EDITOR'S NOTE
Enhancing intervention efforts can improve student performance on math assessments and their overall achievement. This Spotlight will help you evaluate recent trends in students’ math scores; explore growing investments in math education; learn how targeted support is essential for Algebra 1 students to progress to higher level math; examine the long-term benefits of early math supports; gain insights into improving online math assessments; and more.

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Math Assessment & Intervention

"Math Assessment & Intervention"
Explaining That Steep Drop in Math Scores on NAEP: 5 Takeaways

By Sarah D. Sparks

The National Assessment for Educational Progress announced historic declines in math for students in its main NAEP for 2022, with average scores dropping 5 points, to 236 out of 500, in 4th grade, and 8 points, to 274, in 8th grade.

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1. There’s bad news for (nearly) everybody.

Nobody improved in math in 2022. I mean nobody: Students in grades 4 and 8, low-income and wealthier students, boys and girls, students in every racial or ethnic group, and students with and without disabilities, in every region of the country, all stayed flat or fell back.

2. This shouldn’t be a surprise.

The results of the main NAEP come on the heels of similarly grim results from other major tests, detailing the ongoing fallout of pandemic disruptions to schooling and more than a decade of faltering academic progress.

Last month, NAEP’s long-term trend study, which uses a pool of mostly the same questions to compare the achievement of 9-year-olds over time, showed the first decline in math in the test’s 50-year history. And independent, large-scale testing groups such as NWEA and Amplify have been sounding the alarm about learning loss—particularly in math—during the pandemic. The 4th and 8th graders participating in NAEP in 2022 would have been in 2nd and 6th grades, respectively, when the pandemic began and schools faced extended and widespread closures.

Yet experts also noted that the pandemic provided more of a tipping point than a single push. Math scores have been falling off for years, particularly for those in the lowest 10 percent to 25 percent of students.

“Let’s be very clear here: The data prior to the pandemic did not reflect an education system that was on the right track. The pandemic simply made it worse. It took poor performance and dropped it down even further,” said U.S. Secretary of Education Miguel Cardona, speaking in a briefing with reporters on the NAEP results. “As an educator and as a parent, that’s heartbreaking and it’s horrible. It’s an urgent call to action.”

3. There are more students now with severe needs in math.

Only 37 percent of 4th graders and 27 percent of 8th graders are proficient in math—meaning they are considered capable of handling challenging academic work—representing significant declines in both the number of proficient and advanced students in both grades. The share of advanced-level students fell from 9 percent to 8 percent in 4th grade and from 10 percent to 7 percent in 8th grade.

By contrast, 38 percent of 8th graders and a quarter of 4th graders cannot meet NAEP’s lowest benchmark—the basic level. More than half of students in poverty as well as Black, Hispanic, and Native American students in grade 8 performed below the basic level in 2022, along with more than a quarter of white students. In 4th grade, more than 40 percent of Black and Native American students, more than a third of Hispanic students, and 14 percent of white students performed at that lowest level in math.

What does that mean for students? In 4th grade, fewer than 3 out of 5 students now can tell whether whole numbers are even or odd—Asian, Black, Hispanic, and white students all saw drops in average scores in 4th and 8th grades since 2019. Native American students lost some of their progress in 4th grade but held flat in 8th.

None of the states or large school districts that participate in NAEP’s Trial Urban District Assessment improved in math at either grade. Only students in Utah and students in the Department of Defense schools stayed steady in math at 8th grade in 2022, while 4th graders in 10 states (not including Utah) and the Department of Defense schools also showed no change since 2019.

Eighth graders in every kind of school—private Roman Catholic, charter, and traditional public schools—lost ground in math, as did 4th graders in both kinds of public schools. However, 4th graders in Catholic schools held steady at 246.

Charter schools saw the biggest declines in math: 4th graders in those schools declined 6 points, to 232, and 9 points, to 268, for 8th graders.
Let’s be very clear here: The data prior to the pandemic did not reflect an education system that was on the right track. The pandemic simply made it worse. It took poor performance and dropped it down even further.”

MIGUEL CARDONA
US Secretary of Education

“Eighth grade is that gateway to more advanced mathematical course-taking,” said Peggy Carr, NCES commissioner. “This is what these students are missing. They’re missing important skills that will prepare them eventually for [science, technology, engineering, and math] careers. We need to be concerned about getting these students back on track so that they can be prepared for global competition in these areas.”

4. Teachers are overwhelmed.

While fewer teachers reported classroom supplies are a problem in 2022, more teachers problems with too many teaching hours and not enough workspace, teachers reported as part of NAEP’s background survey. For example, 27 percent of 4th graders and 29 percent of 8th graders now have teachers who say their work hours have become a “moderate” or “serious” problem. That’s a higher share in both grades than before the pandemic.

While a majority of students still have educators who are satisfied with being a teacher, teachers were generally less satisfied and inspired by the profession in both grades than in 2019. That may be both a cause and a symptom of widespread teacher shortages, in which math is the subject with the greatest need for staff.

Significantly more 4th grade teachers have received training or become proficient in education technology since the onset of the pandemic. Forty-two percent of 4th grade teachers now have teachers with a full or part-time math coach to support their instruction, up from 37 percent in 2019. However, less than half of teachers who reported having a math coach had one who worked with 4th grade teachers individually or worked specifically on 4th grade content to a large extent.

5. It’s going to take a lot of time and money to fix this.

The federal government has already dedicated $190 billion through ESSER and the American Recovery Plan to help schools address lost student learning during the pandemic. Recent research suggests that’s not nearly enough money, for a long enough time frame. One study published in the journal Education Researcher earlier this month estimated schools will need $500 billion in additional funding—and targeted more specifically to high-need students—to fully recover.

“State education leaders are committed to accelerating learning and recognize it will take years to fully recover from the impacts of the pandemic,” said Carissa Moffat Miller, CEO of the Council of Chief State School Officers. “States have put interventions in place, and many of these began in earnest just before students took the 2022 NAEP exam. We are grateful to have another two years of federal COVID-19 relief funding that will allow these interventions to have their full effect on student learning.”

