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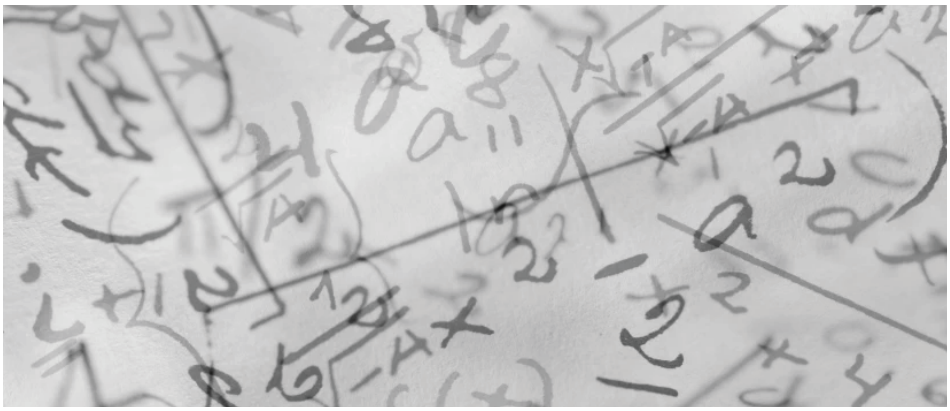
Closing the Math Achievement Gap

EDITOR'S NOTE

Close the math achievement gap by meeting the needs of all students. This Spotlight will help you uncover how AP precalculus aims to better prepare students for advanced math; discover how to use real-world problems to teach math; understand how to support students suffering from math anxiety; gain valuable insights into research on early math supports; examine effective strategies for teaching algebra 1; and more.

OPINION



— iStock/Getty

Published May 19, 2022

A New AP Precalculus Course Aims to Diversify the Math Pipeline

By Ileana Najarro

If students aren't adequately prepared for college-level math courses in high school, it can make completing a college degree more difficult, with some students needing to spend time and money on remedial classes.

The College Board offers Advanced Placement calculus and statistics courses that can jumpstart students' college careers with credits and provide better preparation for college-level courses, but not all high schools offer them and students of color in particular often face barriers accessing them in schools that do.

Currently, only about 5 percent of AP calculus and AP statistics students are Black, and 17 percent are Latino, according to the College Board. And more than half of students who take calculus in high school come from families with a household income above $100,000 a year, according to a 2018 study.

In an effort to better prepare all students for college-level math courses, the College Board will offer a new AP Precalculus course beginning in fall 2023. It will cover a "broad spectrum of function types that are foundational for careers in mathematics, physics, biology, health science, social science, and data science," according to the course framework.

"We think it's important that all students have an incentive to stay invested and interested in math throughout their high school career and make a successful transition to college or a promising career," said Trevor Packer, the senior vice president of AP and Instruction for the College Board.

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>
> **TREVOR PACKER**
> Senior vice president of AP and Instruction, College Board

Big disparities in opportunities for access to high-level math courses

There is currently a variety of ways in which schools organize math courses. Some offer Algebra 1 in 8th grade, others in 9th grade, and others offer Algebra 2 as the highest level, said Adrian Mims Sr., the founder and chief executive of the Calculus Project, a program geared toward increasing the number of students of color and students from low-income families completing AP calculus.

Because of this variety, it can be difficult for some schools to properly prepare and support students' transition into a calculus course their senior year of high school given the limited range of math courses they offer. AP Precalculus can serve as a senior year capstone course that can better prepare students to take calculus in college, avoid remedial classes, and in some cases even offer course credit, said Mims, who served on the advisory committee for creating the new AP course.

So while some students may take AP Precalculus their junior year as a precursor to AP calculus, others can take the new course their senior year more generally as a precursor to college-level math.

And if implemented correctly, the new AP course can help address the disparities of representation in advanced math courses, Mims said. He noted that schools that serve students of color and students from low-income families often don't offer AP calculus courses and so AP Precalculus could fit into schools' existing catalog of courses as an alternative high-level option.

But that also means schools need to ensure these students are able to enroll in AP Precalculus, and not be tracked out of it by rigid recommendation processes that often exclude students from advanced classes. For example, a student getting a B-minus in a precalculus honors course might not qualify for AP calculus in some schools.

Students of color and students from low-income families are also less likely to begin high school on an accelerated math pathway due to teacher perceptions of their abilities, Mims added.

"This is an opportunity to better prepare diverse groups of students that have historically been underrepresented to give them this access, if they choose to do that," Mims said. "However, if administrators, heads of math departments or whatever, if they incorporate this and enhance the tracking, and use it as a gatekeeper course then it's not going to solve the problem."

