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2025

Math Intervention

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Page 6

EDITOR'S NOTE

Providing students with the appropriate math support can ensure they develop the skills and confi-dence they need to succeed. This Spotlight explores effective strategies for providing targeted math support, addressing math anxiety, and promoting student success. From combating math anxiety to leveraging in-school tutoring, these articles offer valuable perspectives. Discover how to provide targeted support for English learners, strategies to boost algebra gains, and more.

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Page 13

OPINION

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Schools Prioritize Reading Intervention. But What About Math?

By Sarah Schwartz

Throughout Tiffany Trevenen's more than 30-year career in Moffat County schools in Craig, Colo., she has seen students experience the same math struggles again and again.

"It was very apparent in upper elementary to me that kids did not have number sense," said Trevenen, now a learning coordinator at Sandrock Elementary School in the district, referencing the basic understanding of quantity, magnitude, and arithmetic that lay a foundation for higher order math skills.

"They didn't have a relationship with numbers. I didn't know how to fill those gaps," she said.

Moffat schools have long used screening assessments in reading to catch students who need extra help early on in their elementary years. But they didn't have anything similar for math. "We didn't have the resources, nor the time slots, to do math intervention," Trevenen said.

This year, though, that changed. Administrators purchased intervention materials and put dedicated blocks in the schedule. Now, Trevenen and her colleagues are puzzling over how best to use the time to support students—whether they should work with them in small groups, for example, or when to use tech programs to practice newly learned skills. "We're at the front end of figuring it out," she said.

Trevenen's experience reflects broader national trends. Elementary schools have long prioritized early interventions to ensure that students can read before they leave the early grades, often at the expense of offering comparable support for students struggling in math, experts say. This pattern persists, even as studies show that early math skills are a key predictor of later academic success.

Math has 'lagged' behind reading in education policy

The tendency for math to take a backseat to reading shows up both in policy and, historically, in public perception.

Over the past decade, 37 states and the District of Columbia have passed legislation or taken other measures requiring that schools shift to evidence-based reading instruction, often mandating interventions for struggling students. Many of these laws have come as national support has swelled for the "science of reading" movement, an attempt to align classroom teaching with research on how young children learn to read.

Only seven states have passed similar legislation in math recently.

"Math, on both the assessment side and the intervention side, has always lagged behind reading," said Ben Clarke, a professor of school psychology at the University of Oregon, who studies math assessment and instruction.

"The joke was [President George W.] Bush had his Reading First initiative—and it was reading first, and math at some point in the future," Clarke said, referencing the federal grant program of the early 2000s aimed at raising reading scores. "Ask 100 people on the street what's the most critical skill kids learn in elementary school, 98 of them are going to say reading."

Data confirm that schools are more likely to offer targeted instructional support and intervention in early reading than in math. A 2015 study of 13 states found that while 71 percent of schools had implemented Response to Intervention practices in 1st grade reading, only 35 percent had done so in 1st grade math. (RTI is a tiered system for intervening, giving progressively more intense support to students who struggle with whole-class lessons. Many schools now use multi-tiered systems of supports, or MTSS, which combines academic interventions with social-emotional support.)

But intervening earlier in math isn't just possible, it can also have big effects for students down the line, said Nancy Jordan, a professor of learning sciences at the University of Delaware.

"We do know that these early number abilities are malleable. If children get these interventions, they can improve their number knowledge," she said. "If you don't learn the early number skills, and you're not facile with those, you're going to have trouble learning the higher order skills, because they're so intertwined."

What early math screeners evaluate

To identify which students need more help, schools might use a math screener—a short assessment to determine whether a student is performing at grade level. Most math screeners that students take in kindergarten or 1st grade aim to get a snapshot of students' number sense, said Jordan.

Number sense is a nebulous term, referring at the same time to kids' ability to understand quantity, relate numbers to each other, and perform simple operations like addition and subtraction. Separate tasks can assess these different abilities, researchers say.

For example, a student might be asked to count a set of objects, with their teacher monitoring for certain skills, Jordan said: Can they count in a stable order? Do they count each number once and only once? Do they know that the final number in the set represents the total number of objects? Students might also have to identify a missing number in a sequence, said Clarke.

To test their understanding of magnitude, students would be asked which number is bigger—4 or 6, for instance. Kids might also be asked to compose and decompose numbers, said Clarke, testing their understanding that 5, for example, is made up of 2 and 3. Older students in 1st and 2nd grades would be screened on their fluency with these kinds of addition and subtraction operations, Jordan and Clarke said.

"Young children who have this good number sense and can think about number operations and can add and subtract small quantities ... they tend to do much better in math when they reach 1st grade and beyond, because they have built these fundamental understandings," said Jordan.

When they learn their math facts, they're not just memorizing at random—they're able to link the fact to their understanding of how numbers work, she said.

Still, screening students for difficulties with these skills is just the starting point, said Clarke. "You have to have that link to intervention, otherwise you're just admiring the problem."

And the tools can be crude: Many label a student with a number, or a color designation—green for on track, yellow for borderline, and red for below grade level. "That's only vaguely helpful," said Mary Pittman, the director of mathematics for TNTP, an organization that consults with schools on teacher training and instructional strategy. "It tells you that you need to figure out what you need to do for that child."

The goal of screening should be to connect kids with these supports, rather than to label them as permanently "behind," said Bailey Cato Czupryk, the senior vice president for research and impact at TNTP. Often, state policy is written to encourage flexible grouping and ensure that students who need additional help aren't missing out on grade-level instruction, "but we don't provide teachers support on how to do it," she said.

How schools are responding to state mandates

In Florida, districts are figuring out how to offer this intervention time after the state passed a law last year that mandates it.

HB 7039 requires that students in grades K-4 who show a "substantial deficiency in mathematics," or the math learning disability dyscalculia, receive targeted support. It also calls for the state's department of education to provide a list of approved intervention programs.

"That law puts math on equal footing with reading, where it's saying both are legislatively required, and you have to figure out a way to fit it into your schedule," said Elizabeth Abel, a district elementary math coach in Florida's Hernando County schools and the president of the Florida Council of Teachers of Mathematics.

Before the law passed, Hernando County was already screening students for math difficulties, and relied on several different resources for interventions, Abel said.

"Often, those strategies will involve hands-on, conceptual understanding," she added, as teachers work with students in small groups to provide concrete representations of mathematical ideas—a practice recommended by the Institute of Education Sciences' What Works Clearinghouse for elementary schoolers who struggle.

Guaranteeing consistent time to provide this additional instruction has been a challenge for some schools, especially if students need support in multiple subjects, Abel said. Some schools in the district are trying to schedule intervention blocks before or after school as a solution.