NAEP background survey data show nearly 70 percent of 8th graders attended schools in 2022 that offered supplemental math instruction weekly to nearly every day, and more than 1 in 4 students received math tutoring outside of school at least once a month.
PROVEN MATH, ASSESSMENT, AND READING INTERVENTION BY RENOWNED EXPERTS

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Why the Gates Foundation Is Investing $1.1 Billion in Math Education

By Alyson Klein

What do you get when you add up more than a billion dollars, plus a foundational but often overshadowed K-12 subject, and multiply it by the influence of the biggest player in K-12 education philanthropy? The Bill & Melinda Gates Foundation is hoping the answer will equal: Exponential change for math instruction.

The foundation will target the subject for as long as a decade, beginning with a $1.1 billion four-year investment. The goals: More and better trained math teachers, a new trove of engaging and effective teaching materials, and a clearer sense of how to teach a subject that many students now find dry and intimidating.

“Math helps students make sense of the world,” Bob Hughes, the foundation’s director of K-12 education told reporters in an Oct. 17 call. “It gives them critical thinking and problem-solving skills they can use later as adults.”

Math educators are excited by the prospect of the investment. But they hope the foundation will take into account the perspectives of seasoned educators, something many saw as lacking in past Gates initiatives on standards and teacher evaluation.

“I’m a little bit giddy that somebody is actually going to help fund improvements in math education, so that maybe we might have the tools that we need to actually address some of these things that are coming out in the research,” said Latrenda Knighten, a mathematics instructional coach in Baton Rouge, La.

The foundation’s math effort will “only be as good as the people [Gates] chooses for [its] advisors,” she said. “You have to talk to folks who are in this business, you have to talk to teachers, you have to talk to the organizations,” including the National Council of Teachers of Mathematics, on whose board Knighten used to sit.

Gates has spent the past year in listening sessions with hundreds of educators, experts, parents, and community members, and will continue those efforts, Hughes promised.

“We expect to learn a great deal and make appropriate adjustments as we listen to and work with the many educators who have helped us shape and formulate the strategy,” he said.

Gates will focus on the four most populous states: California, Florida, New York, and Texas as because of their high populations of children in poverty.

Gates already spends about 40 percent of its K-12 budget on improving math education. The money for this deeper initiative will come, in part, from shifting dollars out of grants for projects in other subjects, including language arts.

Big problems in math achievement, teacher training

Gates is announcing its move into math just over a month after long term trend data from the National Assessment for Educational Progress showed that 9-year-old students scored, on average, seven points lower in math in 2022 than did their pre-pandemic peers in 2020.

In particular, Black student achievement plummeted, falling 13 points from 2020 levels as opposed to 5 points for white students. That widened the gap between the two groups from 25 points in 2020 to 33 points in 2022.

What’s more, the math teacher shortage—a perennial problem—has only been exacerbated by broader concerns about instability in the profession, spurred in part by the pandemic.

“We have shortages everywhere,” said Robbi Berry, an elementary school teacher in New Mexico who focuses on math. “I think people are just feeling overwhelmed with the amount that teachers are being asked to do.”

In response to such concerns, Hughes pointed to “alternative staffing structures” that may help build the teacher pipeline, including teacher residencies, which typically allow prospective teachers to work under the supervision of a more experienced educator while obtaining their credentials.

Technology could be part of the solution

Students, Hughes said, need digital tools that can adjust to where they are on a particular math skill and give them a chance to practice and advance, as well as the opportunity to collaborate with their peers on math problems, explaining to one another how they might have taken different routes to arrive at the correct solution to a particular problem.

One glimpse into the type of tools Gates may have in mind: Zearn, a digital math program that works to quickly catch students up on the background they need to master grade level content. Its CEO and founder joined Hughes on the call with reporters, touting the foundation’s support for her nonprofit organization.

Zearn has shown some promising results. Students who use the program struggled less on grade level math skills than their peers whose schools choose to do math remediation, which seeks to give students a more comprehensive understanding of the skills they failed to grasp in previous grades, according to a recent report.

(Both Zearn and the nonprofit organization that conducted the report, TNTP, have received grants from the Gates Foundation. Editorial Projects in Education, the publisher of Education Week, receives sustaining support from the foundation. The media organization retains sole editorial control over its articles.)
Can Gates stay above the fray in the math wars?

Gates appeared open to helping schools broaden advanced math offerings beyond the traditional peak: Calculus, which has long been seen as a must for students who want to get into the most competitive colleges, even if they’re not planning on majoring in math or going into a STEM profession.

More recently, though, there’s been a push to steer more students to courses like statistics or data science, which may be more applicable to their likely career or major and also build advanced math skills.

Calculus “continues to be an important path, particularly for young people who are looking at physics or engineering or advanced STEM careers,” Hughes said.

He noted that Harvard University, Stanford University, and the University of California system have all expressed support for other options. “We’re not interested in narrowing opportunities for students in math. We want more students to take more math with much greater exposure to things like statistics and data science.”

But Gates seems to be looking to remain neutral when it comes to some of the biggest debates in the math teaching world these days, including whether to emphasize an inquiry-based, problem-solving approach or more traditional teaching methods that emphasize procedures and algorithms. A hot debate over those approaches is currently playing out in California, which is seeking to revise its math guidelines.

“We’re working on a holistic approach to mathematics that enables young people to both gain procedural and conceptual understanding and apply that to real-world problems,” Hughes said, when asked which approach the foundation favored. “We’re really committed to ensuring that kids have interesting, exciting math. We’re really committed that they learn the basic skills they need to be successful in complex problem solving.”

Gates is also agnostic when it comes to how fast to accelerate advanced math students—whether they should be given the opportunity to take Algebra 1 in middle school, for instance—another topic generating controversy in the Golden State.

“The research base is mixed. I think that we’re going to be supporting people who believe [Algebra 1] in eighth grade or ninth grade is appropriate,” Hughes said when asked about the debate. “We want young people to take the math that’s most appropriate to them at the highest level they can actively participate.”

Jon Star, an educational psychologist who focuses on math education and is a professor in the Harvard Graduate School of Education, said Gates has the opportunity to make a big impact, but wondered how the foundation’s decision to side-step divisive issues would play out.

“They have the ability to do something transformative with that kind of investment,” he said. Star, who was among the experts Gates consulted about its plans, said that from what he’s seen, the foundation is focused primarily on equity and “trying not to get into the weeds in terms of the other debates we’ve been having in the field for a while” when it comes to math instruction.

