EducationWeek® | SPOTLIGHT®

2025

Innovative Approaches To Math Engagement

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EDITOR'S NOTE

Motivating students in mathematics requires innovative and engaging approaches. This Spotlight explores strategies to foster a love of math and cultivate students' problem-solving abilities. From creating motivating classroom environments to connecting math to potential careers, these articles offer valuable perspectives. Discover how to build on young students' natural curiosity about math and the importance of making math relevant to students' lives.

Courtesy of Milken Family Foundation

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OPINION

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How to Motivate Adolescents in Math And Science: Tips From an Expert

By Arianna Prothero

Learning linear equations or the functions of cells, especially if it doesn't come easily, requires a generous dose of motivation.

But this intangible quality can be difficult to cultivate. There are no clear-cut equations or experiments that teach a student how to be motivated. Instead, teachers should think about creating a motivating environment in their classrooms, said Emily Rosenzweig, an assistant professor of educational psychology at the University of Georgia who studies adolescent motivation in STEM subjects.

Education Week spoke with Rosenzweig about what's getting in the way of student motivation and what teachers can do about it. This interview has been edited for length and clarity.

What are the big challenges to motivating adolescents in the STEM subjects?

A big one is competence perceptions, like struggling to help students feel like they can learn in STEM, especially if they have certain stereotypes or beliefs.

As students get into middle school, they start to have a big emphasis at the school level on normative comparison with testing and those kinds of things. That makes students hyperaware of how they're doing relative to others, and they'll start to feel less capable. So, in terms of STEM, especially because it's a field that's often stereotyped as hard, you end up with students who really struggle to feel like they can do it. Then there are other students who just struggle to see the value of the STEM subjects [or] the content as useful. Students will say, "I'm just wasting my time learning about the inside of a cell."

I think the third big issue is related to perceiving autonomy or ownership over the learning process. Research has shown that as you go into middle school, the middle school environment is much more constricted and has a lot more rules than the elementary school environment on average. And at that same developmental point, students have this increasing need for autonomy—they want to have ownership over what they're doing, understand why they're doing it—and that can really clash.

Is it too much to say, well, students just need to figure out how to motivate themselves?

I would argue that the reason why we do anything reflects our motivation. Maybe that will come from, "I don't enjoy this, but I think it's useful for me." Our motivation comes from different sources. You can be motivated because you feel confident, you can be motivated because you feel interested, because you feel like something is easy for you. You can be motivated because you think something's very meaningful and tied to your identity.

I think it's fair to tell students, you don't have to like this, but there are other reasons you might need to do it. But I would also say that educators can do a lot more than they think to help students think of what they're learning as relevant.

> **"Choice is really important, giving students some level of ownership over the learning process."**
>
> **EMILY ROSENZWEIG**
> Assistant professor of educational psychology, University of Georgia

What are some other best practices for motivating students in STEM classes?

Make things relevant. And the reason why is because it can help improve lots of different motivational pieces. If you see something as relevant to you, it will seem more tied to your identity or the things you find personally meaningful and important.

It will help you feel more autonomy because you think you're engaging with things for a reason. The more you can make STEM content connected to students' own experiences, their interests, their identities, the better off instructors will be, the more likely these classrooms will foster high-quality motivation for learning.

I think choice is really important, giving students just some level of ownership over the learning process. This is especially important during adolescence just because that is when students have this really strong need for autonomy that research is saying isn't necessarily being met in the classroom.

What would you say to teachers who think, 'If I give them autonomy, it's going to be a circus?'

You can give students choices, but in a structured way. In my assignments at the college level, I have students pick four of eight prompts to write about for an assignment. I choose the prompts, but they get to have some element of choice. It's not a total free-for-all, it's just adding some more ownership on the students' part. ■

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Published May 28, 2024

How Teachers Build Confidence To Motivate Middle Schoolers in STEM

By Arianna Prothero

Middle schoolers embody a messy no-man's land: young enough to get excited by stickers and play-acting, but mature enough to crave autonomy and opportunities to improve their world.