Abel hopes that a sharper statewide focus on intervention leads to more attention on everyday, whole class math instruction, too. Throughout math classes, teachers should be using the same strategies that research shows support struggling students, she said.

It's a view that Clarke, the University of Oregon professor, holds too.

"The real power of these screening systems ... is they often change core instruction," he said. "Educators start to realize, if 60 percent of our kids are off-track, 70 percent of our kids are off-track—and that's common—we cannot small-group our way out of this issue." ■

Math intervention needs an intervention.

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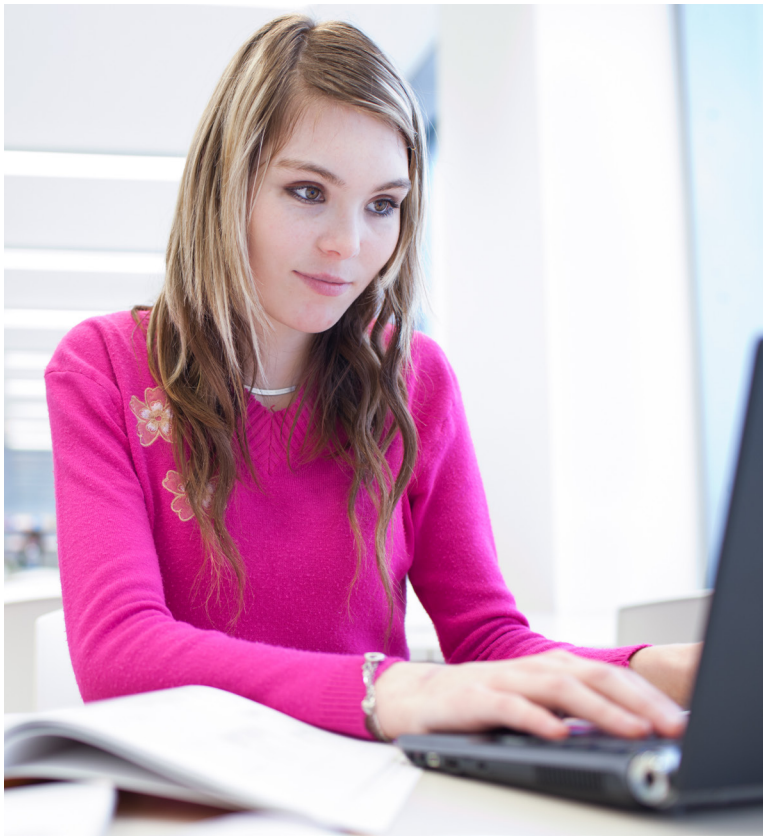

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Published October 17, 2024

What Happened When A District Put Struggling Students in Regular Algebra?

By Sarah Schwartz

When students take Algebra 1 matters.

If high schoolers don't pass the course by 9th grade, they're unlikely to reach college-preparatory math in high school. There are too many courses to get through in four years. As a result, struggling students face two potential pitfalls: being pushed into algebra courses that they're not ready to tackle, or shunted onto a lower-level track that makes it unlikely they'll ever catch up to their peers.

But a new study shows that some students who would have otherwise been placed in remedial math can succeed in 9th grade algebra—if they have the right support structure.

The research, published in a working paper from Stanford University professor Thomas Dee and postdoctoral research fellow Elizabeth Huffaker, examined a de-tracking initiative in one California district that placed below-grade-level and on-grade-level students together in the same 9th grade algebra classes and gave their teachers intensive training on how to support students at different ability levels.

They found that struggling students in these mixed classes went on to pass more high school math courses. And they did better on 11th grade math tests than their peers who had been placed into a remedial track—without affecting the achievement of the on-level students in the class.

The findings demonstrate the importance of "attending to the instructional core," said Dee, referencing the professional development that teachers received on how to reach all students.

While praising the study's outcomes, other researchers noted that it paints a complicated picture of improvement.

"Everybody really wants there to be a path for kids to not get stuck in remedial 9th grade math, and to take Algebra 1 and succeed," said Heather Hill, a professor of teacher learning and practice at the Harvard Graduate School of Education who studies professional learning in math.

The school district pulled many different levers. It provided professional learning, but also encouraged teachers to use a new curriculum, and worked with teachers who volunteered specifically for this special class.

"Professional learning could well have been the glue that held this all together, but there were a lot of different components," she said.

And while more students who started off below grade level made it to higher-level math, many of them struggled and had to repeat Algebra 1—an outcome that might not be "politically palatable" for districts, Hill said.

Algebra intervention provided teachers with support for differentiation

When students should take Algebra 1 has long been a contentious question.

In the 1990s and 2000s, several states and large school systems began requiring students to take the subject in 8th or 9th grade, with the aim of ensuring that all students would be ready for college-level math upon graduation. But these policies often didn't raise student achievement, and in some cases, lowered it.

"Negative effects were really concentrated on students who weren't as developmentally prepared to take Algebra 1 early," said Huffaker. "There is a major academic challenge to those students who are being put in more rigorous courses, and there is a pedagogical challenge to teachers."

The intervention in this study aimed to lessen that challenge.

To test it, researchers randomly assigned incoming 9th graders in the district, Sequoia Union in Redwood City, Calif., to one of two groups.

One was business as usual—students with below-grade-level proficiency in math were placed in remedial pre-Algebra, while on-grade-level students were put into Algebra 1. Historically, this plan resulted in racially imbalanced classes in the district, with Black and Latino students more likely than their white and Asian peers to be placed in remedial classes.

Students in the other group all took algebra together, regardless of their past performance.

Finally, one group of students wasn't a part of the experiment: those who had already taken Algebra 1 in middle school, comprising about a third of the district. These students continued on to the next course in the high school sequence.

Teachers who taught these heterogeneous algebra courses received a suite of supports designed to help them reach learners at different levels: 15 days of professional development, an additional planning period, access to a district-wide professional learning community, coaches that visited four times a semester, and a partner teacher at their school site.

In part, the professional development focused on employing "math language routines" designed to give teachers a way to check for students' understanding in real time, and address any misunderstandings if necessary.

In one of these routines, for example, two students work together to solve a math problem. One has a card with the problem, but

with crucial details left out. The other student has another card with these relevant details. Teachers can evaluate how well students understand the underlying concepts involved by hearing what questions they ask of each other in their attempts to piece together an answer.

Could other districts replicate these results?

The de-tracked algebra class resulted in some positive outcomes for students who started 9th grade with below-grade-level performance in math.