“But on the other hand, that might be admirable, that they’re trying to stay above the fray, be open-minded,” he said. But on the other hand, he worries it could be “the beginning of a fault, a misstep, where we’re not learning from our past mistakes.”

‘There’s no silver bullet’

This isn’t Gates’ first big foray into math. The foundation was a major funder of the Common Core initiative, which specified what students need to know and be able to do in both math and language arts.

The standards were launched in 2009, and adopted in all but four states by the end of 2011. But a major backlash followed that initial success, with several states reversing their decision to embrace the standards, others rebranding them, and more than half ditching tests designed to measure mastery of them.

Parents and educators criticized the foundation for not reaching out enough to teachers and school leaders to get their perspective on implementation. There was similar criticism of the foundation’s push to link teacher evaluation, based in part on test scores, to pay and promotion, another major Gates initiative rolled out around the same time.

The $1.1 billion, four-year expenditure is comparable to the foundation’s previous marquee K-12 initiatives. Gates spent $1.6 billion on small schools and early college high schools, and $1 billion on teacher effectiveness.

Ultimately, Knighten is eager to see what will come out of the ambitious effort. But she already knows it won’t fix all the problems in math education.

“I realize no matter what they do, no matter how much money they bring, they cannot bring the silver bullet,” she said. “Because it doesn’t exist.”
Throughout the pandemic, data from testing has shown that students are struggling in math, making less progress than they might have in other years.

Teachers, too, have said that routines core to their instruction are much harder to do with virtual learners—like showing lots of visual representations, working out problems collaboratively, and having structured student discussions about math concepts. Even with screensharing and digital math tools, they say, it’s not quite possible to recreate the kind of classroom setting where students can work with manipulatives, groups can collaborate on whiteboards, and teachers can evaluate understanding in real time.

Students in all grades may require extra math support next year, but experts say this need is especially urgent in Algebra 1.

The course is often the first math class taken in high school, and it’s a gatekeeper to higher level mathematics that would prepare students for college study or careers in science, technology, engineering, or math. It’s also part of a student’s freshman grade point average, a signifier of whether they will graduate on time or not. Passing Algebra 1 is a graduation requirement in most states.

For this story, Education Week spoke with a dozen instructional experts, teachers, parents, and students about what students starting Algebra 1 next year need and how schools can support them. Representing their reflections and insights is “James,” a composite student about to enter high school and start Algebra 1.

Where things stand for James

When the pandemic hit, James was in the spring of his 7th grade year. Math wasn’t his favorite subject, but there were parts of it he found satisfying—like the moment when an understanding finally clicked into place after lots of examples and repetition. And he liked that math was a social subject, a class where it was not only acceptable but encouraged for students to ask each other for help or bounce ideas off of one another.

He spent most of 8th grade in remote learning. Staring at the screen all day was hard. He would get headaches, and his phone was a constant distraction. Sometimes the Zoom feed would lag and he would miss parts of the math notes his teacher gave. The class moved a lot faster online than he was used to, with fewer opportunities to see his teacher work out example problems.

Asking questions was a drawn-out process. He’d have to stop the assignment, email the teacher, and wait for a response before he could keep going. If he were in a physical class, he might have turned to one of his peers for help. But it felt uncomfortable to do that online, when he didn’t know most of his classmates that well. Instead, he relied on math websites where he could plug in a problem or an equation and get the answer. He wasn’t failing, but he felt like he was barely keeping his head above water.

James’ school opened up for in-person in March 2021. When he came back to the building, his teacher quickly realized that he was struggling with a lot of skills she thought he had mastered—skills he would need to be successful in 9th grade, in Algebra 1. For example: At home, he’d relied on online tools to graph linear equations for him. He wasn’t sure how to do it by hand. And he struggled when asked to find all the positive and negative factor pairs for a number.

But he also had some deeper misunderstandings and unfinished learning around number sense. He was still a bit shaky with fractions and decimals: He might measure $7$ inches on a ruler and note the value as $0.7$ feet, rather than $7/12$ of a foot. Presented with an equation like $\frac{1}{2}x + 3 = 7$, he knew to subtract $3$ from both sides. But then he wasn’t always sure how to “undo” the fraction.

In a normal 8th grade year, teachers said, they would take every opportunity to correct those misunderstandings in the moment and shore up students’ comfort—not only with fractions and decimals, but exponents, radicals, and negative integers, too. Wendy Habeeb, an 8th grade math teacher at Salida Middle School in California, said that she is constantly plotting on a number line on the white board, so that students can see connections between different expressions of numbers—that the square root of 64 is 8, which is the same as $16/2$, for example.

“Having that ability to see relationships between numbers is what leads to success in Algebra 1,” said Phil Murray, a high school math teacher at Early College Opportunities High School in Santa Fe, N.M.

But online, it was harder for teachers to do that kind of constant reinforcement, and harder for students to internalize it. Now that James is back in the classroom, asked to explain his thinking, he draws a blank. He’s hesitant to volunteer answers because he’s afraid they’ll be wrong, and he doesn’t want to look like he’s farther behind than everyone else.

He’s nervous about starting Algebra 1. He’s already having a hard time keeping all the numbers and letters straight in his head, and he knows it’s only going to get more complicating...
What algebra teachers can do

Even in a regular year, teachers say, students come into Algebra with varying degrees of readiness. But this year, the range might be even greater, depending on what opportunities and resources they had during remote learning. James has trouble with fractions, while another student might be fine with fractions but struggle with exponents. For that reason, teachers and experts recommend, lessons should start with checks for understanding.

Experts recommend this kind of targeted, just-in-time support instead of remediation (having James repeat entire units from 8th grade math before moving on to Algebra 1 content). Remediation can be demotivating, said Amy Getz, the interim director of K-12 education strategy, policy, and services at the University of Texas at Austin’s Charles A. Dana Center. It also can push students who are struggling further behind, by limiting their access to grade-level content, she said.

James’ teacher can show multiple representations for new concepts, something that James always found helpful in the classroom—for example, drawing explicit connections between the way a linear function looks written as a mathematical expression, the way it looks as a graph, and real-world examples James might encounter. Teachers can also be explicit about the connections between word problems and the equations meant to solve them, teaching solution methods for different types of problems.