Younger adolescents have shed much of their early-childhood curiosity and confidence that they can do anything. They're hyperfocused on peers, social standing, and extracurriculars, right when the academic rigor of their math and science classes ratchets up.

Good luck getting this difficult-to-inspire bunch excited about the electromagnetic spectrum or fractional coefficients.

Sixth through eighth grade marks a shift in what motivates students, presenting a big challenge for science and math teachers.

"For many [middle school] students, their motivation will decline" starting in adolescence, said Emily Rosenzweig, an assistant professor of educational psychology at the University of Georgia who studies adolescent motivation in STEM subjects.

There are different reasons why this happens, Rosenzweig said, but it surfaces some new problems for middle school teachers: "A big one is competence perceptions: struggling to help students feel like they can learn in STEM," she said.

> **"Like is a big thing, especially for middle school. They are not going to work for someone they don't like."**
>
> **DANI BOEPPLE**
> 8th grade science teacher,
> McDonald Middle School, Mesquite, TX

Key to motivating this group academically, experts say, is giving them the chance to solve real problems in the adult world, while nurturing their confidence in their abilities and potential. Educators must also appeal to both sides of a middle schooler: the adult they are becoming and the child they very much still are.

In this developmental stage, kids want to know why they're learning something and not just be told to do it, said Rosenzweig. That desire to understand the "why" is rooted in adolescents' growing need for independence, she said.

What motivates middle school students?

Connecting what students are learning in STEM subjects to problems they might have to tackle in the real world is an important strategy for motivating this age group.

In Dani Boepple's 8th grade science class at McDonald Middle School in Mesquite, Texas—located in the Dallas metro area—students learn how human activity in their land-locked city impacts ocean ecosystems.

Boepple teaches them that what goes down drains and runs off lawns at home and in school eventually ends up in the ocean. The same is true of litter, which makes its way into local streams and rivers.

Students then develop plans for action they can take in their homes and neighborhoods to reduce ocean pollution from chemicals and plastics.

"Their plans are really simple but effective," Boepple said. "They will say, 'I need to tell my parents to not spray pesticides on the garden and we need to pull weeds. Or I can help my neighborhood by cleaning up the trash that I see in the parking lot.' It's things they can actually do to make an impact."

Projects like these tap into this current generation's interest in fixing their world, she said.

Boepple also takes her students on virtual field trips to see the inner workings of NASA's Johnson Space Center in Houston and the technology behind Amazon fulfillment facilities in different states. Students can see how what they're learning now about the physics behind the movement of objects in our solar system, for example, can be applied to real careers. Hands-on experiments—such as using kinetic sand to make 3D models of topographic maps or mixing chemicals to create reactions—can also be a powerful motivator, said Boepple.

A big challenge to motivating her students, Boepple said, is that many are so afraid of failing that they would rather not try, something she attributes to students internalizing the message that they're behind after the pandemic and a weakening focus on growth mindsets in their schools.

To help students get past their fear of failure, Boepple focuses on something outside the traditional science curriculum: trust.

"If they trust you, they are more willing to try," Boepple said. "Just like if they like you, they are more willing to try. Like is a big thing, especially for middle school. They are not going to work for someone they don't like."

Boosting her students' confidence is a focus for Kristyna Mosqueda-Rogers in her 5th and 6th grade math classes as well. Mosqueda-Rogers teaches at Carr Middle School in Hale Center, a rural community in northwest Texas. Her students struggle with a lack of belief in their capabilities, which leads to disengagement.

Her answer? Food trucks.

Mosqueda-Rogers' 6th grade students are designing their own food trucks, tackling all the math that comes with launching and running a small business, from making decisions about menus and hours of operation to calculating the cost of food, fuel, and wages.

Students build shoebox-sized cardboard models of their food trucks and present their final projects in a classroom food truck festival.