Other experts point to the need for schools to create a sense of belonging for Black and Latino students, in particular, in advanced math courses in tandem with eliminating systemic barriers such as strict course prerequisites.

The new AP course comes with professional development for teachers as well as classroom support and resources for both students and teachers, the College Board said. Teachers interested in leading AP Precalculus can enroll in an AP Summer Institute. ■

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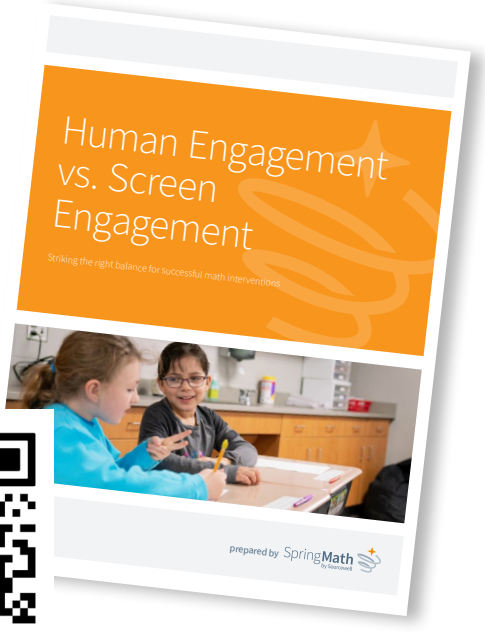

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— Vanessa Solis/Education Week and Getty

Published May 6, 2022

How to Use Real-World Problems to Teach Elementary School Math: 6 Tips

By Alyson Klein

When you think back on elementary school math, do you have fond memories of the countless worksheets you completed on adding fractions or solving division problems? Probably not.

Researchers and educators have been pushing for years for schools to move away from teaching math through a set of equations with no context around them, and towards an approach that pushes kids to use numerical reasoning to solve real problems, mirroring the way that they'll encounter the use of math as adults.

The strategy is largely about setting kids up for success in the professional world, and educators can lay the groundwork decades earlier, even in kindergarten.

Here are some tips for using a real world problem-solving approach to teaching math to elementary school students.

1. There's more than one right answer and more than one right method

A "real world task" can be as simple as asking students to think of equations that will get them to a particular "target" number, say, 14. Students could say 7 plus 7 is 14 or they could say 25 minus 11 is 14. Neither answer is better than the other, and that lesson teaches kids that there are multiple ways to use math to solve problems.

2. Give kids a chance to explain their thinking

The process you use to solve a real world math problem can be just as important as arriving at the correct answer, said Robbi Berry, who teaches 5th grade in Las Cruces, N.M. Her students have learned not to ask her if a particular answer is correct, she said, because she'll turn the question back on them, asking them to explain how they know that it is right. She also gives her students a chance to explain to one another how they arrived at a particular solution, "We always share our strategies so that the kids can see the different ways" to arrive at an answer, she said. Students get excited, she said, when one of their classmates comes up with an approach they never would have thought of. "Math is creative," Berry said. "It's not just learning and memorizing."

3. Be willing to deal with some off-the-wall answers

Problem solving does not necessarily mean going to the word problems in your textbook, said Latrenda Knighten, a mathematics instructional coach in Baton Rouge, La. For little kids, it can be as simple as showing a group of geometric shapes and asking what they have in common. Students may go off track a bit by talking about things like color, she said, but teachers can steer them towards thinking about things like how a rectangle differs from a triangle.

4. Let your students push themselves

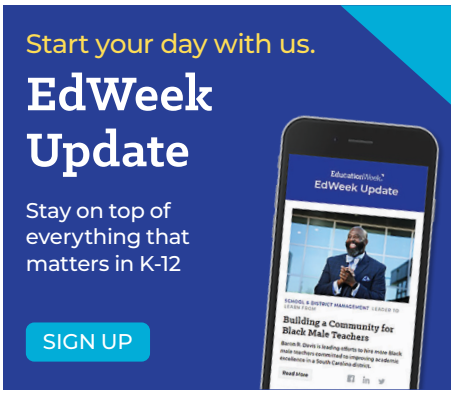
Tackling these richer, real-world problems can be tougher than solving equations on a worksheet. And that is a good thing, said Jo Boaler, a professor at Stanford University and an expert on math education. "It's really good for your brain to struggle," she said. "We don't want kids getting right answers all the time because that's not giving their brains a really good workout." These types of problems require collaboration, a skill that many don't associate with math, but that is key to how math reasoning works beyond the classroom. The complexity and difficulty of the tasks means that students "have to talk to each other and really figure out what to do, what's a good method?"

