Education Week | SPOTLIGHT

2025

Building Foundational Math Skills and Beyond

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EDITOR'S NOTE

Study after study tells us that **early math education sets the foundation for a lifetime**. Young learners gravitate towards math. How do we take advantage of this and instill in them a love for the subject? This spotlight explores **ways to strengthen math instruction, teach skills like fractions in new ways,** and **engage students to make math enjoyable.**

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OPINION

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Published May 28, 2024

Young Students Gravitate to Math. How Teachers Can Build on That Curiosity

By Alyson Klein

Zachary Champagne's 3rd and 4th graders figure out early on that this math class will be different when their teacher tells them: "I don't care about the answer."

The goal is to shift his elementary students' thinking from some numerical endgame toward the problem-solving process itself. In his more than two decades as a classroom teacher and math researcher, Champagne has found this strategy can be a balm for math anxiety, spur students' creativity, and pique their curiosity about a subject many find boring and irrelevant.

Telling students the answer doesn't matter—or throwing it out early on, then working backwards, another of Champagne's go-to strategies—"can reframe the way we think about mathematics," said Champagne, who teaches at The Discovery School, a private school in Jacksonville, Fla.

"If we're thinking about math where the solving is actually the interesting, important part, it frees kids from the stigma of 'I'm not good at this because I always get things wrong,'" said Champagne, who spent more than a decade working in Florida's Duval County public schools and served as a math researcher at Florida State University.

This problem-solving or open-ended approach, which emphasizes flexible thinking and real-world situations, is a powerful strategy for engaging the youngest learners in math. Kindergarten through 5th grade is an important time for building students' skills, confidence, and interest in math—the critical building blocks for middle- and high-school-level math and science, experts say.

Though the approach has been around for decades, districts are striving to incorporate more real-world problem-solving into math class in recent years. California, for instance, recently adopted a controversial framework that puts a heavy emphasis on the approach. And there's new urgency to get students motivated in math as federal data show students' math achievement plummeting.

The vast majority of educators—92 percent—say students are more motivated to learn math and science if teachers employ a problem-solving approach, according to a survey of 1,183 district and school leaders and teachers, conducted by the EdWeek Research Center in April. Despite the fact that this approach is highly popular among educators, many have not been trained in how to use it, the same survey found.

Does using real-world problems motivate students?

The Canadian province of Quebec has been using a problem-based approach for decades—and it helps students connect with math and understand how to use it in the real world, said Krista Muis, a professor at McGill University in Montreal, who has studied student perceptions of the teaching strategy.

"When you look at the motivational profiles of students who are just given traditional word problems, or more standard types of math problems, or math content, their motivation is really low when it comes to the value of what they're learning," Muis said. "The main question they ask is, 'why should I care? How is this relevant to me? How am I ever going to use this?'"

But when students tackle common real problems—a favorite of Muis' asks elementary schoolers to map out the trick-or-treating route that nets the most Halloween candy—they get excited.

"They see the value in it," Muis said. "And they're fun problems. They can do them in groups together collaboratively, they can do them individually."

Quebec students' higher motivation in math may explain why the province outperforms the rest of Canada—and the United States—on the Trends in International Mathematics and Science Study or TIMMS, Muis said.

In 2019, the most recent year the test was given, Quebec's 4th graders didn't perform statistically differently from their U.S. counterparts in math. But 8th graders from the province scored significantly better than their U.S. peers. One reason may be the increased motivation to learn math that Muis believes stems from exposing students to a problem-solving approach early on.

To be sure, a problem-based or open-ended approach to teaching math is often pitted against more traditional, procedural methods—think of the math worksheets full of equations without context.

But many experts and educators see value in exposing students to both strategies.

"I think, really, these things can mutually support one another. And both are necessary," said Julia Aguirre, a professor and the faculty director of teacher certification programs at the University of Washington Tacoma. "I think we can all agree that a math class that's only about worksheets would not be a very fulfilling or interesting math class."

Promote young students' natural curiosity and creativity

The approach is most effective when teachers apply it to students' existing interests.

That's especially important for elementary school students, who start school with a natural curiosity that often dissipates by the time they get to high school, said Molly Daley, a regional math coordinator for Education Service District 112, which serves about 30 districts near Vancouver, Wash.

Thinking about "math is a universal human behavior, and people of all ages engage in math for their own purposes," Daley said.

Students are using math when they play games and make crafts, she said, or even just look at the landscape.

For instance, a preschool teacher might take a picture of the classroom shoe rack and ask students questions like: How many shoes are there? What patterns do you notice? What shapes do you see?

"If we can honor the math that kids are doing beyond the classroom, then we're more likely to create a mathematical connection and really allow every person to see how math is not just useful but enjoyable," Daley said.

In Champagne's mixed age classroom of 3rd and 4th graders in Florida—which he co-teaches with another educator—students turn to math early in the day, the time when younger students tend to be most able to focus on the subject, in Champagne's view.

Champagne typically kicks off with a 10- or 15-minute math routine as a warm-up. That might be a "number talk" in which Champagne will put an equation on the board, say 29 plus 15, and then students will solve the problem in their heads.

They'll spend the next few minutes comparing strategies for finding a solution. One student might have added 30 plus 15 and subtracted one, while another might have added 9 and 5, then 30.

The exercise is aimed at promoting flexibility and the idea that there are multiple ways to solve a problem, Champagne said. It lets students know: "I don't have to revert to just one strategy. I can think about it in different ways," he said. The idea is to gives students a chance to use their creative thinking skills in math class.

Students still learn the basics, but lessons are structured so that students can see how seemingly simple problems play out in different, real-world contexts. For instance, if students are learning about dividing with remainders, they may consider how four people can share 31 balloons. In that case, each person gets seven balloons, with three left over.

But what if it were 31 dollars instead of balloons? How does that change the answer? Or what if 31 people needed to get somewhere in four cars? How could they divide up?

Problems can also get more complex—and interdisciplinary—as students advance in elementary school.

Teachers need more training in the problem-solving approach

Tackling big problems with no clear answer is another way to engage elementary school students in math.

Last school year, Aguirre worked with Janaki Nagarajan's 3rd graders outside Seattle on a project involving a real-life problem with salmon the students had raised and planned to release.

Inexplicably, the fish began dying. So Nagarajan's students used mathematical modeling to estimate how quickly they were losing salmon, answering questions like: Will we have enough salmon for each student on release day? What can we do if we don't? Students worked on the problem in groups, and then presented their answers. The class voted on the solution they thought would work best.