Mosqueda-Rogers' 5th graders engage in a similar exercise: They design their own zoos, including researching and calculating the size of the enclosures for different types of animals.

"It brings in a lot of the concepts that we teach into one realistic scenario," she said. "We're looking at decimals, geometry, finance."

While Mosqueda-Rogers has found project-based learning to be very motivating for her students, talking about STEM careers or big, societal problems that can be solved through the STEM disciplines can be a little too abstract for her 5th and 6th grade students. So, she said, "I have to do stuff that's related to them right now."

But there are many barriers to teaching students math and science from a problem-solving perspective, according to educators in a recent EdWeek Research Center poll.

There are other strategies for motivating this age group beyond project-based learning.

Teachers can find ways to give students more say in their education, said Rosenzweig, the psychologist, to help meet their developmental need for independence. For example, teachers can offer students a choice between an essay or a presentation for an assignment, or consult students in creating classroom rules.

In Boepple's 8th grade science classroom, students can earn tickets for meeting academic goals to spend in the "college store" she has created. She stocks her store with apparel and accessories from different colleges that she buys second-hand or has received through donations. Students in her school are allowed to not wear their required uniforms as long as they are sporting clothing with college names on it, and they go wild for the items, Boepple said.

"That really helps motivate them because they can't afford to go buy a nice college sweatshirt," she said. "They are so grateful, and they wear them every day with pride."

Both Boepple and Mosqueda-Rogers say that stickers that recognize small or big achievements—the currency of many elementary school classrooms—remain powerful motivators for middle school students too.

Motivation is multifaceted, and so are the ways to inspire it

Mosqueda-Rogers also believes that the example she sets, as a Latina math teacher, is helping motivate her students by challenging stereotypes about who can be good at math.

"I have so many little Hispanic girls who have a deeper love for [math] now, and they're just growing tremendously because they're seeing that it can be done by anyone," she said.

Even if middle school students—especially the younger ones—aren't thinking too deeply, yet, about what they want to do when they grow up, it's important that they see it as plausible that they could join a STEM field, said John Dedeaux Davis Jr., a STEM education specialist at NASA. The U.S. space agency employs him to develop resources for educators to spark kids' interest in STEM subjects, so NASA has the scientists it needs in the future.

"That connection is very important because we know early exposure to STEM can help drive people to those careers," said Davis, a former science teacher who taught middle school in Chicago and Texas for 16 years before joining NASA. "Middle school is when students really start to form those ideas of what they might do as a career."

When he was in the classroom, Davis encouraged his students to tap into the inner child they were quickly growing out of and play make believe—acting like a surgeon or astronaut. The idea, he said, was simply to get students to imagine themselves in these roles.

When it came time to dissect animals, Davis decorated his classroom like a lab or operating room and gave students white coats to wear so they could pretend to be scientists or doctors.

When the class studied space, Davis set up different stations around the classroom. For instance, he turned the underside of a table into a rocket cockpit. Students laid on their backs beneath it, similar to how professional astronauts position themselves during take off.

"Connecting things to the real world that they can relate to is a great way to engage them," Davis said. "You don't have to teach straight from the book."

Some students may seem very difficult to get engaged in STEM. But educators should not give up on them too quickly, Rosenzweig recommends.

There's a common misconception that motivation comes solely from within students, when really their environments do a lot to shape motivation—such as classrooms that give students more autonomy and opportunities to see the real world application of what they're learning.

Another big misconception: If a student seems disinterested, then they're probably not motivated to learn about STEM subjects.

"If a student seems to be not paying attention, seems to be kind of disengaged, it could be because that student doesn't like the subject and doesn't want do it," Rosenzweig said. "But it could also be that the student has a more complex profile. Like, they really think this is important, but they're struggling with their confidence for it. Or they feel like this is something they can do, but they were up late doing work for a different class."

And even if a student doesn't seem destined for a career in a STEM field, competency—and confidence—in STEM subjects is still important for them, too, Rosenzweig said.