And the number line that Habeeb, the California middle school teacher, uses doesn’t have to stay in 8th grade: Algebra teachers can continue to plot radicals, exponents, and fractions if students are having a hard time conceptualizing their magnitude. For example:

## “

Having that ability to see relationships between numbers is what leads to success in Algebra 1.”

**PHIL MURRAY**  
High School Math Teacher  
Santa Fe, NM

The idea that the square root of 16 is the same as 4 is the same as 2 squared can feel really abstract to students, said Sheng Lor, another 8th grade math teacher who works with Habeeb. But when she plots numbers like these at the same point on a number line, she said, “it was a like a switch in their head.”

Next comes practice, practice, practice, teachers say—opportunities to build fluency and confidence that students might not have had while learning remotely. Group practice, specifically, also allows teachers to listen to students’ thought processes. James’ teacher could listen in to his group conversation—asking guiding questions to explore his thinking, reinforcing his use of mathematical language, and addressing any misunderstandings in the moment.

But teachers will also have to get students comfortable having these kinds of group discussions again—important for students in all grades, but crucial for incoming 9th graders who may not know their classmates. Lor said that comfort level doesn’t just happen. She had to intentionally set aside time for students to develop relationships. This spring, she had some additional time with her math students due to state testing schedules. She chose to spend part of it just talking—having students share what they were doing over the weekend, for example.

It was a tough choice, deciding to chat instead of squeezing in one more math problem, because Lor knew that these students had already missed so much learning time. But it paid off: Her students were quicker to participate in turn-and-talks during the short time left in the school year.

High school math teachers—who might not usually spend as much time outlining classroom norms as their middle school counterparts—could spend more time on that this year, Getz said. “You model for the students how you can ask questions to try to understand someone’s reasoning, making it really clear that getting a wrong answer can sometimes be a really important step in the learning process.”

## Insights for all teachers

Teachers, experts, parents, and students focused on two big takeaways. First, in math, all of this focus on relationship building and social-emotional learning isn’t an extra, teachers say. It’s integral to students’ academic success.

If students don’t feel comfortable saying they don’t understand, if they aren’t willing to tackle a challenging problem or share their ideas in a group, then they won’t be able to get the practice they need to achieve fluency, or ask the questions that can lead to deep conceptual understanding.

“All the time I would [have liked] to ask a question, but I was afraid of what was going to happen,” said Camryn Smith, a rising 9th grader in Salida, Calif., about remote learning. She was nervous about calling attention to herself by typing into the chat box. And she thinks that it might take her a while to get back in the headspace where she feels comfortable asking questions again.

“Be patient,” Smith advised teachers. “Sometimes it’s really hard getting back into the groove of things.”

But getting back into the groove doesn’t have to mean easing off the challenge. Which leads to the second point: Give all students access to grade-level content. Helping students master challenging work with appropriate support keeps them on track, so that they’re prepared for higher level math and can succeed in the courses they need for graduation. And it can also build their confidence.

“I’m waiting for that ‘aha’ moment when she’s actually excited about the fact that she’s getting it,” said Christina Laster, a Palm Springs, Calif., parent of a rising 10th grader who was in Algebra 1 this past year. “I hope that it’s not as emotionally draining.”
Immediate academic gains from early-childhood programs often fade as children move into upper elementary school. But a new study suggests math supports in the earliest grades may build on each other over years to create longer-term benefits in math achievement and attendance.

In the latest report of an ongoing evaluation of the Making Pre-K Count and High 5s math programs in New York City schools, the research group MDRC found neither program on its own led to significant, sustained math gains by 3rd grade. Yet students who participated in both the preschool and the kindergarten interventions performed significantly better in math and were less likely to miss school by grade 3, compared with students who did not participate.

In the study, students in 2013-14 were randomly assigned within their public schools to participate in standard preschool and kindergarten or the preschool math curriculum alone or with High 5s, a kindergarten enrichment program in which math tutors each met with three to four children for 30-minute math “clubs” three times a week, either during a free period or outside of school.

The enrichment sessions focused on games, songs, and other activities to help students practice geometry, pattern recognition, and other math concepts, rather than basic counting drills in the standard classes.

Shira Mattera, the study author, said the results suggest “the effects seem to be particularly pronounced for children with the most room to grow.”

Students who started preschool with lower-than-average language and attention skills showed math gains by 3rd grade equal to a quarter to a third of a standard deviation. Two years of math enrichment in preschool and kindergarten were enough to produce 3rd-grade math gains large enough to close about 40 percent of the math performance gap between low- and high-income 4th graders.

**Attendance improved for participants**

Moreover, the researchers found that 28 percent of the students who participated in two years of math enrichment were chronically absent—meaning they missed 10 percent or more of school days—in grade 3, compared with 37 percent of 3rd graders who had not received the early math services.

While chronic absenteeism in early grades often comes from family challenges and stressors that the study did not measure, the researchers did offer some speculation about why students who received math enrichment missed less school later on, Mattera said.

“In kindergarten, in our earlier years of analysis, we found effects of the programs on children’s attitudes towards math. Perhaps, how kids either viewed school or viewed math might have influenced whether they wanted to come to school,” she said. “It’s also possible that teachers saw children who were doing better in math or liked math better as more engaged,” and so built better relationships with them.

These academic and attendance benefits may be particularly important for school districts working to catch up large cohorts of students who are now entering preschool with less formal early-childhood education as a result of the pandemic.

Both of these programs build on learning trajectory development. All children develop math abilities on a general developmental sequence,” she said. “If you understand the skills that are associated with that sequence, you identify activities that are appropriate for meeting the child’s needs and learning goals to move them to the next part of the sequence.

“I think it makes a nice addition to how people can think about the wide range of skills that children will be coming in with after COVID, because while some students may be coming in with lower skills, because they’ve had missed opportunities, some children may have had a different set of opportunities and teachers are really going have to differentiate across that,” she said. “And this gives an entre into thinking about how you could use similar math activities to meet the needs of a wide range of children’s skills and experiences.”
Throughout my career as a math educator, one of the most consistent refrains I have heard is: “Where is the research for that?” This criticism only increased with the influence of the National Council of Teachers of Mathematics (NCTM) in the 1990s and early 2000s.