5. Celebrate 'favorite mistakes' to encourage intellectual risk taking

Wrong answers should be viewed as learning opportunities, Berry said. When one of her students makes an error, she asks if she can share it with the class as a "favorite mistake." Most of the time, students are comfortable with that, and the class will work together to figure how the misstep happened.

6. Remember there's no such thing as a being born with a 'math brain'

Some teachers believe that certain students are just naturally good at math, and others are not, Boaler said. But that's not true. "Brains are constantly shaping, changing, developing, connecting, and there is no fixed anything," said Boaler, who often works alongside neuroscientists. What's more, many elementary school teachers lack confidence in their own math abilities, she said. "They think they can't do [math]," Boaler said. "And they often pass those ideas on" to their students. ■



—iStock/Getty Images Plus and Gina Tomko/Education Week

Published March 31, 2022

Math Anxiety Weakens How Students Study. Here's What Teachers Can Do

By Sarah D. Sparks

Math anxiety doesn't just make students choke on tests. It changes their approach to learning the subject in ways that sets them up for ongoing failure.

A new study in the Journal of Experimental Psychology suggests math-anxious students choose less-effective ways to study, like rereading textbooks instead of working through real problems. This, in turn, can make them less prepared for exams and heighten the risk students will also "freeze" on the math test itself.

"The anxiety that happens in the moment [is] really robbing you of the ability to focus and do your best, and that's one of the reasons why math anxiety was often related to poor performance. But we knew that wasn't the whole story," said Jalisha Jenifer, lead author of the study and postdoctoral research fellow at Barnard College of Columbia University. "Now we're able to start pinpointing the way in which highly math-anxious people also ... walk in less prepared."

While students who are initially low-performing are also at higher risk of developing math anxiety, the study focused on students in Advanced Placement calculus courses. Even among these students, whose placement put them above average performance in math, those with high math anxiety were less likely to study efficiently than students with low levels of anxiety about the subject.

> "Solving math problems can help you to understand where gaps may be in your knowledge; you may not notice those things if you're just reviewing practice problems."
>
> **JALISHA JENIFER**
> Lead author of the study and postdoctoral research fellow, Barnard College of Columbia University

For example, researchers found math-anxious students dedicated more time to passive activities like reading their textbooks or looking at already-solved problems—which prior research has found tends to make students think they understand more than they actually do about content. By contrast, they spent less time actually practicing math skills.

"Solving math problems can help you to understand where gaps may be in your knowledge; you may not notice those things if you're just reviewing practice problems," Jenifer said. "Without challenging yourself in those ways ... you may never practice in the ways that you need for the exam."

Pandemic may have heightened math anxiety risk

The findings suggest that focusing on explicit study and anti-anxiety strategies may be critical for educators working to catch up students who lost significant ground in math during the disruptions of the last two years. General anxiety has increased for students during the pandemic, and "it's reasonable to expect increased levels of anxiety around math, especially if [students are] getting signals that you're not where you should be, that you're behind," said co-author Sian Beilock, math anxiety researcher and president of Barnard.

The vast majority of Americans report at least some levels of discomfort with math, and about a third report moderate to severe anxiety about the subject. More than 25 years of research suggests math anxiety can begin in the early elementary grades, but increases through middle and high school, particularly for students in groups stereotypically considered lower performers in math, such as women.

"Math may be a microcosm for what could play out in other areas," Beilock said in an interview. "So if you have anxiety about biology or some other subject you're taking, I think what we're showing here is, one of the reasons that anxiety tends to be correlated with poor performance is that anxiety pushes people to not engage in study material in a way that's efficacious."

In fact, a 2021 study in the journal Nature: Science of Learning found incoming college students with high math anxiety took fewer science, technology, engineering, and math classes, and underperformed in the ones they did take, compared to more-confident students with the same ability in math. Researchers led by Georgetown University psychologist Richard Daker concluded, "Math anxiety can account for associations between math ability and STEM outcomes, suggesting that past links between math ability and real-world

outcomes may, in fact, be at least partially explainable by attitudes toward math."

Simple changes can help math-anxious students

In a 2020 survey, 67 percent of teachers told the EdWeek Research Center that math anxiety was a challenge for their students. But Jenifer and Beilock said simple changes before and during testing can boost students' confidence and performance.