The critical thinking and problem-solving skills developed in STEM subjects apply to virtually all other fields and pursuits. And you can never really know when or how a student might find their way into a STEM field. A student may not follow a straight trajectory from high school, to college, to a career in engineering, said Rosenzweig. They might find their STEM calling later in life.

"In my opinion, the more we can do to cultivate that interest and confidence early, so students continue to see it as for them and continue to develop the basic competencies that leave the door open to lots of paths that they might discover later, the better," she said. ■

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How 3 Top Math Teachers Nurture Students' Ability to Tackle Challenge

By Sarah Schwartz

Some of the biggest challenges in teaching math aren't about the numbers and operations themselves, but students' attitudes toward them.

Getting students to think deeply about problems, persevere through difficult questions, and simply feel confident in math class can be tall hurdles in a subject that many children say makes them anxious.

Education Week spoke with three award-winning math teachers about how they try to lower these roadblocks in the math classroom.

All three—Jenna Stewart, Ashley Davis, and Charday Wilson—are recipients of the 2024-25 Milken Educator Award, a $25,000 cash prize for early- to mid-career teachers, principals, and other educators who have embraced innovative teaching practices and advanced student learning. The contest has run since 1987; Davis is the 3,000th awardee.

Read on to learn how these teachers build students' conceptual understanding, navigate wide ranges of student ability, and work with colleagues to replicate promising practices.

Courtesy of Milken Family Foundation

Back in the classroom, award recipient Charday Wilson teaches a math lesson and answers questions.

Jenna Stewart

5th grade teacher, Longbranch Elementary School, Boone County schools, Ky.

Courtesy of Milken Family Foundation

Teacher Jenna Stewart receives a standing ovation and applause from her 5th grade students after winning a Milken Family Foundation teaching prize.

When Jenna Stewart was a math student, she was a "kind of a nervous Nellie," she said, worried about getting questions wrong.

Now, in the math classes she teaches, Stewart encourages her 5th graders to see mistakes not as evidence of failure, but as an opportunity to learn. It's part of her broader goal to encourage deep thinking in her classroom.

Often, Stewart will pose one question to the class, asking students to work out the answer on a white board. When everyone finishes, students hold up their white boards to compare answers. There are always students who hesitate to share, she said, and immediately want to erase wrong answers. But Stewart stops them.

She has explained to her students: It's better to know that you gave it "110 percent," said you were confused and asked for help, and got the answer wrong, than to not try at all. After drilling that message again and again, Stewart said, "I usually see a mindset shift."

Even when students have mastered the steps to complete a problem correctly, she pushes them to dive deeper into the concepts and relationships that underpin math. With her more advanced students, she offers enrichment activities that aim to develop further conceptual understanding—for example, asking students to write an explanation of how they solved a problem, using mathematical vocabulary.

Courtesy of Milken Family Foundation

Newly minted Milken Award recipient Ashley Davis celebrates with a group hug from students.

Sometimes, she challenges them with logic puzzles that require abstract thinking, an activity that can initially cause some high-performers to "crumble," Stewart said.

She wants them to push past that discomfort, so that when answers don't come easily to them, they know what to do.

Ashley Davis

4th grade teacher, Central Intermediate School, Central Community school district, La.

Ashley Davis knows that 4th grade is a transition point for some big ideas in math.

It's around this time that many of her students are learning how to represent core concepts of addition and subtraction in more abstract ways—instead of using counters or pictures, they're mastering the skills involved in using the standard algorithms, like regrouping.

Still, not everyone is ready. Davis co-teaches in an inclusion classroom with a special education teacher. About half of their students have individualized education programs, or IEPs. Many of Davis's special education students need additional practice with more concrete representation of operations. Throughout the day in small groups, "we go back to the basics," she said.

In whole class time, though, Davis and her co-teacher have worked to develop methods that support their general education and special education students alike.