On average, these students were more likely to pass Algebra 2 by the end of high school than their peers who had been placed in a 9th grade remedial course. They also outperformed the remedial group on 11th grade state tests. And these students were more engaged in school—they attended school more often, and they were more likely to stay in the district than their peers.

But placement into algebra came at a cost for some of this group.

About half of the students sorted into the de-tracked class had to retake the class, or enroll in a special pre-geometry bridge class as sophomores. After this setback, they were then on the same track as their peers in remedial courses.

It's also hard to know how an initiative like this one would scale in another district, said Hill.

The researchers credit students' success to the teachers' professional learning, but the initiative changed many factors at once, she said. Students were exposed to more algebra content, their teachers were encouraged to use specific curriculum materials, and they were in classes with higher-achieving peers, all of which could have played a part in the results.

Then, there's the influence of teacher interest.

Most of the teachers in the de-tracked classrooms volunteered for the job—they weren't randomly assigned. The researchers conducted statistical tests to ensure that there wasn't anything special, or especially effective, about these teachers that drove the results.

Still, the volunteer model used in this study means that results might look different if the same program were implemented in a district where teachers were required to participate, said Hill.

It's important to be "clear-eyed" about how this kind of intervention might play out in different contexts, said Dee. Still, he sees the research as a "compelling proof point."

"You're taking some of the most educationally vulnerable kids, accelerating them into a canonically difficult class, and they're achieving more—not less." ■

Published February 21, 2025

Why So Many Students Struggle With Math Anxiety—and How to Help

By Elizabeth Heubeck

The employment future looks bright for people with strong math skills. But among the nation's K-12 students, that represents a small and dwindling demographic.

Nearly 40 percent of 8th graders, and almost a quarter of 4th graders, demonstrated below basic proficiency on the most recent National Assessment of Educational Progress, released in January. Meanwhile, employment in math occupations is slated to grow much faster than the average for all occupations, at least through 2033, experts project. Even some jobs that don't require a college degree, like carpentry and mechanics, require basic algebra skills.

What's to blame for students' poor math proficiency? One major contributor to the problem might be math anxiety, defined by the late researcher and academician Sheila Tobias as "a learned emotional response" to math-related activities—such as participating in a math class, working through a math problem, or taking a math test.

Here's a closer look at math anxiety: what fuels it, who's likely to suffer from it, and how teachers can work to stave it off.

What does math anxiety feel like, and how common is it?

People with math anxiety can feel "suddenly blank and unable to think" when they look at a math problem, wrote Education Week reporter Sarah Sparks in a 2020 reported essay on the topic. They might experience sweating palms, a racing heartbeat, or other physical symptoms of anxiety.

Experts estimate that math anxiety affects 20 percent to 30 percent of students, and most teachers recognize it as a legitimate problem. In a nationally representative 2020 survey, 67 percent of teachers told the EdWeek Research Center that math anxiety was a challenge for their students.

Notably, once math anxiety is ingrained in a student's psyche, its symptoms tend to surface even before that student begins a challenging math problem or test. Further, math anxiety

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tends to precipitate a student's downward spiral—encompassing reluctance to practice math, further erosion of confidence in one's math ability, and stalled skill development. It's no wonder, then, that it's been linked to long-term poor academic outcomes in math.

No single explanation of why people experience math anxiety

There's no single profile of someone who suffers from math anxiety, which can affect both low-performing and high-performing students, said Colleen Ganley, a professor at Florida State University's psychology department who studies math anxiety in students. Sometimes math anxiety is actually a sign of general anxiety, she said.

Just as environmental influences and life experiences can play a role in the development of general anxiety, experts suggest that the same is true of math anxiety. After all, children aren't born fearing math. Confronting increasingly challenging math content and exposure to others' negative attitudes about math may fuel the problem, research shows.

And plenty of adults harbor negative feelings about math. Nearly 1 in 5 U.S. adults report severe math anxiety, and the 2020 EdWeek Research Center survey showed that 1 in 4 teachers feel anxious doing math. Further, research out of the University of Chicago found that adults' attitudes about math—both teachers' and parents'—can influence students' math performance.

Some instructional strategies can affect math anxiety

While no two students respond identically to a teacher's affect or method of instruction, some approaches may incite math anxiety in students more so than others.

Timed exercises—in which students are asked to solve a certain number of problems within a given time frame to assess their grasp on math facts and fluency—have long been cited as inducing math anxiety in students.

One recent study, published in the Journal of School Psychology, counters this theory. In the study, researchers gave a sample of 113 4th and 5th graders four different math tasks—some timed, others not—and surveyed the students about their levels of anxiety before and after the assigned tasks. The researchers found that timing the tasks made no statistically significant differences in students' (self-reported) anxiety.

It's worth noting that these findings relied on the self-reporting of elementary-age students. And they don't seem to have swayed The National Council of Teachers of Mathematics's sentiment on timed tests, whose position statement on the subject reads: "Timed tests do not assess fluency and can negatively affect students, and thus should be avoided."

Math researcher Ganley emphasized that not all students will react similarly to any given type of instruction.

"Some students may thrive in a fast-paced competitive atmosphere, while others find it anxiety-provoking," she said.

Instructional approaches aside, what happens at home, even before a child reaches formal schooling, can play into how children feel about math.

"What kind of exposure do kids get at a really young age to numbers and numeracy to build that same kind of literacy [as reading readiness]?" asked Auditi Chakravarty, CEO of Advanced Education Research & Development Fund, a national nonprofit dedicated to advancing research and development in PreK-12 education.

Strategies for managing math anxiety

Just as math anxiety doesn't have a single origin, there's no one way to prevent or reduce it. But here, experts offer a number of suggestions for their math-anxious students.

Refrain from putting students "on the

spot," said Ganley. Insisting that a student attempt to solve a complicated math problem in front of the class when that student clearly feels unprepared to do so, for instance, could serve to ramp up anxiety—not get the desired response, or math solution.

Teachers should encourage students to master basic math facts.

"Not possessing fluency adds a lot of cognitive load to each step of a mathematical process," said Michelle Tiu, co-executive director of EF+Math, a research & development program of AERDF that aims to improve math learning outcomes for students in grades 3–8. "If students' cognitive load is not taken up with thinking about basic fluency facts, it frees them up to be able to focus on higher-order thinking and conceptual understanding."

Aim for conceptual understanding as opposed to simply focusing on drills and timed tasks, said Tiu.

"In conceptual understanding, you're really able to look at what we call 'low-floor, high-ceiling' tasks," she said. "Low floor meaning there's a lot of accessible points, no matter students' backgrounds or ability levels. And high ceiling means that there's a lot of different areas for the students to be able to take their approach."