As students prepare for a math test, Beilock said it's important for teachers to explicitly describe what makes study methods effective or not.

"I don't think people are always aware that their study strategies are ineffective and what might be pushing them in different ways," Beilock said. "This research shows that there is a tendency for people who are anxious to stay away from more-difficult problems or more-effortful problems during practice—and just knowing that could push you in the opposite direction."

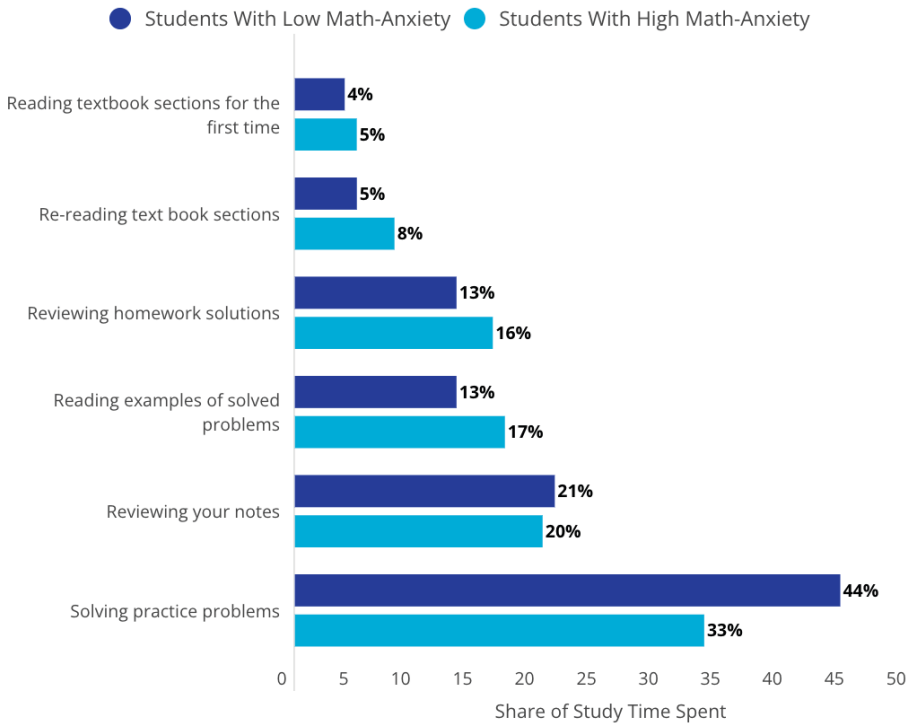
Teachers can help math-anxious students learn to study more effectively by providing both partially worked and unworked practice problems for review, which Jenifer said can ease students into practice. Similarly, teachers can give students more confidence to tackle challenging problems by asking students to solve them as part of games or puzzles, rather than for grades or homework.

On the day of a test, research suggests teachers can also help students reframe their physical symptoms of anxiety—such as sweating palms or a racing heartbeat—as signs of excitement or readiness. This reframing has been shown to help students avoid "choking" on exams.

Over time, helping anxious students learn to prepare more effectively and calm their anxiety in the moment can improve their math performance and help them gain more confidence in math—and even make them more likely to choose math and science work on their own. ■

Here's How Test Prep Changes When You're Worried About Math

Students with math anxiety consciously or unconsciously avoid active problem-solving, according to new Barnard College research published in the Journal of Experimental Psychology. That changes how they prepare for tests.



SOURCE: "Effort(less) Exam Preparation: Math Anxiety Predicts the Avoidance of Effortful Study Strategies," Journal of Experimental Psychology-General.

— E+/Getty

Published December 10, 2021

These Early Math Supports Translated To Gains Later on for Vulnerable Students

By Sarah D. Sparks

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.

> "Both of these programs build on learning trajectory development. All children develop math abilities on a general developmental sequence."
>
> **SHIRA MATTERA**
> Author

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.