"Within the classroom setting, what I try to do is I teach the lesson as it's intended to be taught," she said. "But there's no harm in also showing the concrete and pictorial methods, even when we're trying to move to the abstract."

In practice, this might mean having the whole class practice the same concept, but in different ways. One group might work on a subtraction problem with four-digit numbers, using the standard algorithm, while another might gradually work up to that point—first starting with two-digit numbers represented by blocks or counters.

Davis hopes all of her students feel that they're on a level playing field, she said. "My goal is, if a visitor were to walk in, for them not to be able to tell which one is the special education teacher."

courtesy of Milken Family Foundation

Award recipient Charday Wilson teaches a math lesson and answers students' questions.

Charday Wilson

Master teacher, Logansport High School, DeSoto Parish schools, La.

Charday Wilson wants math teachers to be able to learn from each other.

"If we stay in the classroom that we're in, then we have the perspective from one classroom in the building," she said.

At Logansport High School, which serves grades K-12 in Louisiana's DeSoto Parish, Wilson facilitates educator observations between classrooms and professional learning communities so that teachers can try out practices that have worked well for their colleagues.

Through these conversations, educators at the school have discovered that they share a lot of the same challenges, Wilson said. One big issue that crosses upper elementary, middle, and high school grades is stamina—helping students develop the ability to persevere through multi-step word problems, for instance.

Another is showing their work. Many students think that being "smart" means having the ability to do math quickly, in their heads, Wilson said. But when students don't show their thinking, it's harder for teachers to address any misconceptions that can lead to wrong answers.

To address this, teachers have shared strategies for encouraging "visible thinking." And schoolwide, teachers are promoting a new idea: that being "smart" isn't just about getting the right answer, but being able to show all of the steps taken to get there.

Making that shift, Wilson said, "has been a game changer for us." ■

Published May 28, 2024

The Motivational Power of STEM: This Program Connects Students to Potential Careers

By Lauraine Langreo

Ruier Fang loves science class, especially the hands-on experiments, such as creating chemical reactions and dissecting parts of an animal brain. "But I didn't know how that would apply to a career," said Ruier, a 12th grade student at Thurgood Marshall Academic High School in San Francisco.

Princess Canlas, an 11th grade student at Thurgood Marshall wants to follow the lead of some of her relatives and go into the medical field. But she wasn't sure how to pursue that goal.

Enter: Mission Bay Hub, the San Francisco school district's new program designed for students like Ruier and Princess, who are interested in learning more about careers in the health and life sciences fields. Now, both students—who participated in the program in its inaugural year in 2023-24—say they have a better understanding of what they want to do after high school and are more motivated to pursue those goals.

Mission Bay Hub is a one-year, specialized STEM program for 11th and 12th graders and counts toward a science, English, and elective credit. Students, who come for half the day from their high schools, learn more about science disciplines such as biochemistry and neuroscience.

More districts are renewing efforts across the country to provide high school students with the opportunities they need to access and excel in STEM fields. The Biden administration launched a STEM initiative in late 2022 that includes more than $1.2 billion in investments from the federal government, industry leaders, and nonprofit organizations.

Jobs in science, technology, engineering, and mathematics fields pay substantially more than those in other fields and are growing at a faster rate than all other occupations, according to the U.S. Department of Labor. And recent technological advances—especially in the field of artificial intelligence—mean more organizations are in search of STEM-savvy employees.

"One thing we know is that when students think of STEM, they think of doctor, they think of generic scientists, and they think of, maybe, computer programmer," said Maud Abeel, a director for Jobs for the Future, a national nonprofit that develops programs and public policies on boosting students' college and career readiness. "But there's a huge variety of STEM occupations out there that allow you to move between different sectors in the economy."

Peter Prato for Education Week

Seniors at Thurgood Marshall Academic High School in San Francisco practice the use of a pipette as part of a STEM initiative.

Beyond its economic impact, STEM learning also nurtures skills—such as creativity, persistence, and problem solving—that are transferable to almost any field students choose to pursue after graduation, experts say.

