suppose a math teacher emails to say, "if your program can help with students' productive disposition, it would help." Would you know what the teacher means? You could always ask or look online. Or you could look in the Math Glossary (available in the Math Toolkit on the 21st CCLC NTAC website), which defines *productive disposition* as "the inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy." So, the math teacher hopes you can find ways to make math seem interesting, relevant, and doable. Use the glossary as a quick reference. Then follow up with the math teacher to make sure you understand the request and get any other information and resources you may need.

*Do not worry about your difficulties in mathematics.*
*I assure you mine are still greater.*

— Albert Einstein

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