Present challenging math problems to students as a game or puzzle, rather than a task that will be graded, said Jalisha Jenifer, lead author of a study in the Journal of Experimental Psychology on the study habits of math-anxious students.

And help students reframe their physical symptoms of anxiety in real time. That could involve having students consider their sweating palms or racing heartbeat on the day of a math test not as symptoms of anxiety, but as "signs of excitement or readiness," said Christopher S. Rozek, an assistant professor in the department of education at Washington University in St. Louis whose research focuses on helping students manage their emotions. ■

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How In-School Tutoring Benefits Both Attendance and Math Scores

By Olina Banerji

Tutoring has become a popular prescription for academic recovery, thanks to lots of evidence showing that sustained tutoring blocks at least three times a week can boost students' improvement trajectories.

Now, two new research studies conclude that one of the critical pieces is making sure it happens during school hours—not outside of them. What's more, students themselves seem to want to come to school when they know they're going to receive personalized attention.

In essence, the two findings suggest compounding benefits for embedding extra help in the school day: academic improvement and better attendance.

On March 27, researchers at Chicago University's Education Lab released preliminary findings from a study of two school districts in Chicago and Georgia showing "meaningful" improvement in math scores for the 2,200 students in grades K-11 who received tutoring.

The gains equaled about two-thirds of a year of math learning—improvement that is in line with other studies on tutoring, even though students on average got less tutoring time than in other studies.

> "The message to school leaders is to protect the tutoring block in school."
>
> **MONICA BHATT**
> Senior research director,
> University of Chicago's Education Lab

"These gains are strikingly like the ones we've seen in previous studies on tutoring. The difference is that the implementation was much lower [from other efforts]. ... It shows that even tutoring done in a sub-optimal way can be beneficial," said Monica Bhatt, a senior research director at the University of Chicago's Education Lab, and one of the authors of the study.

Doing in-school tutoring can be challenging. So some principals have devised new support systems and designated on-site coordinators to organize the programs.

Those efforts have helped pay dividends for attendance, too. In the second study, released earlier this month, researchers with Stanford University's National Student Support Accelerator found that students are 7 percent less likely to be absent on days they have scheduled tutoring sessions. The study, conducted over the 2022-23 school year, examined absenteeism rates of 4,478 students in 141 schools in the District of Columbia.

"There are lots of reasons why students are absent. Being disengaged in school is one reason," said Nancy Waymack, the director of partnerships and policy at the NSSA." Tutoring is one way that students can have one more meaningful relationship in school. Tutoring can be one tool to move the needle in the right direction."

Taken together, the studies point out a growing connection between tutoring, student attendance, and test scores. The critical factor: Committing to tutoring at school, not as an add-on.

"It shouldn't be ad-hoc, or on-demand. It's not homework help," said Bhatt. "The message to school leaders is to protect the tutoring block in school."

Contrasting two types of tutoring

Bhatt's team initially picked four sites to study tutoring interventions over the 2022-23 school year to contrast two different kinds of tutoring. Fulton County in Ga., and Chicago Public Schools offered tutoring in school, while the other two sites—schools in New Mexico districts and a mid-size urban California school district—respectively offered evening and weekend slots, or after-school sessions.

In New Mexico's case, only 527 students signed up for evening or weekend classes out of a total 34,000 that were eligible, and only about two thirds actually attended. In Cali-

fornia, the urban school district that the researchers wanted to study saw a much lower rate of participation. In both cases, the participant numbers were too low to conduct a random-assignment study.

"The districts found that after-school or weekend programs are dependent on kids or their parents raising their hands. And it's not the same set of kids who may need this tutoring the most," noted Bhatt. "If we want to ameliorate education inequalities, we have to meet kids where they are literally, and in terms of where they are academically."

For the other two districts, Bhatt's team analyzed test scores for 429 students out of the 548 K-11 students randomized across 13 Chicago schools. One group was offered the tutoring at least three times a week at school. Schools picked which students would be part of the sample and school leaders prioritized students in the bottom quartile in terms of performance. All the students were offered tutoring at least three times a week for 30-minute sessions.

In Fulton County, Ga., the team studied outcomes of 1,163 students out of the 1,500 selected across 17 schools. Reading help was offered to students in grades 3-8, and math help was offered to students in grade 9.

In both cases, the treatment group received a much higher number of tutoring sessions, on average. (The control group also received some tutoring sessions).

As for the Stanford study, it's part of an ongoing look at tutoring sponsored by the District of Columbia's Office of the State Superintendent of Education, examining who received tutoring and how much it boosted learning.

"One of the things that stood out was the impact on attendance," said Wymack. "We were able to compare how often students came to school on days when there was tutoring vs. days there wasn't a session planned."

The studies both point towards the benefits of fitting tutoring in during the school day. It means a more diverse set of students will have access to additional help. And if instruction is differentiated for everybody, Bhatt added, students who need tutoring support the most will feel less stigmatized. And the findings are also good information as recovery dollars begin to dwindle.

"We felt an urgency to release these preliminary results because school leaders are making decisions about where to spend their remaining ESSER dollars," said Bhatt, referring to the federal aid for schools. ■

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The algebra crisis isn't about algebra—it's about preparedness

By Dr. Joseph L Goins, CEO, Pathway2Careers

Whenever NAEP scores decline or remain stubbornly stagnant—as they have since 2019—educators and parents seek explanations. Some point to outdated curriculum materials, while others call for more effective teaching strategies.

But to truly tackle the issue, we need to take a step back and reconsider student engagement in light of broader systemic factors that shape learning.

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Today's schools, by and large, don't have an algebra-specific problem; they have colossal preparedness gaps that underscore weaknesses in *all* K-12 math education. Most students who struggle with algebra are foremost struggling with foundational math skills—which they should have mastered long before educators presented them with algebraic concepts.

Data paints an alarming picture. In most large cities and counties across the US, the average eighth grade student scores below proficiency level in math. These learners haven't mastered fractions, ratios, roots, or proportions—essential building blocks for higher-level mathematics. Students who cannot confidently navigate these core concepts face insurmountable challenges in algebra and beyond. Placing them in an algebra course is akin to casting someone who cannot fry an egg on *Top Chef*.