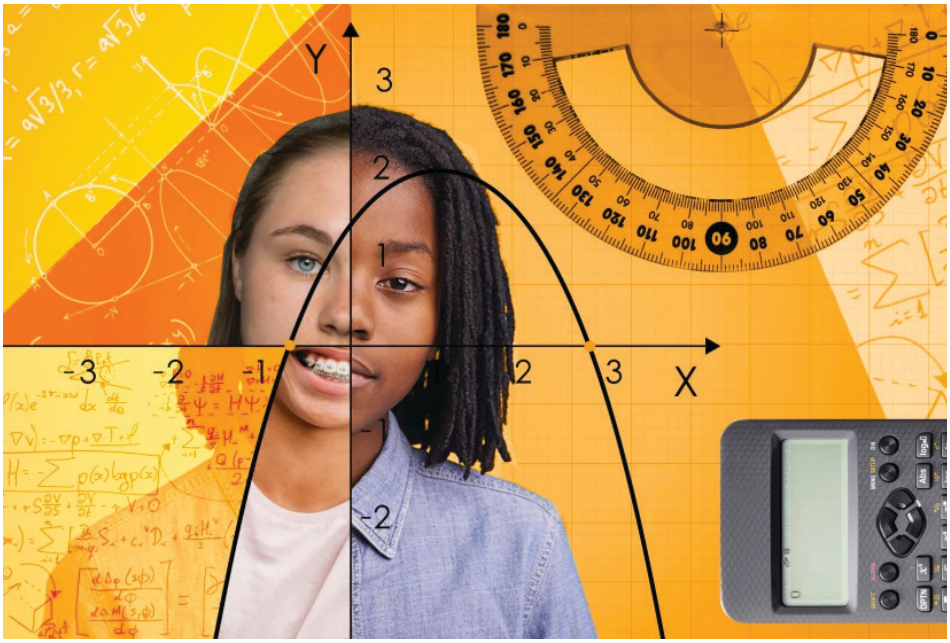
While chronic absenteeism in early grades often comes from family challenges and stressors that the study did not measure, the researchers did offer some speculation about why students who received math enrichment missed less school later on, Mattera said.

"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." ■



—Collage by Vanessa Solis/Education Week (Images: Getty)

Published June 22, 2021

Algebra 1 Is a Turning Point. Here's How to Help Incoming Students

By Sarah Schwartz

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 allowed 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 complicated from here. Next year also means the start of high school: a new group of students, new teachers, and the expectation, he worries, that he'll be able to handle more advanced work on his own. He doesn't feel ready.

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.

Teachers can figure out what skills and understandings are prerequisites for the new concept they're starting to introduce, and then give students a couple of questions that would allow them to show their knowledge—or demonstrate that they have unfinished learning. Then, teachers can develop a task or mini-lesson to shore up that prerequisite skill, and make explicit its connection to the new learning. For example, teachers could review the basics of linear functions and how to plot them on a graph right before introducing slope-intercept form.

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: 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."

> "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."
>
> **AMY GETZ**
> Interim director of K–12 education strategy, policy, and services, University of Texas at Austin's Charles A. Dana Center

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 weekends, 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 Camrynn 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." ■

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Understanding & Implementing a Math Intervention Solution

Understanding Math Intervention

Often tied to a multitiered system of support (MTSS) and Response to Intervention (RTI), math interventions support students in reaching subject mastery. Interventions can be provided individually, or at the classroom level.

What is MTSS?
MTSS is a framework that helps educators provide academic and behavioral strategies for students with various needs. MTSS grew out of the integration of two other intervention-based frameworks: Response to Intervention (RTI) and PBIS.

What is RtI?
RTI is a multitiered approach to the early identification and support of students with learning and behavior needs. The RTI process begins with high-quality instruction and universal screening of all children in the general education classroom. Struggling learners are provided with interventions at increasing levels of intensity to accelerate their rate of learning.

What is individual math intervention?
Some children do not progress as expected, even though they participated in high-quality curriculum and received small and large group support. For these children, more intensive, individualized instruction is needed.

What is classwide math intervention?
Classwide intervention has been demonstrated to be highly useful in improving learning in many research studies in reading and mathematics following Greenwood's study of classwide peer tutoring. Common models include:

- Peer-assisted Learning Strategies
- SpringMath Classwide Intervention

Should every district have a math intervention program?
Regardless of a district's specific approach, having a math intervention program in place benefits teachers and students alike.

State standards for a program

Math intervention programs are useful for ensuring districts are able to meet (or exceed) state standards. An effective math intervention program will reinforce the Common Core Standards for Mathematical Practice:

A. Make sense of problems and persevere in solving them
B. Reason abstractly and quantitatively
C. Construct viable arguments and critique the reasoning of others
D. Model with mathematics
E. Use appropriate tools strategically
F. Attend to precision
G. Look for and make use of structure
H. Look for and express regularity in repeated reasoning

The COVID-19 pandemic led to increased focus on the quality of instruction and learners' academic progress. Investing in standards-aligned solutions will help reinforce the decisions of administrators, principals, and teachers.