The question of a “research basis” for math curricula also came into question with select programs initially funded by the National Science Foundation published during the 1990s, which ostensibly tried to embody the 1989 Standards’ core emphasis on problem solving and communication.

In the “math wars” that emerged in the late 1990s, many educators considered (and often dismissed) the 1989 and 2000 NCTM Standards as vast and too aspirational. Critics increasingly asked: “Where is the research for that?” particularly when the standards were presented as a framework for all students, including those who were failing in mathematics. Straightforward, direct instruction that helped students (particularly struggling students) demonstrate procedural competence had a proven research base in both mathematics and educational psychology, yet the questions continued. “Why should we waste valuable class time having students discuss mathematics or individually articulate their thinking in detail?”

Balancing research with a sensible, 21st century framework dominated my thinking as I developed (and have continued to update) TransMath®, a middle school math intervention program for struggling students.

Changing Values, Changing Standards

What debates over “research-based practices” often miss is that standards can reflect a shift in values, thus making some of them ahead of the current state of research in a domain like mathematics. Moreover, values are more than just the well-developed opinion of a like-minded group of educators.

“What does it mean to be ‘mathematically literate’ in today’s world?”

The Common Core Standards (2010), for example, reflect a careful review of math practices from countries around the world whose students generally perform at higher levels on international assessments such as TIMSS and PISA. Most importantly, the values behind math standards also reflect the undeniable and dramatic influence of rapidly changing technology. What it means to be “mathematically literate” in today’s (and tomorrow’s) world is significantly different from what it was in the 1980s.

By Dr. John Woodward, professor emeritus, University of Puget Sound, author of TransMath
Nonetheless, various agencies in the U.S. Department of Education, such as the Institute of Education Sciences, have tried to keep up. The What Works Clearinghouse (WWC), for example, has funded an array of expert panels in mathematics whose members have crafted instructional recommendations based on a thorough review of high-quality research. The results from these panels are Practice Guides developed intentionally for teachers and administrators, not just other academics. The recommendations from these guides do not attempt to provide a comprehensive foundation for everything found in state and national standards today. Instead, they offer research-based guidance for core practices in topical areas such as early childhood mathematics, fractions, algebra, and problem solving.

The What Works Clearinghouse (WWC) has funded an array of expert panels in the area of mathematics that have crafted instructional recommendations based on a thorough review of high-quality research.

I have participated on two WWC Practice Guides in mathematics, once as a chair for the problem-solving panel and more recently as a panel member on the Assisting Students Struggling with Mathematics: Interventions in the Elementary Grades (2021). This guide was particularly meaningful to me because of my career in special education.

The Assisting Students guide provides empirical support for some of the practices seen as dubious to some educators in the 1990s. For example, students are encouraged to communicate their thinking in the classroom. But rather than free-wheeling discussions, a core recommendation in the guide encourages teachers to model the use of appropriate vocabulary as well as provide hints and prompts to initiate student communication. Teacher-student and whole-class discussions create the opportunity for formative assessment and constructive feedback. Some may regard this recommendation as almost prosaic in today’s math classroom, but it is a radical departure from the model of research-based practices—grounded largely in arithmetic procedures and math facts—for struggling students 20 years ago.

Manipulatives and Visual Representations

For example, encouraging the careful use of manipulatives and visual representations along with student and classroom talk links directly to a pair of recommendations in the guide. Their use can be central to the development of conceptual understanding.

Cuisenaire rods, for example, can be important tools for helping students understand part to whole relationships in a dynamic manner (e.g., a rod that is used as “the whole” can in turn be used as “the part,” thus pushing students to see beyond just the symbols of numerators and denominators \( \frac{1}{2} \)). (Figure 1)

```
FIGURE 1

A brown Cuisenaire rod is initially used as the whole, and as the visual above shows, the purple rod, by comparison, represents \( \frac{1}{2} \).
```

Later, the purple rod can be used to represent the whole, and other rods in relation to the whole can be used to represent different fractional values. (Figure 2)

```
FIGURE 2

The Whole

\( \frac{1}{2} \)

\( \frac{3}{4} \)
```

Shifting rods like this using well-chosen, visual representations helps students see the dynamic relationship between the part and whole, particularly when students articulate their thinking and make the direct connection to the fractional symbols of \( \frac{1}{2} \) and \( \frac{3}{4} \). The effectiveness of these representations and student discussions was borne out recently in a high-quality, random assignment research study conducted with fifth-grade students in special education.

This is just one example of the research-based practices advocated in current standards that I have tried to incorporate in my intervention curriculum, TransMath. This example also reflects the “push and pull” of standards and research that is likely to continue as rapidly increasing use of technology redefines what it means to be mathematically literate.

To learn more about TransMath or to watch John Woodward’s webinar visit voyagersopris.com/webinar-series/2022/math-standards-research-and-the-making-of-a-curriculum.
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Math’s Composite Score: A combination of multiple Acadience Math measure scores, which provides the best overall estimate of the student’s math proficiency. Every grade has a Math Composite Score benchmark target for beginning-, middle-, and end-of-year measures.
The Problem With Giving Math Tests Online
And How Teachers Are Solving It

By Madeline Will

In the midst of the coronavirus pandemic, teachers have had to rethink pretty much everything they do with students—and that includes how they give math tests.

With many students working remotely, there’s no point in administering assessments that ask students to come up with a single answer; it’s simply too easy to cheat. Instead, teachers are focusing more on assessing students’ conceptual understanding of the mathematics—and they’ve had to do that without being able to gauge students’ body language or talk in person.

These changes are especially prominent in schools that have remained completely remote, but they hold true even when students come to school a few days a week. Teachers in schools doing hybrid instruction say they don’t want to spend all their limited in-person time administering tests and quizzes, so remote assessments are still a factor. And even when school buildings do reopen for full-time in-person instruction, some teachers say they hope this shift in how they assess students will continue.

“I think this is good for a lot of us math teachers because it’s forced us to rethink what assessments are supposed to accomplish,” said Matthew Rector, a math teacher and department chair at Grant Union High School in Sacramento. “In the past, most of us have thought about assessments as ranking tools—give a kid a grade and move on. Assessments should be about moving mathematical knowledge forward.”