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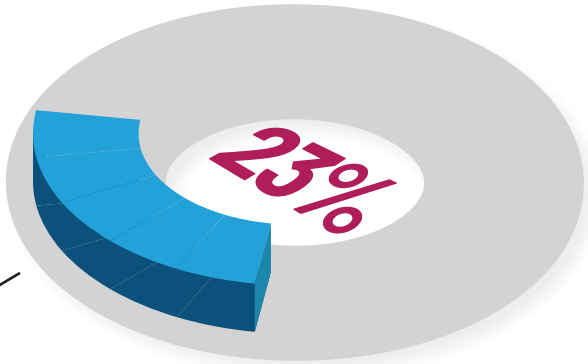

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Efforts to intervene and remediate students before algebra level are essential. Yet, such programs often fail to address the true source of students' struggles with math. Traditional interventions tend to merely delay students' poor algebra performance for a school year rather than right a student's concerning trajectory and get them up to speed with their peers.

Weak foundations cannot hold students up

A struggling student cannot hide in an Algebra course. If, for example, they haven't grasped fractions, then equations that involve reciprocals will evade them. If they lack proficiency in ratios and proportions, they have little chance of following along when their teacher demonstrates inverse variations or cross multiplication.

This disconnection illustrates that algebra is not an isolated struggle but a reflection of broader deficiencies in early math education. Or to borrow a math term, not addressing a student's early deficiencies risks rapid, exponential decay in their math skills.

Career-connected learning beats traditional interventions

Efforts to address the math crisis have long relied on the same ineffective strategies: more worksheets, more homework, and more reliance on standardized textbooks that are more likely to frustrate students than engage them. More, more, more.

These methods fail to address the core issue: many students don't see the relevance of math to their lives and future aspirations. They don't answer the key questions every student wants to ask (and are not shy about asking their teacher): *When will I ever need to know this in the real world? Why does this matter?*

Students who have struggled with math for years need a compelling reason to finally engage—or re-engage—with the subject. They don't need more busy work; they need more context. Effective intervention should focus on making math relevant, not just repeating the same concepts with the same tired approaches. After all, a student who finds literature uninteresting will not suddenly develop an appreciation for Shakespeare if they are given the text without any explanation. The same principle applies to math. Context and real-world connections make all the difference.

Career-connected learning provides those much-needed connections and explanations. By linking math to real-world applications, students can see that what they are learning has tangible, practical value—and as a result, boosts their engagement and ability to succeed.

Just ask educators at New Mexico's Hatch Valley High School. Within just one-year of switching from traditional curriculum to Pathway2Career's career-connected math lessons, P2C Math, Algebra I students realized more than a 90-point gain in their Quantile measures and Algebra II students saw an incredible 150-point lead in their measures.

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When students understand that math is not just an abstract subject but a critical tool for careers in engineering, healthcare, automation, aviation, graphic design, and countless other fields, their motivation and commitment to learning grow.

Learners deserve age-appropriate interventions

Not all intervention methods will be equally effective. *How* math problems and concepts are presented can have an enormous impact on students' perceptions—of both math itself and of their own ability to excel within it.

Remedial materials are too often designed for much younger children. Worksheets composed of elementary-level content—including cartoon animals, cheerful rhymes, and fairytale illustrations—can be discouraging and even humiliating for older students who may already feel self-conscious about not advancing to a higher-level course with their peers.

The importance of making remedial materials age-appropriate cannot be overstated. Rather than reinforcing a sense of failure or starting from scratch, these programs should respect students as learners and provide them with the tools and confidence to succeed. **When remediation is presented in a way that maintains students' dignity, they are more likely to invest in their own learning and make meaningful progress.**

Math education needs a makeover

Simply switching from one curriculum provider to another will not produce different results if the underlying teaching philosophy remains unchanged. That will merely expose students to *different* math problems, not a more effective teaching and learning approach.

Improving math education requires a novel approach—one that prioritizes engagement, relevance, and foundational skill development over rote memorization and test preparation.

Addressing the preparedness gap requires addressing the most fundamental math concepts *and* students' most fundamental complaint about math: their perception that math is irrelevant to their current everyday lives and near-future careers. Teachers, administrators, and education advocates alike must commit to interventions and strategies that emphasize conceptual understanding—and make it age appropriate and career-relevant.

Schools much say goodbye to remediation that merely rehashes ineffective teaching methods—which struggling students have already struggled to connect with—and instead, focus on creating meaningful learning experiences that help learners build confidence and competence in mathematics.

The solution lies in improving the quality of engagement, not the quantity of homework assignments or instruction time. Until the focus shifts from algebra itself to students' readiness for it, math performance across the country is unlikely to improve.

The stakes are too high to continue with business as usual. Students deserve an education that equips them with the skills they need to succeed—not just in algebra, but in life.

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Math Has Its Own Language. How Can Students Learn to Speak It?

By Sarah Schwartz

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Math is, by definition, a subject about numbers. But at the National Council of Teachers of Mathematics this week, math educators said the subject has its own language, too—and knowing how to speak it is critical to success.

In presentations and discussions at the annual conference, held this year here in Chicago, teachers, administrators, and higher education faculty enumerated the ways that math literacy unlocks students' understanding.

Some words have one meaning in general conversation, but another meaning in math. Others, like "square," can have two different math definitions: the geometric figure, and the square of a number, a type of exponent. Math also has its own grammar—decimal points, commas, parentheses, and brackets, for example, all have meanings distinct from those in an English/language arts class.

Internalizing and using this language is one way that students build math knowledge, said Gladis Kersaint, the vice provost for academic affairs at the University of Connecticut, in a presentation on supporting English learners in the subject.

For every lesson, she said, teachers should ask themselves: "What language objective do I have to attend to so that my content objective can be achieved?"

Presenting multiple definitions could help students understand new math concepts

Emily Illig, a 4th and 5th grade math teacher in Chicago schools, said she sometimes has trouble defining abstract concepts with her students.

When Illig can't demonstrate ideas with physical manipulatives like counters, "there becomes this disconnect," she said in a Q&A session at the conference. "And then I'm like, well, how do I get them ready for middle school, when things get more abstract?"

In a separate presentation, Matthew Winsor, an associate professor of mathematics at Illinois State University, explained one strategy he used to help English learners grasp complex definitions when he taught high school.

Winsor tasked students with creating "word squares"—index cards divided into four quadrants. In the top left quadrant, students wrote a math term in their own language; in the top right quadrant, they wrote the term in English. Then, they wrote a definition in their own words in the bottom left quadrant—in whichever language they chose—and drew a picture or wrote an example in the bottom right.

Students rely on these tools throughout the course, Winsor said: "I've had a student come back to me the year after and say, 'Hey, Mr. Winsor, I used my word squares today.'"

Other educators used similar strategies with younger students.

In a presentation on supporting struggling elementary schoolers, Laura Drechsel and Carolyn Stadlman, both math educators in the Crystal Lake school district in Illinois, discussed using the Frayer Model, another way to diagram vocabulary words.