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Features of a quality math intervention program

When you seek out a math intervention program, it's important to consider which solution will best meet state standards but more importantly the specific needs of your district. Use the following list to evaluate programs during your search:

A transparent logic model

Does the program specify exactly what the mechanism of action is for what type of student outcomes?

Published evidence of assessment accuracy, utility, & intervention efficacy

Is there primary, published research investigating the accuracy, utility, efficacy, equity, and cost of the math intervention program?

Design linked to implementation science

Is the implementation of the program preceded by supports, such as recommendations for intervention dosage and use?

Cost effectiveness data comparison

How does the program ensure a positive return on investment? Has the vendor measured and reported what it costs to attain learning improvements in math using its program?

Coaching feedback loop

Does the program use student learning gains to direct coaches to support math interventions?

Published dosage and integrity data

Are the effects of interventions evaluated in tandem with intervention use?

To learn more about the features of a quality math solution, visit: springmath.org/key-features

Accelerate student achievement with math interventions

The pandemic hindered students' academic growth.

The full impact of COVID-19 on learners' progress is not yet understood.. With this in mind, traditional methods of screening students are unlikely to be effective. A remedy for this problem is to build classwide interventions and progress monitoring into instruction.

Classwide math interventions are a research-based, cost-effective way to accurately screen students and close the math achievement gap. This style of intervention is built upon a peer-to-peer tutoring model, which has been proven to help students build confidence in math. Similar to individual student interventions, classwide interventions are used to help a group of learners attain mastery. Progress should be monitored from week to week to assess growth and provide individual interventions as needed.

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Best Practices for Implementing a K-12 Math Intervention Program

Set your district up for success with these practical tips

Your school or district has decided to invest in a math intervention solution — or maybe you're narrowing down your options. Regardless of where you are in your math intervention program journey, a key consideration is implementation. While often overlooked, a robust implementation plan enables the success of any program.

From identifying your goals to streamlining implementation with a proven process, here are some practical tips to ensure you get the most of out of your math intervention solution.

Pause and reflect

Prior to implementation, school and district leaders should pause and consider why the program is being adopted. Will it support a district initiative? Is it going to help solve a challenge? Articulating goals ahead of time is essential for making the most of a new investment.

Confirm when the program will launch

Identifying a "go-live" date — when educators will start using the program — helps keep implementation activities on track.

Consider the logistics

Depending on the type of program being implemented, school and district leaders may need to coordinate with technology and/or data teams. Ahead of the go-live date, the implementation team can collaborate with the program provider and internal staff to complete logistical steps, such as uploading student rosters, importing data, and facilitating integrations.

Determine roles and responsibilities

Implementation is not a one-and-done process — it unfolds over time and requires consistent, long-term support.

Consider:

- Who will be the main point(s) of contact before, during, and after launch?
- Where can staff seek additional training and support?

Well-rounded implementation teams are interdepartmental, collaborative, and include:

- District leaders, who will maintain communications with vendors and internal and external stakeholders.
- Building administrators and instructional coaches, who will support teachers' usage of the program.
- District data administrators, who can support the technical side of implementation.
- Implementation champions, who can help communicate the "why" and "how" of the program (and build enthusiasm for it).

Communicate with staff, then parent/guardian

After roles and responsibilities are outlined, the implementation team should prioritize sending an update to teachers and other staff. To ensure transparency, families who will be impacted by the implementation also must be notified.

Staff communication should address:

- Why the program was purchased.
- How it will benefit staff and students.
- Expectations around usage.
- Information about training and support resources.

Parent/guardian communication should cover:

- A high-level overview of the program.
- How it will benefit their student(s).
- Rationale for implementing the program.
- When, where, and how the program will be used.

Download the "Best Practices for Implementing a K-12 Math Intervention Program" infographic.

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SpringMath by Sourcewell

Published December 2, 2020

Kids Are Behind in Math Because of COVID-19. Here's What Research Says Could Help

By Stephen Sawchuk & Sarah D. Sparks

Are students' math struggles during the COVID-19 pandemic completely unprecedented? Yes and no.

Disruption in schools has also meant disruption in testing, so it's been hard to pin down exactly how much the school closures and transitions in and out of virtual learning have affected students' learning—but the evidence so far doesn't bode well, particularly in math.

But research on math development and anxiety, summer learning loss, and math achievement after other disasters can all provide windows into why math learning seems to be taking a bigger hit during the pandemic, and what educators and school leaders can do to stop it. Here are the key things to know.

How much math learning will students really lose during the pandemic?