The project was "really engaging," said Nagarajan. She believes that students will be motivated to learn math if they "feel the skills have some purpose outside the classroom."

But she thinks that many teachers don't know how common procedures learned in math class could be applied in the real world, so they struggle to make those connections for their students.

Nagarajan began teaching in Renton, a different, Seattle-area school district this school year, largely because it provides more support for teachers to use the real-world problem-solving approach in elementary school math.

Though the approach was encouraged in her previous school, Nagarajan said her new district uses a curriculum that embraces problem-solving and provides coaches who can help her implement the strategy.

Professional development in the problem-solving approach remains uneven. About one in five educators said they "completely agree" that their districts have offered deep and sustained professional development into how to teach math and science from a problem-solving perspective, while just over 40 percent said they disagree—at least somewhat—that they've been offered that level of support.

That professional development can be particularly important for elementary school teachers who typically "aren't math specialists, right? They are generalists," said Muis of McGill University. "Often, teachers who are not comfortable with mathematics don't necessarily understand it fully themselves. And so when you bring in complexity that scares them. And then you see teachers kind of stepping back going, 'I can't really teach this, I don't really know what I'm doing.'"

And the approach requires teachers to respond to what students see or notice, which can be stressful for some, Daley said.

"We can get too hyper focused on 'this is my goal'" in a particular lesson, she said. That can look like: "We're learning about fractions, but the student made a comment about multiplication. I gotta ignore that.'"

Teachers need to learn not to be afraid if students go off script, Daley said. A problem-solving approach is about "creating more space for students' ideas and students' thinking versus just letting your own dominate."

Making that shift isn't easy. But if teachers are successful, they positively shape their students' relationship with math, potentially for years, Daley said.

"Especially with younger learners, when we're following their lead, that's how we're going to tap into their connection and their motivation to engage with math and build up their sense of themselves as a mathematician," she said. ■

Additional Resource
View this article's charts

Allison Shelley for All4Ed

A kindergarten teacher leads a small group in a math activity.

Published April 19, 2024

3 Ways to Strengthen Math Instruction

By Madeline Will

Students' math scores have plummeted, national assessments show, and educators are working hard to turn math outcomes around.

But it's a challenge, made harder by factors like math anxiety, students' feelings of deep ambivalence about how math is taught, and learning gaps that were exacerbated by the pandemic's disruption of schools.

This week, three educators offered solutions on how districts can turn around poor math scores in a conversation moderated by Peter DeWitt, an opinion blogger for Education Week.

Here are three takeaways from the discussion. For more, watch the recording on demand.

1. Intervention is key

Research shows that early math skills are a key predictor of later academic success.

"Children who know more do better, and math is cumulative—so if you don't grasp some of the earlier concepts, math gets increasingly harder," said Nancy Jordan, a professor of education at the University of Delaware.

For example, many students struggle with the concept of fractions, she said. Her research has found that by 6th grade, some students still don't really understand what a fraction is, which makes it harder for them to master more advanced concepts, like adding or subtracting fractions with unlike denominators.

At that point, though, teachers don't always have the time in class to re-teach those basic or fundamental concepts, she said, which is why targeted intervention is so important.

Still, Jordan's research revealed that in some middle schools, intervention time is not a priority: "If there's an assembly, or if there is a special event or whatever, it takes place during intervention time," she said. "Or ... the children might sit on computers, and they're not getting any really explicit instruction."

2. 'Gamify' math class

Students today need new modes of instruction that meet them where they are, said Gerilyn Williams, a math teacher at Pinelands Regional Junior High School in Little Egg Harbor Township, N.J.

"Most of them learn through things like TikTok or YouTube videos," she said. "They like to play games, they like to interact. So how can I bring those same attributes into my lesson?"

Part of her solution is gamifying instruction. Williams avoids worksheets. Instead, she provides opportunities for students to practice skills that incorporate elements of game design.

That includes digital tools, which provide students with the instant feedback they crave, she said.

But not all the games are digital. Williams' students sometimes play "trashketball," a game in which they work in teams to answer math questions. If they get the question right, they can crumble the piece of paper and throw it into a trash can from across the room.

"The kids love this," she said.

Williams also incorporates game-based vocabulary into her instruction, drawing on terms from video games.

For example, "instead of calling them quizzes and tests, I call them boss battles," she said. "It's less frightening. It reduces that math anxiety, and it makes them more engaging.

"We normalize things like failure, because when they play video games, think about what they're doing," Williams continued. "They fail—they try again and again and again and again until they achieve success."

3. Strengthen teacher expertise

To turn around math outcomes, districts need to invest in teacher professional development and curriculum support, said Chaunté Garrett, the CEO of ELLE Education, which partners with schools and districts to support student learning.

"You're not going to be able to replace the value of a well-supported and well-equipped mathematics teacher," she said. "We also want to make sure that that teacher has a math curriculum that's grounded in the standards and conceptually based."

Students will develop more critical thinking skills and better understand math concepts if teachers are able to relate instruction to real life, Garrett said—so that "kids have relationships that they can pull on, and math has some type of meaning and context to them outside of just numbers and procedures."

It's important for math curriculum to be both culturally responsive and relevant, she added. And teachers might need training on how to offer opportunities for students to analyze and solve real-world problems.

"So often, [in math problems], we want to go back to soccer and basketball and all of those things that we lived through, and it's not that [current students] don't enjoy those, but our students live social media—they literally live it," Garrett said. "Those are the things that have to live out in classrooms right now, and if we're not doing those things, we are doing a disservice." ■