In this model, students write the word they're defining in the middle of a four-quadrant box. In each of the squares, they write 1) the definition in their own words, 2) facts and characteristics of the concept, 3) examples, and 4) non-examples.

"When I first started teaching kindergarten, I thought, 'I'm going to just learn the curriculum, and that's going to be OK,'" said Drechsel, now an interventionist. She soon learned, she said, that she needed tools like this model to help shore up some students' understandings.

English learners will face specific math challenges—but also bring unique founts of knowledge

During Kersaint's talk on supporting English learners, several teachers identified a hurdle in assessing their newcomer students' math knowledge.

Many recent arrivals have experienced interruptions to their education in their home countries, they said. It can be hard to distinguish when students truly have gaps in their knowledge from when students know the material but don't have the math language in English to communicate it.

Math teachers need to be "listening hard" to their English learners, Kersaint said. For example, a student might offer a partial definition in English, a Spanish word, and draw a picture—teachers should consider all of this information as students' demonstration of their knowledge, she said.

English learners may also bring unique skills to math class, said Larisa Bukalov, a math teacher at Bayside High School in New York City.

When these students learn English, they often get explicit instruction in diagramming sentences—a skill that can help them parse word problems. "If you're not a native speaker, you're a lot more sensitive when you try to translate the [words in the] problem to the algebra," Bukalov said during Q&A after Kersaint's presentation.

For this reason, she said, she often has English learners model how they solved word problems for the group—positioning them as classroom leaders. ■

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4 Questions to Boost Algebra Gains for Middle Schoolers

By Sarah D. Sparks

Martine Severin/E+

More than 1 in 3 public school students now take Algebra 1 before high school. For those students to succeed, schools must adjust middle school programs to better match student readiness to class support, experts warn.

New federal civil rights data show that more than 931,000, or 36 percent, of U.S. public school students took Algebra 1 in middle school as of 2021.

However, students who are ready to tackle algebra don't get equal access to the course.

A separate study of nearly 4.4 million students in grades 3-8 during the pandemic found among students with above-average math scores, 55 percent of Black, Hispanic, and Native American students enrolled in algebra by 8th grade, compared to 63 percent of white students and 72 percent of Asian students. The disparities highlight gaps in both the course offerings in middle schools and how students get placed in challenging math courses.

Similarly, the civil rights data show that while 85 percent of students who took algebra by 8th grade passed it, that ranged from 89 percent of Asian students to 78 percent of Black students.

While efforts to promote universal access to algebra by 8th grade have gained traction in states and districts, studies find they have produced mixed results both in boosting students' math progress and closing racial, gender, and socioeconomic gaps in higher math course-taking.

To ensure middle school math programs serve a wide array of students well, experts say administrators should ask key questions.

1. What are our long-term goals for students?

Algebra 1 is a graduation requirement in every state, and a necessary prerequisite to higher math in high school and beyond. Studies show that for students interested in a two- or four-year postsecondary degree, completing that content before high school provides a huge boost.

Federal data show students who took Algebra 1 in middle school were 24 percentage points more likely to enroll in a four-year degree than students who took the course just a year later. Moreover, students who waited until 10th grade or later to take Algebra 1 were more than twice as likely as those who took middle school algebra to forgo postsecondary education at all.

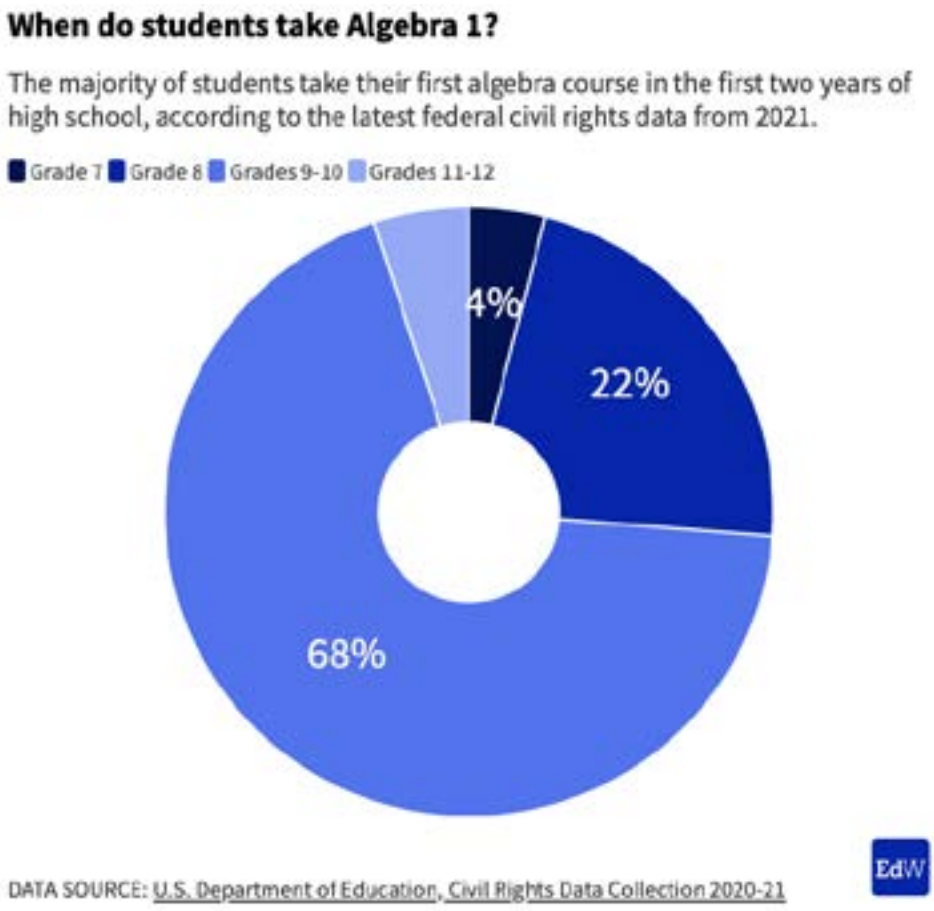
School district leaders should ensure middle school programs align with overall college-readiness needs at high school and at area postsecondary requirements.

> **"It completely comes down to this question of, what level of growth can you reasonably expect?"**
>
> **SCOTT PETERS**
> Director of research partnerships, NWEA

2. How quickly do your students learn?

Beyond just math achievement, schools should consider the pace of student learning when identifying which students participate in algebra before high school, said Scott Peters, the director of research partnerships at the testing group NWEA and author of a new guide to identifying student algebra readiness.