That's why it's important to show students, especially those in high school, the relevance of STEM learning.

How to connect STEM learning to real-world applications

With Mission Bay Hub, the San Francisco district is making STEM learning relevant by giving students exposure and access to professional scientists and their work.

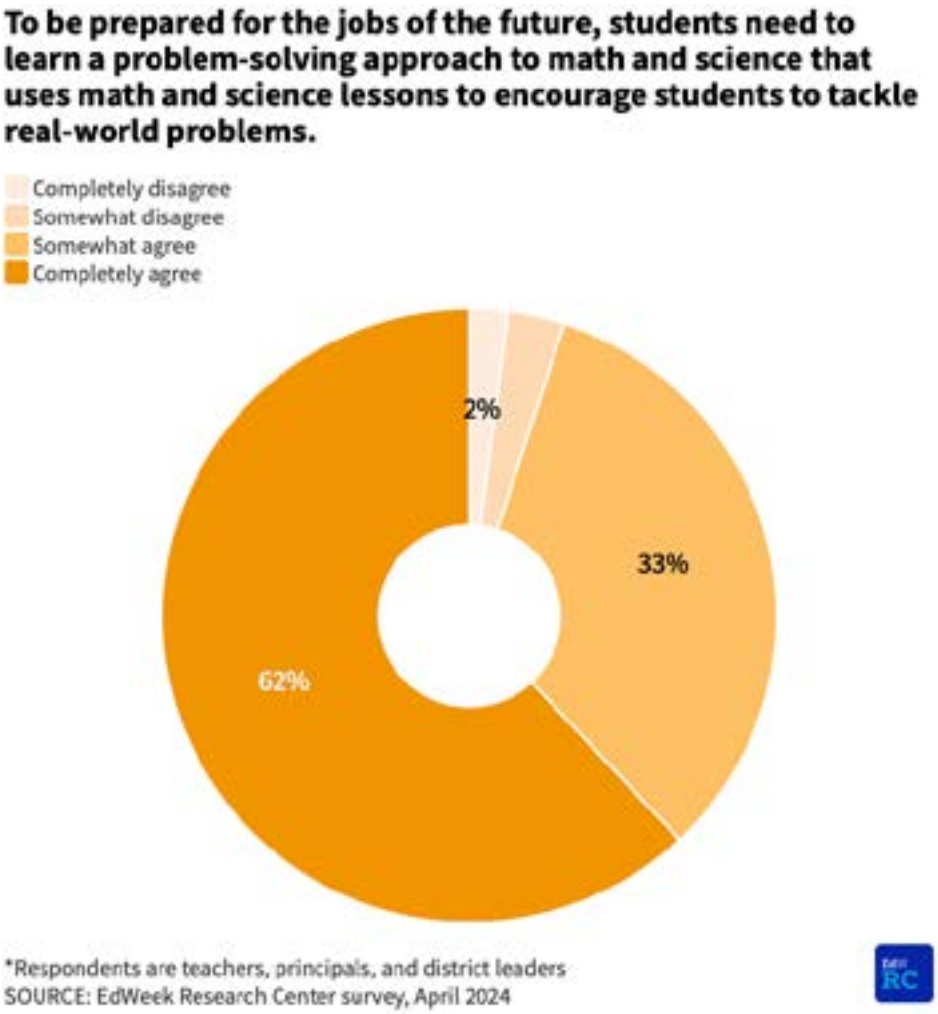
The program is fortuitously located in a region where many health and life sciences research organizations and companies are based. For now, students attend the program on the University of California, San Francisco campus. (The district expects its newest school building, which is mostly an elementary school with the top floor dedicated to the Mission Bay Hub, to be ready by fall 2025.)

The district's location in a region with lots of STEM-related companies and organizations makes it much easier for it to provide work-based learning experiences for the students who attend the program, said Erik Rice, the director of Mission Bay Hub. The program partners with UCSF to provide students with work-based learning experiences with scientists working in different medical fields.