Of course, making sure students can explain the math they’re learning isn’t a new concept: The Common Core State Standards, which were created more than a decade ago and are still being used by the majority of states in some form (though often under a different name and with some modifications), encourage math teachers to balance conceptual understanding, procedural skills, and fluency with real-world application. There has long been a debate about the right balance of procedural fluency and conceptual understanding in instruction, but most educators agree that both are necessary.

“I think we’ve been seeing this shift [in assessments] in the last few years,” said Trena Wilkerson, the president of the National Council of Teachers of Mathematics. “[The transition to remote instruction] has helped continue the momentum. … I think teachers are thinking creatively and out-of-the-box in how to assess student understanding and student thinking and then how to use that to support instructional decisions.”

Instead of having students solve a series of equations, teachers are asking students to break down a problem and explain how they reach its solution, either online, on video, or by sending a picture of their work on paper. They might give students problems solved incorrectly and ask them to find the mistakes. Some teachers are assigning projects rather than tests, asking students to do some reflective journaling about math concepts, or allowing students to redo problems they got wrong.

“We’re in an age where every answer we could possibly imagine is in the palm of our hand,” Rector said. “It makes absolutely no sense to give an answer-getting test, because what’s the point?”

Getting Creative

This year, asking students to record themselves explaining a math concept or telling how they would solve a problem has become a popular grading tool for many teachers.

“It allows them to express their thoughts better,” said Bobson Wong, a high school math teacher in New York City. And there’s another benefit: “It’s very hard to plagiarize.”

Meanwhile, Joey Grabowski, a math teacher at Pioneer Valley Performing Arts Charter Public School in South Hadley, Mass., said he has pivoted to unit projects instead of unit tests. For example, he had his Algebra 1 students use Massachusetts census data to select a categorical group (like gender or race) and a quantitative variable (like income or age). Students then had to compare the distributions of two or more groups of people, and write a report discussing their statistical analysis and their conclusions.

“[With a statistical report], they are analyzing and critiquing things,” Grabowski said. “Computers can do a lot of these calculations for us, but they can’t interpret data.”

Robert McAusland, an Algebra 1 teacher at American Martyrs School, a Catholic private school in Manhattan Beach, Calif., said he tells his students at the beginning of the year: Learning to understand mathematics is “not about right or wrong. … There are no bad mistakes.”

After every assessment, he allows students to attempt similar problems to the ones they got wrong, which will add to their overall grade. At the beginning of this remote semester, he said, initial assessment scores were unnaturally high, possibly because students were looking up answers at home. But as the semester has progressed and stu-
Math Assessment and Intervention

Assessing Students’ Understanding
Conceptual questions on math tests ask students to explain, evaluate, or synthesize.

Maria wants to enter $8 - (-5)$ into her calculator, which is shown at right. She types the following keystrokes:

8 - - 5 =

Why did her calculator report a “syntax error”?

What keystrokes should she have typed instead? Use only the keys shown in the diagram.

In their curriculum and what they need to assess, cutting out any extraneous concepts.

Changes From States?

Experts say much of the assessment change has remained at the classroom level, with individual teachers or schools revamping the tests they give. Most states have not changed their standardized tests to better fit into the new reality of remote instruction and assessment, said Scott Marion, the executive director of the Center for Assessment, which works with states and districts to design and implement more meaningful assessments and accountability practices.

But if states assess some of their students in person and the others online, the results may not be comparable, he said, given the concerns about both student cheating and student motivation. Some states might consider remote proctoring, where the proctor watches the students take their test through a webcam. Still, Marion said there are ways for students to still cheat on the exam, depending on the camera angle.

It remains to be seen if it will be possible to test students in person safely this spring, and states will need federal approval to skip required standardized tests. But some states have already said they won’t administer tests remotely, Marion said, and the federal government can’t force them to do so.

A policy adviser for President-elect Joe Biden said in October that the transition team would have to look into whether states would receive waivers from federal testing mandates this year, and it “depends on how much progress we can make in supporting our schools and getting them up and running.”

Some educators have called for a moratorium on standardized tests altogether this year, including Alan Schoenfeld, a professor of education and mathematics at the University of California, Berkeley, who was one of the lead authors for the mathematics content specifications for the Smarter Balanced Assessment Consortium, which develops common core-aligned tests.

Schoenfeld has long advocated for a “balanced diet” of skills, concepts, and problem-solving in math curricula and assessment, saying that approach helps students apply math concepts long after the class is done. Assessments should reflect that approach, he said.

Remote learning, Schoenfeld said, has opened the door for a meaningful change in assessment: “This should be a ‘What do you have to lose?’ situation.”

Mr. Bobson Wong, a New York City high school math teacher, said he’s finding that “scores are normalizing more toward a traditional expected outcome.”

Still, focusing assessments on conceptual understanding can mean a lot more work for teachers than checking to see if a student solved a problem correctly. A nationally representative survey by the EdWeek Research Center, administered Sept. 30 to Oct. 8, found that teachers are working an average of 10 hours a day, an hour more than they said they worked prior to the pandemic.

“It takes a little bit more time to read responses—to not only grade them, but to respond to them in order to give feedback,” NCTM’s Wilkerson said. “It’s not a question of whether a student got a right answer or not, it’s more about their thinking and what they need [in terms of support].”

Math teachers say they have tried to streamline their curriculum to only teach the most relevant content this year, given that instructional time is at a premium. Experts have advised focusing on skills and understandings that are going to be most important to students’ future success, and prioritizing depth over breadth.

“Teaching very overwhelmed with grading, as every teacher I know feels,” Wong said. “It’s forced me and other teachers to think about what’s really important—to think about what concepts we really need students to know because we all have limited time. It forces us to think about, ‘What lessons do I really need to do, and how do I test that with as few questions as possible?’”

This summer, math teachers at De Pere Middle School in De Pere, Wis., spent a lot of time looking at the standards within their content area and coming up with a list of the highest priorities, which students must know and be able to do by the end of the school year. Those essential standards, the teachers agreed, would be what they write their common formative assessments around and the areas in which they would provide the most time and support.