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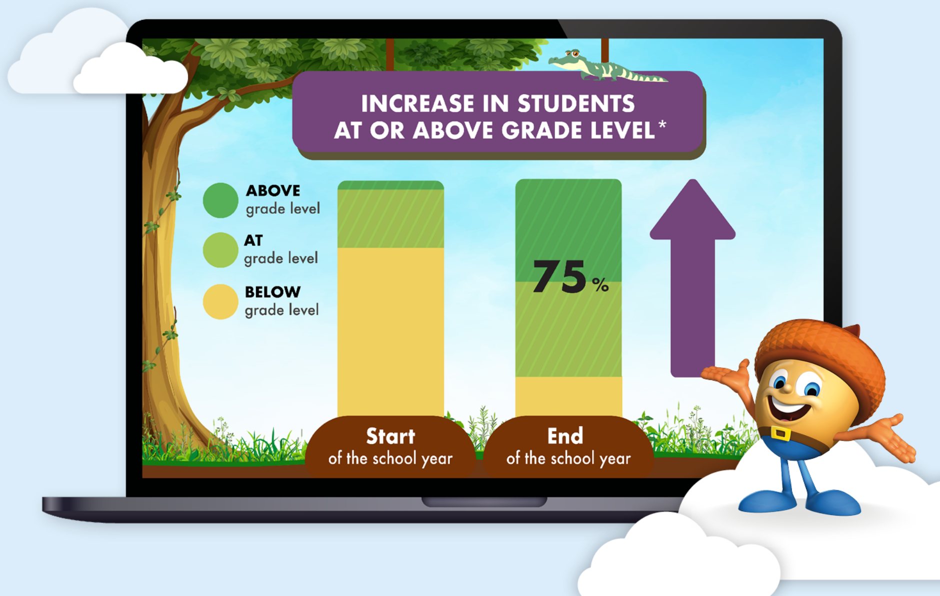

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Published February 28, 2024

What Is a Math Screener, and How Can They Help Young Students? 3 Things to Know

By Sarah Schwartz


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When elementary school students in her district struggle in math, Elizabeth Abel wants to get them support as soon as possible.

That's because addressing students' gaps in kindergarten, 1st, and 2nd grades makes it much more likely that they will be successful in upper-elementary grades, said Abel, a district elementary math coach in Hernando County schools in Brooksville, Fla.

So she was glad when Florida lawmakers passed a measure last year mandating that schools do just that—evaluate students for early difficulties, and intervene.

"That's something that we in the math community were really excited to see," said Abel. "Now people have to make a concerted effort to make sure that they are fitting those minutes in."

Florida is one of seven states that have recently passed laws requiring schools to screen students for early math difficulties—giving short assessments that evaluate whether a student is performing at grade level. While these screeners are commonplace in early reading instruction, fewer districts have similar systems set up in math to find and support students who need extra help.

But working with these students to improve their number sense—their basic understanding of quantity, magnitude, and arithmetic—can pay big dividends, said Nancy Jordan, a professor of learning sciences at the University of Delaware. These abilities lay a foundation for higher order math skills that students learn in upper elementary and middle school.

Earlier in her career when she'd just started studying math screening, Jordan recalled a principal telling her that students in the school didn't start struggling in the subject until 3rd grade. "People just thought that it wasn't important early on, or that the difficulties can't be identified early," Jordan said. "But in fact they can."

Math screeners come in multiple forms that serve distinct purposes, and they evaluate different skills at different grade levels. Experts also caution that screening should only be the first step in planning intervention. Read on for three things to know about these short tests.

1. Different screeners assess different math skills

For the most part, screening systems in math assess students several times a year—once in fall, winter, and spring, said Ben Clarke, a professor of school psychology at the University of Oregon, who studies math assessment and instruction.

The tests range in length, with the shortest taking only a few minutes, and the longest lasting up to an hour.

The National Center on Intensive Intervention, a program of the American Institutes for Research, publishes evaluations of different screening measures in math. The ratings show how well tools correctly identify students who are at risk, whether there's evidence that the tools are reliable and valid, and various usability features.

Most screeners for young children test their ability to understand quantities and manipulate numbers. But within those broad goals are a number of discrete skills.

The most commonly assessed are counting, identifying the Arabic numerals that represent numbers, being able to discriminate between larger and smaller quantities, and determining missing numbers within a set, according to a 2022 review of studies on screening measures published in the Journal of School Psychology.

Children who struggle with these tasks can make gains with interventions, said Jordan. But foundational math skills aren't always bounded in the same way that early reading skills are, she said.

In reading, once students learn how to map spoken sounds to written letters, they can move on from practicing phonics. But some math skills are more open-ended, and can't be fully mastered in that same way, said Jordan.

For example, a task such as determining the missing number in a set can get harder if the set is bigger. Some tasks become more difficult when students move from working with concrete representations—such as counters or blocks—to symbolic representations, like written numbers.

"With math, a lot of it is so conceptual," Jordan said. "There are some children that will need a lot of intensive support throughout their schooling."

2. Older kids may need different supports

As students move through the grades, screening measures evaluate more—and more complex—skills.

In 2nd through 5th grade, students still need to know basic computation, said Carrie DeNote, the past president of the Florida Council of Teachers of Mathematics. But they also need to be able to apply those skills in different capacities, such as in solving increasingly complex word problems.

There are also gateway skills that predict students' ability to succeed in higher level math, said Jordan, such as fluency with fractions.

"Given the multifaceted nature of mathematics, identifying one or two measures that represent mathematics proficiency broadly over multiple grade levels seems elusive," the authors of the 2022 Journal of School Psychology paper write. In other words, there's not one universal indicator that can flag potential problems.

And older students can still struggle with foundational concepts.

Laura Jackson, a consultant and coach who works with parents of dyscalculic children and teachers who support these students in the classroom, said that she works with many children are in late elementary or early middle school. Dyscalculia is a learning disability that affects individuals' ability with math and number-based learning.

These students don't have basic number sense, and the hands-on interventions designed to build that skill can feel infantilizing for preteens, like preschool math, she said.

"Meanwhile they're in 7th grade math, 8th grade algebra, and it's really a struggle for them," she said. For Jackson, the emotional roadblock that older students can experience reinforces the need for schools to catch and address problems early.

3. Screening students should be part of a 'coherent instructional program'

Screeners can tell teachers that students aren't performing at grade level, but they don't usually show why, said Mary Pittman, the director of mathematics for TNTP, an organization that consults with schools on teacher training and instructional strategy.

It's important for schools to break that information down further, she said, looking at sub-scores on different skills and using those to plan for intervention.

"Screening has to be a part of a coherent instructional program, where we are screening so that we can support kids in strategic ways to get to grade-level content," said Bailey Cato Czupryk, the senior vice president for research and impact at TNTP. "The purpose of knowing where they are is so that we can do something." ■

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Published November 14, 2023

This Educator Uses Coding and SEL to Make Math More Engaging

By Lauraine Langreo

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Math skills, such as data analysis and statistics, are one of the most sought-after skills for new employees, even in fields outside of STEM. But many students think that they're not a "math person" and disengage from math topics.

In addition, students' math scores hit historically low levels on national assessments during the pandemic, and educators are looking for ways to engage their students in the subject.