For instance, Ruier's work-based learning experience was with clinical researchers who were seeing patients with prostate or bladder cancer. She shadowed doctors, nurses, pharmacists, and pathologists, and got to ask them questions about what they do and how they do it.

"Mission Bay made it a lot easier for me to get connected with these kinds of people," Ruier said. "It also helped me decide, 'oh, I want to work in health care.' "

Tess Carlson, the founding science teacher of the program, said giving kids these opportunities has been "really powerful." Carlson



co-teaches the class with an English teacher, Anita Feingold-Shaw.

Carlson's students opted into this program, so they have some interest in science. But she said the majority of them weren't sure they wanted to go into science or didn't know exactly what they wanted to study.

"Having these concrete experiences and meeting actual people, instead of having scientists be this abstract concept—that's been really powerful for them to envision themselves in the field, and then start making plans about how they're going to get themselves into the field," Carlson said.

That's how it was for Ruier. She was interested in health care careers, but didn't know which one she wanted to pursue.

"This [program] was perfect for me, really," Ruier said. "I got to meet a lot of people, ask a lot of questions, and now I think I'm leaning toward pharmacy."

Research shows that connecting what students are learning with their real-world experiences helps motivate them.

"The more that you get in the upper grade levels, the more real it needs to be," said Todd Kelley, a professor of technology leadership and innovation at Purdue University. "Students get to a place where they think, 'I'm just doing this for a test. I'm just doing this because the teacher gave me this assignment.'"

What's important is to show students "real science" and that means they have to go out in the world and collect data and do their own research, he said.

Ruier said the Mission Bay Hub program "makes the learning experience more interesting." She's not just "stuck in a classroom, reading, writing." Instead, she sees "how your learning will be applied in the real world."

"I think that's sometimes missing from a lot of my classes," she added.

It's all about providing supports for success

Not every student has access to these opportunities.

There's a misconception that students aren't interested in or motivated to go into STEM careers, said Margaret Eisenhart, a professor emerita of educational foundations, policy, and practice at the University of Colorado Boulder. But she argues that it's not just a matter of motivating students. Rather, it's all about supporting students to go through the steps to get there.

"Most students that I encounter know that STEM is a good area to go into," Eisenhart said. "I think what happens along the way is that they're discouraged in a number of ways."

For instance, students might not be able to take advanced STEM classes if they don't have the right grades, or students might not know about all the different classes they can take. Or those STEM subjects might not be available at their school, or they fear their peers would think badly of them for taking those courses, she said.

Beyond those challenges, not every district has the resources to provide these opportunities. To make a program like Mission Bay Hub work requires time, money, and access to professionals working in those fields, according to researchers and educators.

Plus, educators often don't have the necessary industry experience or the training to teach various STEM concepts or career paths. Counselors don't have the bandwidth to make sure every student is aware of STEM opportunities. And sometimes, because of graduation requirements, students don't always have time in their schedules for other classes, according to researchers.

Mission Bay Hub was made possible in part because there were already plans to build a new school in the area, and the district wanted to know if there were other ways it could use the space, so funding wasn't a big challenge, Rice said.

Rice saw what other schools had done with specialized programs and thought the district should take advantage of the Mission Bay area's plethora of medical and biotech companies.

With the program, now "it's very easy for our students to leave our campus and go be part of the 'real, real' context," Rice said. "Equally important is how easy it becomes for the adults that are steps away to come into our space."

Industry partners are a necessary part of the equation, according to Rice and Carlson, especially because schools typically don't have the funding to access much of the technology students would encounter in STEM fields. Industry partners can provide access to those tools, as well as the professionals who use them. This school year, along with UCSF, Mission Bay Hub partnered with health care company Kaiser Permanente and the Golden State Warriors, the NBA team.

But finding partners and building those relationships are challenges facing Mission Bay Hub.