In a logistically challenging school year where time is limited, that kind of focus and clarity was critical, said Adrienne Burns, a math coach and interventionist at the school: “If we know exactly what we’re doing, we can do that in a more succinct way.”

The planning quickly came in handy. Teachers started the school year in a hybrid model, with kids coming to campus two days a week. But due to rising COVID-19 case numbers, the De Pere school district went completely virtual before teachers even made it to the end of the first math unit.

Teachers then had to grapple with the question, “When you’re not there fully monitoring what they’re doing, how do we evaluate that work?” Burns said.

Students solve math problems with pencil and paper, then scan their work into Google Classroom for it to be graded. And teachers now more frequently assess students with questions that promote explanation and creation, Burns said.

For example, teachers might ask students to explain why multiplying a positive number and a negative number equals a negative number. Or instead of asking students what $10 + -14$ equals, teachers might ask students to create an addition problem with the sum of $-4$. “We’re giving them the parameters, but they’re creating the problem,” Burns said.

These types of assessment questions—as well as reviewing scanned images—do take longer for teachers to grade, Burns said. But having the essential standards in place has helped them narrow down what they need to focus on.
I’m a Teacher. Here’s Why I Don't Care About the NAEP Scores

By Jay Wamsted

The 2022 National Assessment of Educational Progress results got released this week. I cannot stress the level to which I do not care.

Let me be clear. I am a teacher, a career educator. I have been teaching mathematics in Georgia for the last 17 years, at all levels from 8th to 12th grade. I have an undergraduate degree in mathematics and a Ph.D. in math education. I care about my students and I care about their test data.

I crave our end-of-the-year state assessments because they give me a snapshot of how good a job I did for my students. We have an in-district math test designed to demonstrate growth, one that we did for my students. We have an in-district math test designed to demonstrate growth, one that we did for my students.

However, I cannot bring myself to care about these NAEP outcomes. In a normal year? Maybe. This year, our first one back with any semblance of normalcy after three straight years of extreme COVID-19 disruption?

Nah. I just don’t care. Allow me to briefly explain why.

During the past two and half years, COVID-19 has infected close to 100 million people in the United States alone. Over 1 million of those cases resulted in death. Millions were seriously ill and recovered; many were hospitalized. All of this disruption came at great expense to the routines and home lives of children who were forced to live with the effects of pandemic in their households, including the death of close family members. Are we to be surprised that students whose families were struggling with serious health issues and even loss of life had a difficult time taking an optional test tacked on to the end of the second year of disruption? I think not.

In 2020, the United States average household income decreased by roughly 3 percent since the previous year, when adjusted by inflation, with lowest-income households hit even harder. Is it unreasonable to think that millions of families undergoing economic hardship in the face of the pandemic were going to experience a shock to their children’s test scores as well?

Critics of the SAT college-entrance exam have long noted that its most predictive power is one of showing that high-income families do well on tests. Couldn’t we expect that an entire nation in economic turmoil would have a dip in NAEP scores?

It is worth pointing out that to varying degrees, depending on district-level decisions, every child in America missed some amount of school. Why shouldn’t we expect to have some dip in the amount of material we learned? I went home in March 2020 and limped virtually through the remainder of the school year. I taught 100 percent virtual in the fall of that year for nine weeks, then did a hybrid for the rest of the school year—half in the room and half on Zoom.

Then for the 2021-22 school year, we were all in the class—in theory. In fact, children were out constantly all year due to illness. None of these plans worked perfectly, and they were all tremendously disruptive. A dip in test scores—noted across the board in all manner of states—was likely inevitable.

Also, I have trouble understanding how we can treat last year’s test as comparable to past years’ in any way. Ask any teacher you know: The 2021-22 school year was miserable. Most of our students had been out of the building for 15 months or more, and then they came back, completely bonkers.

Think about the 8th graders—they went home at the end of 6th grade, hit puberty alone in their bedrooms, then came back in the building to see their friends for the first time in over a year. It was everything we could do to keep them marginally focused on school instead of just focused on each other. Then, toward the end of a terrible year, we asked a small selection to go into a room alone and take an optional test that “didn’t count as a grade” but “was important to the school.” Anybody who’s ever worked with children knows how that message can influence scores. And we think this is good data? No way.

Let’s put this score drop into perspective. In 8th grade, math scores dropped from 282 to 274, a decrease of 2.8 percent. Reading scores dropped from 263 to 260, or 1.1 percent. In a year where millions of families were upended by job loss, hospitalization, and death due to a global pandemic, can we not put a 1 percent to 3 percent loss in test scores in perspective? Like the economy, why should we expect perpetual growth in our test scores? This year, more than any, we should look at this small dip as “pretty good news.”

Americans have a hard time losing at anything, but it is time to admit that the pandemic beat us. Let’s take these NAEP scores in stride. Yes, all else being equal, we should not expect a significant drop in test scores in any given year. But the past few years have been far from “equal.” Educators are working hard; students are settling in. Children are nothing if not elastic. This cohort will recover if we can intentionally fill in the learning gaps as we move forward. Let’s look at these scores again in a few years before we start freaking out.

Until then, color me unworried and untroubled. This “news” is not news at all.

Jay Wamsted teaches middle school math in Atlanta.
Four Teacher-Recommended Instructional Strategies for Math

By Larry Ferlazzo

What is the single most effective instructional strategy you have used to teach math?

Today, Cindy Garcia, Danielle Ngo, Patrick Brown, and Andrea Clark share their favorite math instructional strategies.

‘Concrete Representational Abstract’

Cindy Garcia has been a bilingual educator for 14 years and is currently a district instructional specialist for PK-6 bilingual/ESL mathematics. She is active on Twitter @CindyGarciaTX and on her blog.

The single most effective strategy that I have used to teach mathematics is the Concrete Representational Abstract (CRA) approach.

During the concrete step, students use physical materials (real-life objects or models) to explore a concept. Using physical materials allows the students to see and touch abstract concepts such as place value. Students are able to manipulate these materials and make sense of what works and what does not work. For example, students can represent 102, 120, and 201 with base 10 blocks to create an open-area model, then draw an open-area model, and finally use the multiplication algorithm. In algebra, it is STILL beneficial to practice using algebra tiles to multiply polynomials using an open-area model.