A handful of studies since last spring have used data from millions of students participating in computer-adaptive tests, such as the Northwest Evaluation Association's MAP Growth test and Illuminate Education's FastBridge assessments, to estimate students' learning growth during school closures last spring compared to prior years, and project how much that rate of growth is likely to slow during 2020-21.

The studies vary in how severe they gauge the so-called "COVID slide" to be, but all of them found on average, students would lose more ground in math than in reading. Three studies based on NWEA data predicted students could learn half or up to a full year less math in 2020-21, compared to what they would learn in a typical year. The study based on the FastBridge test data showed smaller but still troubling learning losses across every grade: two-and-a-half to four-and-a-half months of learning lost, compared to a month or two in reading.

There are some basic caveats here. These studies looked at spring 2020, when schools shuttered abruptly amid statewide emergency orders and many districts scrambled to set up services

—elenab/iStock/Getty

and instructional plans for remote learning. The studies assume students in remote learning look like students during the summer, with little formal instruction. That's not the same picture as the 2020-21 school year, in which districts have reopened with formal instructional plans, but classes that may shift from day to day and week to week from in-person to virtual instruction.

Early testing data from this fall seem to bear out that the pandemic has hit students harder in math than reading.

NWEA researchers compared the results of more than 4.4 million students in grades 3-8 tested this fall to their peers tested in fall 2019. They found no difference in reading gains, but on average a 5 to 10 percentile-point difference in math, with Black and Hispanic students in upper elementary seeing the worst learning losses.

Similarly, Curriculum Associates, a company that offers testing, curriculum, and professional development services, compared the test results from a nonrepresentative sample of students in grades 1 to 5 in more than 1,000 schools to those of students for the last three years. It also found students lost more ground in math than reading, and 5 to 9 percentage points more students scored two or more grade levels behind in math.

In any case, none of the research so far is granular enough to say that students have lost specific skills, content, or foundations in math, like fractions or number sense.

Moreover, a new national survey from the Understanding Coronavirus in America study found that while parents of K-12 students generally think instruction has not gone back to pre-COVID-19 quality, they were significantly more concerned about math than reading, and particularly if their students attended virtual or hybrid classes.

Why might pandemic learning loss be worse in math than other subjects?

Math may be more sensitive to pandemic-related schooling disruptions for a few reasons, experts say:

- Unlike reading, math is almost always formally learned at school. Parents are often less well-equipped to help their children with math, at a time when parent support can be even more crucial to student progress.
- Broader stress and trauma related to the pandemic may worsen existing math anxiety in some students, and math anxiety can exacerbate students' other stress while in class.
- It can be more challenging for teachers to engage in effective math instructional practices via remote platforms.

What's the role of stress and trauma in math learning loss?

As many as 1 in 5 U.S. adults report severe math anxiety. An EdWeek Research Center study published in January found 67 percent of teachers reported students' math anxiety was a challenge. That existing stress may be magnified now by increased worries about illness, money troubles, housing instability, and parent tensions.

In that, the COVID-19 slide may mirror natural disasters more closely than summer slumps. After Hurricane Katrina, for example, researchers found students lost the most ground in math, coming back to school two years below grade level on average. Some of this academic loss was chalked up to outright missed instruction—due to closures or evacuations, for example—but researchers have found stress and trauma from the disasters weighed on students academically and mentally for months or even years. And there's evidence that test anxiety and post-traumatic stress may have fed off each other.

It may be helpful for schools to partner teachers with school psychologists and other support

staff to identify students with existing math anxieties as well as those who have higher stress and trauma exposure during the pandemic.

Experts in math anxiety also suggest teachers incorporate short anti-stress exercises into remote instruction and ask about students' stress levels explicitly, as it may be difficult to impossible to read expressions in virtual settings.

How will remote learning affect math teaching?

While hybrid and virtual schools have been gaining traction in the last decade, the sudden and complete move to virtual learning for most districts last spring and the ongoing shifts in format have been highly disruptive to instruction.

The need for teacher training in new ed-tech platforms and tools may crowd out needs for other professional development, according to Sarah Johnson, chief executive officer of the nonprofit Teaching Lab. "One pre-COVID problem was [a lack of] math elementary teacher content knowledge and pedagogical content knowledge," Johnson said. "As we shift to online instruction and teachers have to manage so much more, teachers might just not have the time to develop their content knowledge skills in that."

David Blazar, an assistant professor of education policy and economics at the University of Maryland, who has studied math teaching, agreed. In one study of elementary math teachers, Blazar found the more teachers used inquiry-oriented instruction—in which teachers pose questions and scenarios to help students think through a problem and connect procedures to broader math concepts—the greater students' math learning. But it's a kind of teaching that is challenging even in physical classrooms.