Lindsay Gold, an associate professor in the school of education at the University of Dayton in Ohio, and one of her undergraduate students wanted to find out if incorporating coding and social-emotional learning into math lessons would increase elementary students' interest in math.

"There are other ways to teach math that are not stress-induced and pressure-forming, because we want the students to see that math is fun," Gold said. "We don't want it to be the subject that everybody hates and dreads."

In an interview with Education Week, Gold explained how she integrated coding and SEL principles into 3rd, 4th, and 5th grade math lessons and how it affected student engagement.

This conversation has been edited for brevity and clarity.

How did you incorporate coding into elementary math lessons?

To introduce coding principles, we talked about the engineering design process. It was a basic version of the "ask, imagine, plan, create, and improve" process. Then students had to write what their idea of coding was. Some drew pictures, some wrote up sentences. A lot of the things they could think of had to do with video games and that kind of stuff. We also read technical writing to be able to think about different coding languages.

Then using Texas Instruments' TI-Nspire [a graphing calculator] and TI Innovator Rover [a robotic vehicle], we taught students to code for sound and color. First, we had students get used to what happens when you input a code [in the graphing calculator]. For instance, they would enter a value for red, green, or blue, and see what color it makes together. Then they can go back and manipulate [the values] to change the color. We did the same thing for sound. We talked about frequency and pitch. And then we got into the geometry aspect of it, coding for lines, segments, arrays. We asked them to code a line segment that was X centimeters long. And then we did the same thing with angles, rectangles, triangles, pentagons, etcetera.

Once we got through that portion, we had a track challenge for those who were comfortable. We taped off a track on the floor and they had to see if they could completely write their own program to get the rover to go through the track. We purposely put in angles and things that we just talked about into the track to see if they could do that. Everybody was successful, and they all got their driver's license to drive the TI Rover.

> **"There are other ways to teach math that are not stress-induced and pressure-forming, because we want the students to see that math is fun."**
>
> **LINDSAY GOLD**
> Associate professor
> School of education at the University of Dayton

How was social-emotional learning added to the mix?

SEL was a big part of it. We wanted to get students to work together, to be self-aware, to be aware of others, to get confidence in providing their own opinion, and to work on the ability to listen to others. We wanted the students to feel like everybody had a voice, and that doesn't always happen in the mathematics classroom. There tends to be this hierarchy where students either feel really confident and comfortable in their ability, or they feel very much like they're not a math person. We have to talk a lot about there's no such thing as a math person. It's not the secret club that you weren't invited to. [SEL] showed the students that everybody had something to offer.

What did teachers think of this activity?

In the beginning, they were really hesitant. They were very nervous about the calculator and extremely nervous about coding because they didn't have experience with that. But they saw that their elementary students could do it, and that they could use this technology to enhance instruction. I wanted to show them that there are ways to teach math and engage in math that students will remember and internalize and want to do more. When we do this again, we're going to do even more teacher professional development to make sure that they're comfortable.

How did this activity affect student engagement and performance?

They very much enjoyed the coding, and they very much enjoyed having the ability to make something work. They felt more comfortable with the concepts, in their abilities to do the math, to engage in STEAM [science, technology, engineering, art, and math] learning, they better understood the engineering design process. And while we couldn't track actual student achievement to see if there was a correlation there, we were able to see that in the spring, when the teachers talked about angles again, the students remembered what we had done in the fall. Projects like this are teaching students how to really problem-solve and think versus just memorize. ■

Published March 13, 2025

Pi Day Celebrations Add a Tasty Twist to Math Class

By Jennifer Vilcarino

On March 14, math classes across the country will celebrate Pi Day—a national holiday in honor of the mathematical constant pi, which represents the ratio of a circle's circumference to its diameter and starts with the digits 3.14.

It's a time when students can take a break from a traditional way of learning about math and get more creative using pizza, pies, and more.

"[Pi Day is] to remind kids that there are fun aspects about math," said Joseph Bolz, a math teacher at George Washington High School in Denver.

Education Week spoke with three educators about how they're celebrating Pi Day in 2025.


Debbi Smirnoff/iStock/Getty

In Colorado, a Pi Day celebration is growing this year

This year, Bolz is excited about the expansion of Pi Day in his high school.

In previous years, he would spend half of the math period creatively teaching about pi—for example, using hands-on tools to measure the angles and radius of a cookie—to make it easier for kids to understand, Bolz said.

In the other half of the period, Bolz's students would go to the library, where they'd meet other math teachers, students, and parents, and engage in Pi Day festivities.

Students would grab pie and create a pi chain, write jokes about pi and math, or decorate a pi skyline, with numbered buildings in the order of pi.

"It's always amazing when I can see the kids' faces when they're coming into the library [in reaction to] all the different stuff that we have," Bolz said.

Parents and local businesses donate and volunteer to create a memorable Pi Day celebration, Bolz said. But this school year will look a little different as the high school has a sponsor: T-Mobile.

"[T-Mobile is] going to bring a truck that has a bunch of science and engineering gear so I'm trying to get my science classes involved in Pi Day that way," he said. This will create a cross-departmental celebration of Pi Day, with both science and math, he added.

In Illinois, students compete in Pi Day activities

In the Chicagoland area, Catalina Perricone, a high school math teacher currently on maternity leave, has celebrated Pi Day for more than 12 years throughout various schools in the region.

"It's important for students to know the historical importance [of pi] and how closely it's tied into such big concepts like circumference and radius and area, and that's it's been known for generations and evolved for so long," Perricone said.

Perricone has celebrated Pi Day through hands-on activities like having students collect, measure, and calculate circular household items like a Pringles can or roll of paper towels.

But one celebration that sticks out is competition-based activities, like Jeopardy games and trivia or department-wide contests. Another one of Perricone's favorite pi-related activities is having students draw a circle using their arm as the radius and voting on who drew the most perfect circle.

"Students really get into it," she said. "They get very competitive, which I love."

She is excited to get back into the classroom and celebrate another Pi Day.

"Math isn't always the [most fun] for students, so if you are going to make it fun for them, make it tangible for them," she said. "Then they're going to be excited as well."

In New Jersey, Einstein's birthday is a key part of the day

In Princeton, N.J., the community gets together to celebrate PI Day along with Albert Einstein's birthday, who lived in the town.

For the last 15 years, community partners and local organizations have put together a series of events throughout the day and around town related to both pi and Einstein.

Many Pi Day events are held at the Princeton Library, which is at the center of the town, bringing together teachers, parents, and kids. (When Pi Day falls on a weekday, like this year, the celebrations are held on the weekend.) The library curates educational materials and hosts events like Einstein Story Time, and pi-iku, in which students make haikus about science or math.