Using data from a multi-grade computer-adaptive test and state assessments in Ohio, Georgia, and Texas, Peters and his colleagues compared students' math learning growth in grades 6 and 7 to their likelihood of scoring at the proficient level in their state's 8th grade Algebra 1 test (That threshold is associated with a score of 238 on the adaptive tests, which uses a scale score of 100 to 350).



"By most of our research, 30 to 40 percent of 8th graders are ready for Algebra I and have a good chance of being successful," Peters said. "We should probably stop the binaries of either the top 2 percent or 100 percent" of middle school students taking algebra.

"It completely comes down to this question of, what level of growth can you reasonably expect?" Peters said.

On average, students grow more slowly from year to year in math as they progress in grades. For example, in 6th grade, the average student improved by about 5 points a year (on a scale of 100 to 350) on the NWEA's test, and students in the top 30 percent improved by 8 points. By 8th grade, students on average saw only 2 points of growth in math, with the students in the top 30 percent growing only 6 points.

"If the school is set up in such a way that there are lots of supports—there's peer mentoring, there's tutoring, lots of technology resources, the algebra curriculum is designed with lots of scaffolding built in—then you can let in students with a lot lower level of readiness because you can leverage that higher level of growth," he said. "But if you have a stereotypical, hardcore 'sink-or-swim' math teacher and there's no extra help, ... you really can't let in those lower-scoring students, because they're going to struggle and be much less likely to be successful."

For example, Karen Rambo-Hernandez, an associate professor of education at Texas A&M University and former algebra teacher, suggested schools may consider allowing a broad range of students to take algebra, but creating a one-hour algebra class for advanced students and a two-hour class for those who learn at average or slower rates, to give them more time to process the content.

3. What should the class makeup be?

There's little consensus on what makes for the most effective mix of student abilities in math class, but it is clear that teachers cope with a widening array of student needs.

Across U.S. 8th grade classrooms, 35 percent of students scored at or below the lowest benchmark on the 2019 Trends in International Math and Science assessment for math, while 14 percent met or exceeded the advanced math benchmark, according to a recent study.

More than a third of 8th grade classrooms included students across all four achievement levels. Nearly 40 percent of the variance in math performance on the TIMSS happened among students within the same classroom. In practical terms, this means the same 8th grade Algebra 1 class could include students who are comfortable solving multivariable linear equations, while others have an elementary-grade understanding of whole numbers.

"So many districts are either saying [8th grade algebra] has got to be everybody, you know, universal enrollment, or else it's only for the uber-mathematically gifted kids," Peters said. "I just think both of those really ignore like human diversity. ... The whole point is to try to remove those biases, provide more relevant criteria, and much more proactively align kids with the curriculum they're ready for."

4. How interested are students?

While prior student achievement and growth are the strongest predictors of success in middle school algebra, Rambo-Hernandez suggested schools also consider students' individual interests and motivation toward math. For example, "kids who have stronger self-efficacy may not get intimidated when they get to algebra as much as someone who has lower self-efficacy."

For one thing, students are more likely to read for pleasure than to pursue algebra practice outside of class and homework. Schools can use extracurricular activities, such as math or robotics teams, to boost interest in challenging math in younger middle school grades.

"In reading, you can just pick up a harder book if you want it once you've got the basics of decoding, without the direct instruction of a teacher," said Rambo-Hernandez. "Whereas in math, you kind of need a teacher to say, okay, you've mastered this skill, so we're gonna move on to this next skill." ■

Additional Resource
View this article's charts

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OPINION

Published August 31, 2023

Math Is Also a Foreign Language To English-Learners. How to Reach Them

By Larry Ferlazzo

'4 Essential Messages'

Isabel Becerra is the sheltered-instruction facilitator for the multilingual programs department in the Garland ISD in Texas. She was born in Bolivia and has been an educator since 1992. She is a passionate advocate for emergent bilingual learners:

As an educator for the past 28 years, I have seen firsthand the impact we make in the learning process of our emergent bilingual students by only providing the right supports, and scaffolds, to make content comprehensible and meaningful for them, even if they are at beginning levels of English proficiency.

In my role as the sheltered-instruction facilitator, I serve as an active and passionate advocate who seeks to provide an equitable learning environment for all learners. I do this by promoting the sheltered-instruction approach as a learning framework for best practices that offers students equitable opportunities to develop content and language. This second-language acquisition method is implemented within all grade levels and content areas to ensure that emergent bilinguals are fully engaged in meaningful and rigorous learning.

When we teach our emergent bilingual students math, we do need to understand that we are teaching another language. Math itself is a second language to many, due to the number of new terms, concepts, and process that need to be learned. Our emergent bilingual students come with limited background knowledge, cultural and linguistic differences, and they bring diverse learning experiences, which makes learning math too challenging for them.

When we don't connect and scaffold instruction for our EBs, we are setting them up for failure. We need to provide a language-rich and interactive learning environment for our students to have enough background to make sense of what they are learning. We use the sheltered-instruction research from Seidlitz Education, The 7 Steps to a Language-Rich and Interactive Environment as our framework. We equip teachers with instructional strategies that will allow all students to have access to content.

Some of the strategies that I recommend using with our EBs in math classes are:

1. To make academic vocabulary and concepts explicit and visual, we encourage our teachers to use Step 5, use visual and vocabulary strategies, to make content material comprehensible for emergent bilinguals by building context for vocabulary and incorporating supporting visuals. Visual and vocabulary supports assist in mastering grade-level objectives; strategies are implemented intentionally to make the learning accessible to all students.

2. To focus on academic and class discussions, EBs need to internalize content so that they can externalize it. This means we need to plan for multiple opportunities for students to speak math. Step 6, students participate in structured conversations, is one way that will allow students to process learning through structured discussions while developing academic language. Peer conversations support academic language use while content and language are equally developed in all learners.

One very common strategy in this step is the use of QSSSA (Question, Signal, Stem, Share, Assess). This strategy is helpful to scaffold a conversation, and it helps develop a sense of community among peers as well as it lowers the affective filter of our EBs when asked to discuss or respond to a question. Whether you are a kindergarten math teacher or a high school algebra teacher, I challenge YOU to try this amazing technique with your students.

3. Step 2, speak in complete sentences, will provide supports for students to speak at an academic level when discussing their learning. One way to do this is by using sentence stems for students to form complete responses in a way that they can adopt new language structures to use independently.

Instructional strategies are all about the student and equity in learning. To ensure that we approach our students with this mindset, we must consider what message our instruction is sending to them. How learning is delivered says a great deal about our attitudes, values, and beliefs.

The four essential messages that emergent bilinguals must hear from every educator are:

- You are important.
- What we are learning is important.
- You can do it.
- We will not give up on you!