The CRA approach provides students P-12 with multiple opportunities to explore concepts and make connections with prior concepts. Some teachers try to start teaching a concept at the abstract level, for example, the standard algorithm for multiplication. However, they soon find out that students have difficulty remembering the steps, don’t regroup, or don’t line up digits correctly. One of the main reasons is that students don’t understand this shortcut and they have not had the concrete & representational experiences to see how the shortcuts in the standard algorithm work.

‘Encouraging Discourse’

Danielle Ngo is a 3rd grade teacher and Lower School math coordinator at The Windward School. She has been a teacher for 10 years and works primarily with students who have language-based learning disabilities.

Growing up, so many of us were taught that there is one right answer to every math problem, and that there is one efficient way to arrive at that conclusion. The impetus to return to this framework when teaching math is a tempting one and one I’ve found myself having to fight actively against during my own classroom instruction. In my experience, the most effective way to counter this impulse is to mindfully increase the discourse present during my math lessons. Encouraging discourse benefits our students in several ways, all of which solidify crucial math concepts and sharpen higher-order thinking and reasoning skills:

Distributes math authority in the classroom: Allowing discourse between students—not just between the students and their teacher—establishes a classroom environment in which all contributions are respected and valued. Not only does this type of environment encourage students to advocate for themselves, to ask clarifying questions, and to assess their understanding of material, it also incentivizes students to actively engage in lessons by giving them agency and ownership over their knowledge. Learning becomes a collaborative effort, one in which each student can and should participate.

Promotes a deeper understanding of mathematical concepts: While the rote memorization of a process allows many students to pass their tests, this superficial grasp of math skills does not build a solid foundation for more complex concepts. Through the requisite explanation and justification of their thought processes, discourse pushes students to move beyond an understanding of math as a set of procedural tasks. Rather, rich classroom discussion gives students the freedom to explore the “why’s and how’s” of math—to engage with the concepts at hand, think critically about them, and connect new topics to previous knowledge. These connections allow students to develop a meaningful understanding of mathematical concepts and to use prior knowledge to solve unfamiliar problems.

Develops mathematical-language skills: Students internalize vocabulary words—both their definitions and correct usage—through repeated exposures to the words in meaningful contexts. Appropriately facilitated classroom discourse provides the perfect opportunity for students to practice using new vocabulary terms, as well as to restate definitions in their own words. Additionally, since many math concepts build on prior knowledge, classroom discussions allow students to revisit vocabulary words; use them in multiple, varied contexts; and thus keep the terms current.

‘Explore-Before-Explain’

Patrick Brown is the executive director of...
STEM and CTE for the Fort Zumwalt school district in Missouri, an experienced educator, and a noted author:

The current COVID-19 pandemic is a sobering reminder that we are educating today’s students for a world that is increasingly complex and unpredictable. The sequence that we use in mathematics education can be pivotal in developing students’ understanding and ability to apply ideas to their lives.

An explore-before-explain mindset to mathematics teaching means situating learning in real-life situations and problems and using those circumstances as a context for learning. Explore-before-explain teaching is all about creating conceptual coherence for learners and students’ experiences must occur before explanations and practice-type activities.

Distance learning reaffirmed these ideas when I was faced with the challenge of teaching area and perimeter for the first-time to a 3rd grade learner. I quickly realized that rather than viewing area and perimeter as topics to be explained and then practiced, situating learning in problem-solving scenarios and using household items as manipulatives can illustrate ideas and derive the mathematical formulas and relationships.

Using Lego bricks, we quickly transformed equations and word problems into problem-solving situations that could be built. Student Lego constructions were used as evidence for comparing and contrasting physically how area and perimeter are similar and different as well as mathematical ways to calculate these concepts (e.g., students quickly learned by using Legos that perimeter is the distance around a shape while area is the total shape of an object). Thus, situating learning and having students use data as evidence for mathematical understanding have been critical for motivating and engaging students in distance learning environments.

Using an explore-before-explain sequence of mathematics instruction helps transform traditional mathematics lessons into activities that promote the development of deeper conceptual understanding and transfer learning.

A ‘Whiteboard Wall’

Andrea Clark is a grade 5-7 math and language arts teacher in Austin, Texas. She has a master’s in STEM education and has been teaching for over 10 years:

If you want to increase motivation, persistence, and participation in your math classroom, I recommend a whiteboard wall. Or some reusable dry erase flipcharts to hang on the wall. Or some dry erase paint. Anything to get your students standing up and working on math together on a nonpermanent surface.

The idea of using “vertical nonpermanent surfaces” in the math classroom comes from Peter Liljedahl’s work with the best conditions for encouraging and supporting problem-solving in the math classroom. He found that students who worked on whiteboards (nonpermanent surfaces) started writing much sooner than students who worked on paper. He also found that students who worked on whiteboards discussed more, participated more, and persisted for longer than students working on paper. Working on a vertical whiteboard (hung on the wall) increased all of these factors, even compared with working on horizontal whiteboards.

Adding additional whiteboard space for my students to write on the walls has changed my math classroom (I have a few moveable whiteboard walls covered in dry erase paint as well as one wall with large whiteboards from end to end). My students spent less time sitting down, more time collaborating, and more time doing high-quality math. They were more willing to take risks, even willing to erase everything they had done and start over if necessary. They were able to solve problems that were complex and challenging, covering the whiteboards with their thinking and drawing.

And my students loved it. They were excited to work together on the whiteboards. They were excited to come to math and work through difficult problems together. They moved around the room, talking to other groups and sharing ideas. The fact that the boards were on the wall meant that everyone could see what other groups were doing. I could see where every group was just by looking around the room. I could see who needed help and who needed more time to work through something. But my students could see everything, too. They could get ideas from classmates outside of their group, using others’ ideas to get them through a disagreement or a sticking point. It made formally presenting their ideas easier, too; everyone could just turn and look at the board of the students who were sharing.

I loved ending the math class with whiteboards covered in writing. It reminded me of all of the thinking and talking and collaborating that had just happened. And that was a good feeling at the end of the day. Use nonpermanent vertical surfaces and watch your math class come alive. ■

Larry Ferlazzo is an English and social studies teacher at Luther Burbank High School in Sacramento, Calif.
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