"We try to mix it up every year and think of different ways we can highlight both the number pi as well science and math in general," said Janie Hermann, the adult programming manager at Princeton Public Library.

The library also displays relevant books and sends a list of ones about pi or Einstein to teachers in the community.

"There are some people who are just interested in the math aspect and that's great, but by broadening it and trying to tie it into books and making it a broader scope, you're going to attract more people to the topic and maybe then they can discover something about math and science," Hermann said. "Maybe they can discover something about pi and its importance and what it is." ■

Published September 26, 2023

Making Sense of Fractions: This Tactic Helped Students Grasp a Key Math Topic

By Sarah Schwartz

Fractions are an important building block in students' mathematical foundations. Understanding how they work and why is crucial for success in Algebra and more advanced math courses. But fractions are also notoriously difficult to master.

Studies have shown that a significant portion of students—about one third—don't make much progress in their understanding of the topic between 4th grade, when operations with fractions are typically introduced, and 6th grade, when students are expected to be fluent in fractional arithmetic.

Fractions are so challenging in part because they don't operate in the same way that whole numbers do, said Nancy C. Jordan, a professor of learning sciences at the University of Delaware. Numbers of the same magnitude can look very different: Take 2/4 and 8/16, for example. And sometimes, when the numbers in a fraction grow bigger, the magnitude actually gets smaller—1/4 is bigger than 1/8, for instance.

On Tuesday, Jordan presented her work on a fraction sense intervention for struggling 6th graders at an Institute of Education Sciences Math Summit, an online conference hosted by the U.S. Department of Education's research wing.

Jordan's work, which is funded by an IES grant, will scale up a program that she and her colleagues found improved students' understanding of fraction concepts and measurement, as well as their ability to apply that understanding to solve problems.

The intervention "aims to make explicit mathematical connections," said Jordan, demonstrating how fraction magnitudes are represented across different contexts.

Parts of a whole vs. values on a number line

Traditional fraction instruction emphasizes fractions as part of a whole, said Jordan. Think about an eight-slice pizza with two slices missing to represent 6/8, for example, or a group of four circles with three colored in to represent 3/4.

But teaching fractions this way, rather than representing them as numbers with their own magnitudes, can lead to misunderstandings, Jordan said. She shared examples of student work from pre-tests in her research. In one question, students were asked to shade in 3/4 of eight circles. To get the question correct, students would need to shade in 6 circles.

But when students got the question wrong, many shaded in three circles, because they thought of 3/4 as three parts—rather than a value between the numerals 0 and 1.

In Jordan's intervention, teachers use a number line to represent fractions. This allows teachers to show fraction equivalence on the number line—to demonstrate, for example, that 3/4 is the same distance between 0 to 1 as 6/8. Teachers also link the number line to other fraction representations: fraction bars, a collection of items, or liquid in a measurement cup.

Teachers then help students connect these representations to numbers and equations, and students get regular practice distinguishing between and performing different operations.

Teaching fractions with a number line isn't a new practice. It was emphasized in the Common Core State Standards introduced in 2010, which at the time represented a major shift in how fractions were taught in schools. The underlying idea behind this change is that number lines help students put fractions into context—demonstrating their relationship to integers.

But Jordan said that presenting fractions as part of a whole is still a common teaching method—as are procedural shortcuts that can leave students with little conceptual understanding of why operations work the way they do. She gave the example of the "butterfly" method of adding and subtracting fractions, which relies a multiplication trick to find a common denominator.

Jordan said her intervention demonstrates that even if students have misconceptions, it's possible to help them develop deeper understanding in older elementary grades: "Even students who are struggling mightily with basic fractions after three years of instruction can learn to make sense of fractions." ■

More Like This

How Addition Fluency Develops: A Visual Explainer

Kids Need to Know Their Math Facts. What Schools Can Do to Help

Julia Nikhinson/AP

Student teacher Sara Neal teaches math at Whitehall Elementary School in Bowie, Md.

Published May 31, 2023

3 Takeaways About Math Fact Fluency

By Sarah Schwartz

Figuring out a word problem. Calculating area and perimeter. Finding the measure of an unknown angle.

All these tasks, and more, draw on an essential foundation of math knowledge, said Brian Bushart, a 4th grade teacher in West Irondequoit Schools in New York: fluency with math facts.

"Everything else we do in math relies on your ability to use that knowledge pretty quickly," he said.

Bushart was speaking on an Education Week panel on May 25, focused on two important pieces of early math instruction: fact fluency and beginning word problem-solving.

Having a strong grasp on fact fluency—such as single-digit arithmetic, and multiplication tables—frees up mental space for students to solve more advanced, multistep problems, said Nicole McNeil, a professor of psychology at the University of Notre Dame, and another speaker in the panel.

"If we are spending all of our time 'counting on' to solve a pretty basic arithmetic fact, we're not going to have resources available to do those higher-order problem-solving tasks," she said.

Here are three takeaways from the panel about how teachers can help students develop fact fluency. To read more about this topic, or others in early math education, see Education Week's new report, Math Foundations for All.

Learning math facts is a 'multi-year progression'

The end goal of math fact practice is for students to be able to recall them "automatically," or calculate them "within a second or two," said McNeil.

But students work up to that goal, said Bushart: "There's a multi-year progression of learning."

In kindergarten, students learn how to do basic work with numbers—how to count, for instance. Then, teachers introduce the idea that it's possible to join and separate numbers.

From there, students learn strategies for joining and separating numbers in a more efficient way. For instance, Bushart said, students can use their knowledge of adding by 10 to make adding by 9 easier—pulling 1 from the other number to transform the problem into one where students are adding by 10, so that 9 + 6 is transformed into 10 + 5.

Then, quickly recalling these facts becomes the goal. Bushart tells his students: "The reason we're doing it is that practice of remembering is actually what's going to strengthen your memory over time."

Math facts should be taught as part of an 'interconnected network'

Automaticity with math facts is important, but students should understand the why behind them too, Bushart said.

He talked about teaching students who could solve 8 x 5 quickly, but didn't know what 8 x 6 was. Part of his goal is to help students see these two equations as related.

"I want kids to start to notice that … 8 x 5 is almost 8 x 6, which is almost 8 x 7. That's the kind of space I want them to be in," he said.