Visuals and Manipulatives

Beth Skelton has over 30 years of experience as a language educator in many different contexts. She currently provides professional development, coaching, and consulting with schools around the world focused on providing equitable education for multilingual learners.

Tan Huynh is an international educator specializing in language acquisition. He advocates equitable learning for multilinguals through his blog, podcast, webinars, and books.

Tan and Beth are co-authors of Long-Term Success for Experienced Multilinguals.

Math is not a "universal" language as some may suggest; the language for math is just as challenging for English-learners as any other content class. In fact, math teacher Concepcion Molina even titled his book The Problem with Math is English.

We believe math classes provide a wonderful opportunity to teach both math skills and language if teachers design lessons following three essential principles: 1) enhance comprehension of the concepts; 2) increase student-to-student interactions; and 3) teach academic language.

Enhance Comprehension

Before introducing an algorithm for solving problems, we recommend that students have the opportunity to simply make sense of the concept and problems. Providing students with practical examples of the math concept in contexts connected to students' lives is a great starting place for enhancing their understanding of the math concept. For example, when teaching students to divide by fractions, first provide them with a practical scenario like the following:

Class, I would like to bake you some cookies. The recipe calls for 1 and 3/4 cups of flour, but I only have a 1/2-cup measuring cup. How many 1/2 cups will I need to make 1 and 3/4 cups of flour? Providing examples of 1 cup and 1/2 cup measuring cups will help all students see the problem. They can also experiment with scooping 1/2 cups of flour to see how many 1/2 cups make the total of 1 and 3/4 cups.

Visuals also enhance comprehension by linking unfamiliar words with physical objects. For example, many teachers think about using pizzas to visually represent 1 and 3/4 divided by ½. We can visually show students what the concept looks by showing pizzas and asking: How many 1/2s fit into 1 and 3/4 pizzas?

Manipulatives, objects that can be moved around, can also help students understand mathematical concepts. In the example of dividing by fractions, students can use 1/2- inch paper markers and a number line to figure out how many 1/2 markers are needed to reach 1 and 3/4 on the number line.

Increase Student-to-Student Interaction

While math is often done alone, when it becomes interactive, multilingual learners develop deeper understanding of the math concepts as well as the academic language to speak like mathematicians. We encourage teachers to structure these student-to-student interactions so that everyone has an equitable opportunity to explain their thinking using math-specific language.

Many of Kagan's cooperative learning structures are especially well-suited for the math class. For example, students could work in teams to figure out how many 1/2 cups of flour they would need to make the cookies, how many 1/2 pizzas fit into 1 and 3/4 pizzas, and how many 1/2-inch markers would make 1 and 3/4 on the number line. In teams, they can explain their thinking as they work with the manipulatives and visuals.

After teachers introduce the algorithm for solving problems, students need plenty of practice opportunities. When students work in partnerships to practice solving problems using a structure like Kagan's Sage and Scribe, they practice both the math skill and math language.

In this structure, the "Sage" tells the "Scribe" what to write to solve the problem. In a way, the "Sage" thinks aloud stating the steps for solving the practice problems, and the "Scribe" has the opportunity to listen, think about the steps, and write the solutions with support. The partners take turns with each role. Multilingual learners can be the "Scribe" first, which allows them to hear the steps from their partner first, before they take a turn describing the steps. Word banks and sentence frames support all students during this structured interaction.

Teach Academic Language

Math classes are filled with linguistic challenges, but they are surmountable when we teach the language mathematicians use. Most teachers spend some class time focused on teaching math-specific terms like property, common denominator, and place value, but they may not realize that multilingual learners may also grapple with other vocabulary challenges such as:

- Multiple meaning words like table, mean, and round.
- Homophones like sum/some; sine/sign; and two/to/too.
- Minimal pairs such as 30 and 13.
- Prepositions: The temperature fell from 50 degrees; the temperature fell to 50 degrees; or the temperature fell by 50 degrees.

Awareness of the linguistic challenges multilingual learners face in math class is an important first step to providing necessary supports. Some of the most effective supports include:

- Labeled visuals
- Visual word banks
- Written numbers (not just verbal numbers)
- Many opportunities to hear and practice words in context

Enhancing comprehension, increasing interaction, and teaching academic language can solve the problem of math for multilingual learners. Math is not just the study of numbers but also the language wrapped around those numbers!

'Four Mindsets'

Jim Ewing is an associate professor and author of the book Math for ELLs, As Easy as Uno, Dos, Tres. *Jim provides motivating, relevant, and strategy-driven workshops for teachers that get results. To learn more about his workshops and book, go to EwingLearning.com:*

Multilingual learners are not doing well in mathematics as a whole. This is not because they are not capable but because we are not meeting their needs (Ewing, 2020). Solely focusing on strategies is not enough—we also need to consider our mindsets. If educators do not have the proper mindsets, then using strategies will not be effective.

Below are four mindsets that we should have to accompany strategies.

Position multilingual learners to be successful. One strategy often used by educators is to assign helpers to assist multilingual learners, but this can position multilingual learners as weak (Chval et al., 2021). We can better position their success by ensuring that multilingual learners are helping other students, too.

We can ask multilingual learners questions about their strengths so other students see them as capable mathematicians. Educators can revoice students so they have mathematical voices in the class. Merely calling students "multilingual learners" instead of "English-language learners" can let other students know how talented they are for knowing more than one language. Regardless of the strategies we use, we need to po-

sition multilingual learners to be successful mathematicians.

Be culturally responsive. Using visuals can be an effective strategy, but what are multilingual learners visualizing? If multilingual learners cannot visualize themselves in our math curriculum, they will not be successful. If the visuals we use do not look like the multilingual students in our classes, then they may feel that they do not belong in the math discourse. Another strategy is to engage students at the beginning of the math lesson by reading books to them, but if the characters in the book are not about multilingual learners, these students will not be hooked.

Focus on persevering, not working fast. A third mindset is to focus on persevering over working fast. This is important for many students but imperative for multilingual learners who are often translating from their first language. Using manipulatives is a useful strategy for building concepts and providing access, but if multilingual learners are not also provided enough time, using that strategy will fall short.

Have high expectations. There are many strategies for providing multilingual learners access to the content, such as using gestures, but if we have low expectations for students, this will be counterproductive. If we apply the first three mindsets: position multilingual learners to be successful, be culturally responsive, and focus on persevering, they can engage in challenging math. Thus, it makes sense to raise our expectations for multilingual learners.

We can meet the needs of multilingual learners, and they can be successful, but just learning strategies is not enough. Let's also change our mindsets and celebrate multilingual learners' success in mathematics. ■

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