In online settings, teachers will need to draw "super explicit links to help make sense of mathematical concepts," Blazar said, and find ways for students to show their work. And while apps and worksheets can help students practice procedures they've learned, some math researchers worry that, especially in the upper elementary grades, teachers might rely on them too much to the detriment of reasoning and modeling with math.

"I think what's going to fall through the cracks is the kind of discussions around meaning-making in math that they will be challenged to do remotely," said Jon R. Star, a professor at the Harvard Graduate School of Education who studies children's math learning. "I think that's going to be so hard to do, and in some ways could make the curriculum less meaningful, and less conceptual, and less kind of deeply mathematical, which is already something we struggle with."

> "I think what's going to fall through the cracks is the kind of discussions around meaning-making in math that they will be challenged to do remotely."
>
> **JON R. STAR**
> Professor, Harvard Graduate School of Education

Star and Blazar both voiced concern that it can be more difficult for teachers to monitor and guide small groups of students tackling a problem together online without the right tools.

What should happen with curriculum?

There's a movement in some states and districts to identify "power standards," or the most critical elements of learning in each grade. But some math experts warn about those approaches because newer math curricula tend to be spiral, with concepts introduced in early grades reappearing. That means in later grades the curriculum will assume students have learned things they may not have learned.

"This is a choice about which is the lesser evil, from the teacher's perspective," Star said.

"There are smart ways to do this and not-so-smart ways to do this, and the smart way is to see the standards fitting into a progression, rather than saying, 'This is important, and these ones aren't,' " said William McCallum, professor emeritus of math at the University of Arizona and CEO of Illustrative Mathematics, an open-source math curriculum. "You merge and combine and give greater emphasis to your main points."

Inevitably, though, some things are going to receive less emphasis than in prior years, and teachers in later grades will need to be made aware of what was de-emphasized. One likely loss? Star predicts it will be geometric concepts introduced in grades 3-5. Because algebra is a key gatekeeper to higher-level math courses and an entrance requirement to higher education, teachers are likely to focus on the underpinnings of algebraic reasoning over geometry.

Schools in more than 10 states have experimented with computer-based "curriculum playlists," which use algorithms to map out and deliver customized lessons to students as they master different skills. This format, which may be easier to transfer back and forth between remote and hybrid classes, is likely to see more use during the pandemic. But large-scale studies of programs using the approach on math have found widely disparate implementation and mixed results on whether this curriculum format accelerates student learning.

How can teachers and parents work together to bolster students' math learning during the pandemic?

One of the most common themes across learning loss research is the importance of parent support in student learning. Students with highly involved parents who report participating in educational activities over the summer tend to lose less ground. And early studies of responses to the pandemic have found schools are "increasingly dependent on families to facilitate instruction during the current crisis," according to Douglas Harris of the Education Research Alliance for New Orleans, in a study of district reopenings during the pandemic.

That can be a heavier lift in math. Studies have suggested families may be less likely to engage in math versus reading activities with their children due to math anxiety and new instructional methods for teaching Common Core State Standards that differ from how parents themselves learned math.

Kelly McCormick, a professional learning consultant for NWEA, said if a district moved to a common-core-aligned program or another kind of new curriculum, teachers can use their own training as a model to think of math processes that are likely to trip up parents and provide short videos or chats with parents to help them prepare.

Educators may suggest math-related games and apps that encourage families to integrate math conversations into their home lives. Some studies have found children of math-anxious parents who regularly used a family-focused math app showed more progress in math than students of similar parents who did not use the app. ■

OPINION

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Four Teacher-Recommended Instructional Strategies for Math

By Larry Ferlazzo

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

This post is part of a longer series of questions and answers inviting educators from various disciplines to share their "single most effective instructional strategy."

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:

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 and count each model to see the difference of the value of the digit 2 in each number.

During the representational step, students use pictures, images, or virtual manipulatives to represent concrete materials and complete math tasks. Students are making connections and gaining a deeper understanding of the concept by creating or drawing representations.

During the abstract step, students are now primarily using numbers and symbols. Students working at the abstract stage have a solid understanding of the concept.

The CRA approach is appropriate and applicable to all grade levels. It is not about the age of the student but rather the concept being taught. In 3rd grade, it is beneficial to students to have them use 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 to have 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' understand-

ing 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.

> **"The single most effective strategy that I have used to teach mathematics is the Concrete Representational Abstract (CRA) approach.**
>
> **Cindy Garcia**
> Education Week

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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