This is one reason why calculators can't replace prowess with math facts, said McNeil—if kids are relying on calculators, they're not developing this relational knowledge. "When students are fluent in math facts, it becomes part of an interconnected network," she said.

Avoid 'bombarding' children with failure when they practice

Bushart only assesses his students on math fact recall once a week or once every other week. He also intersperses facts that students already can recall easily with ones that they're trying to memorize.

"You don't want to bombard them with, I don't know, I don't know, I don't know," he said. "You want a lot of success in there."

McNeil endorsed this strategy. "Children are only developing automaticity with a few facts at a time," she said. "Do not practice all of the facts at one time."

She offered another suggestion: It's important that students have strategies, like making 10, to compute the facts that they can use if they can't recall the answer automatically. These strategies can act as a back-up, she said, so that kids can still solve for the answer. ■

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OPINION

Published January 17, 2025

One Thing We Get Wrong About Teaching Math (and How to Fix It)

How to stop students from turning their 'math brains' off

By Sara Delano Moore

Nataliia Tymofieieva/Getty + Education Week

When I was a new teacher, I wanted my students to see math not just as numbers and equations but as a tool to understand the world around them. My goal wasn't for them to simply memorize formulas to complete their homework but to develop a deep, conceptual understanding of math that would lead to long-term fluency and enable real-world application.

Yet, when I used traditional teaching methods, it felt like I was cramming too much into each lesson. Students seemed to turn off their "math brains" as soon as we switched subjects, struggling to retain what they'd just learned.

I learned that I was not alone. Teachers often follow a curriculum that requires them to teach multiplication from start to finish in two months. Then, students are expected to apply those skills weeks later when they start a new unit. Evidence suggests this instructional approach, known as massed learning, isn't effective. It's similar to cramming for a test, only to forget the material afterward.

Students, from their earliest years in school, must regularly practice foundational math skills, as concepts build on themselves throughout the school year and beyond. This practice can be done in the form of games, station activities, or other experiences beyond completing worksheets. Teaching information in small increments (with breaks) over time, known as spaced learning, is the opposite of massed learning. Research shows it's an effective approach that helps elementary students retain math better. And these ideas apply to middle and high school students as well.

Midway through my teaching career, I transitioned to spaced learning in my science classroom to boost engagement and retention. Teaching 6th grade life science, I found students tuned in only when topics felt personal, like human anatomy. Motivated by this, I restructured the course to center on human systems with comparisons to other living things, sparking curiosity and better content retention—a success that inspired me to apply spaced learning in my math classroom as well.

I began integrating spaced learning by restructuring my 50-minute math class, not reducing time but using it differently. Instead of focusing on a single topic for extended periods, we rotated through smaller chunks—two weeks on fractions, followed by geometry with continued fractions practice, then returning to fractions.

This approach kept students engaged and reinforced learning through distributed practice. Students would complete a few problems at a time rather than finishing an entire worksheet. I also integrated math skills into science and other subjects—even though the content existed only in our math textbook. This approach not only reinforced student learning but also helped students see the connections between math and the world around them.

This new approach wasn't without its challenges. It took time, energy, and commitment to redesign my lesson plans. Yet, seeing how much my students benefited from this new approach made it worthwhile. They weren't just retaining knowledge; they were becoming better problem-solvers. Their performance improved, achievement gaps narrowed, and they went into the next grade better prepared and with a stronger grasp of concepts.

Unfortunately, many educators today face significant barriers to implementing similar changes. Limited time, insufficient resources, and the challenges of aligning curricula and finding supplemental materials make it difficult for teachers to adopt strategies like spaced learning. For many, a complete lesson plan overhaul feels unattainable despite its proven benefits.

However, starting small can make a big difference for educators looking to boost learning in their classrooms. Educators can introduce spaced learning by rethinking the sequence of their existing lesson plans to spread out instruction over time and create connections between concepts.

For example, in grade 1, educators might introduce teen numbers early in the year and revisit them later when teaching place value, emphasizing teen numbers as 10 plus some 1s.

In grade 3, four-digit numbers could be taught in the first month and revisited weeks later when covering comparing and rounding. These small adjustments allow students to engage in ongoing practice throughout the year, reinforcing understanding and building fluency.

For those seeking a more structured approach, some curricula recognize the efficacy of spaced learning and pace materials accordingly. One example is Stepping Stones, a math curriculum from ORIGO Education, where I am a vice president. The curriculum spirals concepts throughout the year. (While I was not involved in its initial development, I now contribute to its ongoing revisions.) Students begin learning multiplication facts early on and continue practicing them in small doses, revisiting the concept regularly and connecting it to other topics.

I've seen spaced learning create tangible results and significant improvements in many districts. For example, when Pennsylvania's Conestoga Valley school district adopted the Stepping Stones curriculum, the district raised 2nd grade math proficiency scores from 57 percent to 70 percent over three years. Feedback from coaches, shared during a presentation at the National Council of Teachers of Mathematics 2024 annual meeting, highlighted how educators noticed shifts in how both they and their students engaged with the material.

Similarly, Maryland's Worcester County public schools saw special education students thrive using a spaced-learning approach. Teachers praised the approach for simplifying math instruction and making lessons more effective and accessible for all learners.

Reflecting on my time as an educator and conversations with fellow teachers, I've seen how spaced learning transforms math instruction. By revisiting concepts in small, manageable doses, students develop a deeper understanding and an improved retention of material. This approach fosters long-term mastery, enabling students to connect and apply their knowledge across different contexts. Moreover, it helps close achievement gaps, allowing all students to progress at a more equitable pace.

Spaced learning is an effective alternative to the traditional massed-learning approach, unlocking greater potential for both teaching and learning. ■

Sara Delano Moore is the vice president of content and research for ORIGO Education, which produces pre-K-6 math curriculum and professional learning resources. Previously, she taught math and science in grades 3-8 at both public and private schools and served as a university professor embedded in a local middle school.

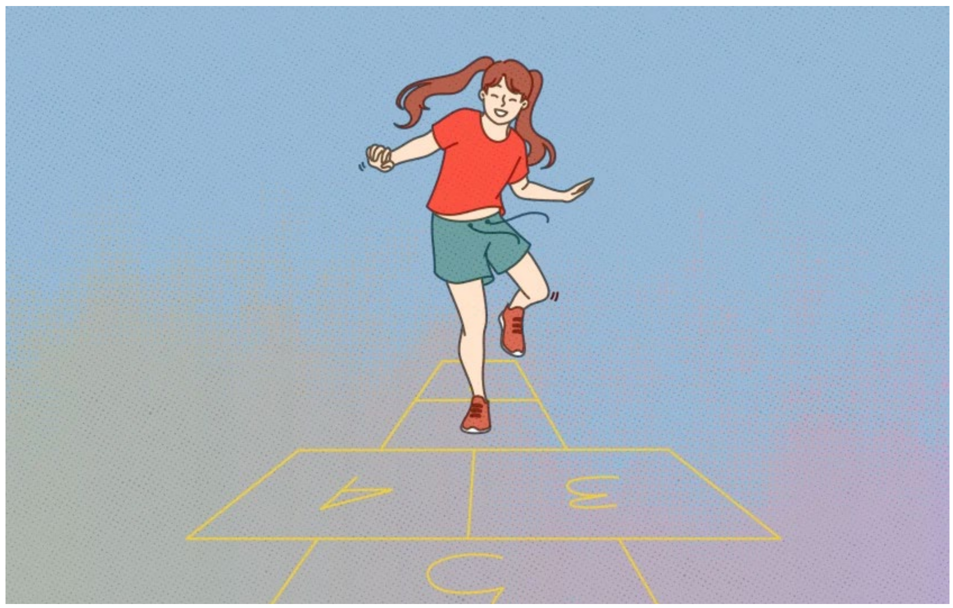
OPINION

Published September 22, 2023

Get Kids Moving During Math Lessons. Trust Me, It Helps Them Learn

How to use physical activity as an instructional tool

By Kendall Stallings



Mikhail Seleznev/iStock + Education Week

With the return to school comes a return to students sitting at their desks for hours every day—and teachers' subsequent challenge of managing those fidgeting students. There has been considerable research and emphasis on incorporating physical activity into learning through brain breaks or brief energizers, and I have found implementing it in my own classroom to yield positive results.

Considering movement integration through this lens falls short, however. Students, especially younger ones, need more than just brief breaks to move the body before resuming sitting and learning. Movement can reap significant benefits in content mastery when used as an instructional tool instead of a break from learning itself.

Movement integration more commonly appears in literacy curricula, as movement can help develop phonemic awareness and letter-sound recognition. A reading program might, for instance, ask kindergartners to "sky write" letters before writing on paper or to tap out phenomes on their fingers.

Seeing the advantage of connecting movement with content, I was curious if this benefit would extend to other subjects. While completing my master's degree in early-childhood education, I researched the extent to which movement could improve math instructional strategies by building number sense and fact fluency—the numerical equivalents of letter-sound recognition and phonemic awareness.

Indeed, movement integration works particularly well with elementary math lessons, as it offers students a chance to engage physically with abstract concepts and demonstrate their understanding kinesthetically. For instance, a kindergartner struggling to conceptualize the value of teen numbers may find some benefit in using manipulatives, but even then, counting 14 Unifix cubes is a largely visual task.

When some of my 1st graders struggled to count backward from 20, I had them stand in a line and take turns counting down and jumping backward when it was their turn. Instead of simply reciting words they did not understand the value of, they watched the concept come to life as they physically moved in accord with the counting.

Another teaching strategy rooted in movement integration may look like having students do 10 jumping jacks and then switch to clapping four times. This exercise forces the students to count and be cognizant of when they reach 10. The switch to clapping after the first set of 10 allows them to make the connection that teen numbers are 10 plus some more ones.

Students learn as they move, and doing so reduces the need to take movement breaks unrelated to the lesson. This allows learning to continue uninterrupted by planned breaks, inevitable teacher redirections, or distracted students.

As pediatric occupational therapist Angela Hanscom explains in her book Balanced and Barefoot, "In order to appeal to all types of learners, it is best to incorporate movement into the actual learning experience." In fact, she asserts that short bouts of movement unconnected to learning, for example sitting on a bouncy ball or wiggle breaks, "may also distract most children and actually hinder their learning." Movement integration must therefore be strategically implemented.

So, how do we, as teachers, provide students with meaningful educational experiences that capitalize on a child's need to learn? Consider implementing some of the following movement-integration techniques into your elementary math lessons for improved engagement and understanding.

- **Switching movements.** As described in the teen-numbers example, this strategy uses physical movements that change at different intervals to allow children a kinesthetic option for developing number sense. Students do a movement for a set amount of times and then switch to a different movement, such as 10 high knees, then 10 frog jumps, then hops on one foot to conceptualize groups of 10.

- **Skip movements.** This strategy promotes skip-counting fluency by assigning different movements to different values. For instance, students may stand in a circle and count chorally but only say the even numbers aloud. When a student says a number, she steps forward; the next student simply claps. It would sound something like this: “Two, [clap], four, [clap], six, [clap], etc.” This exercise gets students in the habit of skip counting with a movement to account for the skipped numbers so that students do not get confused.

- **Embodied movements.** With this strategy, students become the concept. In other words, they use movements to represent a concept. An example may entail having students create shapes with their bodies; for example, four students could stretch out on the floor to create a square.

- **Auditory and motion movements.** This strategy can be helpful for reinforcing math rules and problem-solving steps. Using a verbal component, students recite the steps for solving a math problem or other math rule with movements to go along with the words. It can be a rhyme or song, but that is not a requirement for this practice to be successful.

(Several resources detail these strategies and more, such as Suzy Koontz’ Math and Movement program.)

Why take time to integrate movement other than for the sake of movement? Research shows that movement-integration consistency yields statistically significant increases in math assessment scores, as well as increased curiosity in the subject. That curiosity, in turn, gives students greater sustained attention and, ultimately, an improved understanding in early-childhood and kindergarten math achievement.

The transition back to school does not have be a strain on seated learners wanting to move and frustrated teachers attempting to hold learners in their seats. Teaching strategies that integrate movement decrease the need for disruptive movement breaks. They also improve academic achievement overall.

The first time I told my students to do jumping jacks while counting aloud, they looked at me with confusion. Now, when I say that it is time for math, I am met with excitement and requests to start our lesson with one of the movement warm-ups with which we often begin. I have students that struggle with mental math who will clap or do small movements while working through a question as they conceptualize abstract concepts through physical engagement. This positive mindset toward math, coupled with kinesthetic learning, creates an ideal math instructional strategy for young learners. ■

Kendall Stallings is a 1st grade teacher in Baltimore County, Md.

Published by Editorial Projects in Education, Inc.
6935 Arlington Road, Suite 100
Bethesda, MD, 20814
Phone: (301) 280-3100
www.edweek.org

Counting Isn't Enough:
The Shift to Conceptual Thinking in the Early Years

Mathematical success begins long before students encounter their first multiplication table. It begins in the earliest years, when we have an extraordinary opportunity to shape young minds.

While literacy programs have long captured headlines and funding, we're now discovering the tremendous potential that lies in early mathematical learning.

Research reveals that ages 5 to 8 represent a golden window of opportunity, when children are naturally developing number sense, discovering patterns and building the cognitive skills – like working memory and flexible thinking – that become the foundation for all future mathematical learning.

"In recent years, several states have begun expanding early learning legislation to embrace not only reading but also numeracy, recognizing that foundational math skills are equally powerful predictors of lifelong academic success."

The belief that 'meaningful math learning starts around the fourth year of school' overlooks the remarkable potential of young learners. While math content may appear more complex in later grades, the cognitive and conceptual foundations for mathematical thinking can be cultivated much earlier, particularly in pre-K through second grade.

"Make the most of this critical window and you're building mathematical minds that will thrive."

With everything we know from research, school leaders now face a clear pathway forward: embrace what science tells us about early numeracy and invest where we can achieve maximum impact for every child.

Counting on the future:
Why we have to get early numeracy right

As touched on above, major longitudinal studies consistently identify **early numeracy skills as the** most reliable predictor **of future academic achievement** – evidence that reveals incredible possibilities for young learners. And the reasons extend far beyond mechanical counting and computation.

From ages 3 to 5, children rapidly develop executive function skills like working memory and cognitive flexibility, the mental tools that support mathematical thinking. By age 7, these brain networks resemble those of adults, making the first years of school a prime opportunity for support.

"It's during this time that key foundations like number sense, spatial reasoning and problem-solving are established and strengthened. "

Recognizing this optimal learning window, several state departments of education are now prioritizing early numeracy within their ESSA-aligned intervention frameworks – creating valuable opportunities for schools to access funding and implement evidence-based supports at the stage when impact is greatest.

3P Learning

Counting Isn't Enough:
The Shift to Conceptual Thinking in the Early Years

The equity potential is clear. Math achievement gaps by income, race, and geography often emerge early, but targeted support holds great promise for creating more equitable outcomes.

Since these foundational skills develop naturally in the early years, every day we invest in quality early numeracy instruction is a day we strengthen mathematical thinking and open doors for all learners.

The foundation for success:
How strong early math skills are built

When we invest in strong early math foundations, the benefits become clear around age 8–9, just as curriculum demands expand in third grade. The University of Oregon researcher Ben Clarke's findings illuminate a powerful opportunity:

"For kids that have a fundamental weakness in mathematics, 80 percent or 90 percent of the time that's going to be linked to a lack of understanding numbers."

With robust number sense, students navigate mathematical challenges with confidence and flexibility.

The key often lies in strengthening working memory — helping children hold one part of a problem in mind while manipulating another, making multi-step reasoning achievable and rewarding.

These strengths prove particularly valuable for applied problem-solving, where students develop the flexibility to interpret novel situations and go beyond memorized procedures.

In states prioritizing comprehensive literacy support, foundational numeracy skills are now recognized as powerful allies for academic success, as strong readers often demonstrate parallel strengths in applied problem solving and quantitative reasoning.

Students with strong symbolic number sense develop the mental agility to adapt when problems are presented in different ways.

"The earlier we build these foundations, the more dramatic and lasting the impact becomes — meaning we're working within the optimal window for developing executive function skills."

Targeted support that focuses on strategic thinking and efficient techniques, such as counting on from known cardinal values – creates remarkable progress for students from all backgrounds, especially when paired with early screening for conditions like dyscalculia and personalized learning approaches.

The exciting shift:
From rote counting to flexible thinking

In the early grades, there's a wonderful opportunity to move beyond counting aloud or identifying digits to build real mathematical understanding.

As mentioned above, true fluency celebrates number sense: a sophisticated understanding of numerical relationships and the ability to connect counting, number knowledge and basic operations in meaningful ways. And it matters more than we give it credit for.

Studies show that a child's number sense in first grade can predict their math achievement years later: not just in calculations, but in the kinds of real-world problem solving. In fact, number sense contributes an impressive additional 12 percent to overall math achievement and up to 17 percent in applied problem solving by third grade.

3P Learning

Counting Isn't Enough:
The Shift to Conceptual Thinking in the Early Years

The lasting impact of number sense is hard to overstate.

In fact, this advantage grows stronger as mathematics becomes more complex. Think of it as the mathematical equivalent of phonemic awareness in reading: without it, students may appear proficient in early years but inevitably struggle with fractions, place value and reasoning tasks that demand flexible thinking rather than mechanical recall.

"The solution lies in creating rich and highly engaging mathematical environments where students explore numbers through multiple representations."

Everyday experiences like playing on the playground, helping in the kitchen, or shopping with family provide natural opportunities for children to explain their thinking and build conceptual understanding. Supplemental programs that use gamified, developmentally appropriate activities can embed number sense into real-world contexts and strengthen conceptual understanding.

Strategic leadership moves for strengthening early mathematics

Where can educational leaders make the greatest impact in strengthening foundational mathematics skills?

The path begins with investments in high-quality curriculum that build conceptual understanding and number sense, rather than relying solely on procedural memorization. Leaders should also provide targeted professional development in evidence-based early math strategies—an urgent need, as many elementary teachers report low confidence in teaching foundational math and often feel underprepared to build number sense in the earliest grades. Finally, classroom environments deserve closer attention. As Nancy Jordan from the University of Delaware observes: "Often, I'll go into classrooms with literacy stuff all over the walls, but nothing in terms of numbers."

To shift this pattern, elementary spaces should be numerically rich, featuring number lines, math games, and playful opportunities that weave number sense into concrete skills. Universal screeners such as the Number Sense Brief (NSB) can help identify at-risk students early, before small gaps grow into significant barriers. Aligning early math strategies to ESSA tiers of evidence or MTSS frameworks strengthens interventions and supports funding eligibility. Just as important, teachers need support in viewing mathematics as a developmental progression—from counting through fractions and beyond—rather than as isolated grade-level standards.

The foundation for mathematical success starts now:
Download your free guide

For the complete roadmap to building strong foundations in the early years, download our free guide, '[Early Numeracy as a Cornerstone of Long-Term Academic Success](#)', an evidence-based resource for educators committed to closing learning gaps and building stronger math foundations for every student.

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