And Eisenhart points out that specialized programs are "great, but they're scattershot." A quality STEM education should be "built into the school system," but typically students have these opportunities one year but not the next, or only in limited courses.

Princess, the 11th grade student who's participating in the Mission Bay Hub program, said she's worried about next school year because she won't have the program, which sparked her interest in the field of radiology.

"I feel like there's just a gap there," she said. "But I'm planning on taking more medical-related classes, [Advanced Placement] classes, maybe internships, too."

Her classmate Ruier graduates in June and then she's off to the University of California Berkeley to study chemical biology—a step that puts her well on the way to pharmacy school.

"This program was really good at exposing me to all these different kinds of careers," Ruier said. "That motivated me [because I saw] these people are doing it. This is an option. I can do it. This is also an opportunity to build a network of people that you may be working with or for in the future." ■

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Prodigy

Fueling Math Enthusiasm for K-8 Students

For many students, math is a subject that feels challenging and disconnected from their everyday lives. Yet, *math is everywhere.* It shapes how we think, solve problems and interact with the world. So, how do we change the narrative and help students feel enthusiastic to learn math?

The key lies in fostering engagement and making math both accessible, applicable and enjoyable. This article explores how educators and parents can fuel enthusiasm for math in K-8 students, transforming their learning experience and attitudes toward the subject.

Why Math Enthusiasm Matters

Fostering enthusiasm for math is about more than just improving test scores. It's about *building foundational skills* and *positive attitudes* that shape how students approach challenges, both inside and outside the classroom.

The Long-Term Benefits of Loving Math

1. **Building Confidence:** Students who feel capable in math are more likely to tackle complex problems with persistence.
2. **Reducing Anxiety:** A positive experience with math reduces the fear and stress often associated with the subject.
3. **Promoting a Growth Mindset:** Students learn that effort and resilience lead to improvement, an attitude that translates to other areas of life.
4. **Paving the Way for STEM Opportunities:** Early enthusiasm for math can inspire students to pursue STEM-related careers.
5. **Higher Academic Outcomes:** One study showed that students who enjoy math are more likely to achieve higher academic outcomes.

The Role of Engagement in Building Enthusiasm

Enthusiasm for math doesn't come from rote memorization or repetitive worksheets—it grows from meaningful and engaging experiences. *Engagement* is the bridge between math as an abstract concept and math as a skill that feels empowering and fun.

Digital game-based learning (DGBL) is a particularly effective tool for fostering this type of engagement. Platforms like Prodigy can turn math into an adventure, where students solve problems to progress in a fantasy world. This gamified approach combines fun with achievement, making math feel achievable and rewarding.

And many studies have backed up the power of digital game-based learning. It has shown that digital games contribute to:

- Greater learning gains
- Significant increases in math scores
- Improved math skills

The adaptive features available with DGBL, that tailor challenges to individual learning needs, help to enhance engagement and create positive attitudes towards math.

How Digital Games Engage and Excite Elementary and Middle School Students in Math

Digital games are uniquely positioned to capture students' attention and turn math practice into an activity they eagerly anticipate. By combining education with entertainment, the gap between learning and play is bridged. This makes math enjoyable for students at every level while having a positive impact on academic performance.

Here's how these games work their magic for elementary and middle school students:

For Elementary Students: Nurturing Early Enthusiasm

At the elementary level, students are still developing foundational math skills, such as addition, subtraction, multiplication and division.

Digital games tailored for younger learners focus on creating an engaging environment that encourages exploration and discovery.

1. **Interactive Visuals and Playful Characters**
   Games like Prodigy or Math Playground use vibrant graphics, friendly characters and immersive storylines to draw students into the learning experience.
2. **Immediate Feedback and Encouragement**
   Elementary students benefit greatly from instant feedback. When a game acknowledges correct answers with cheers or visual effects, it reinforces their confidence and encourages continued practice.
3. **Building Confidence through Repetition**
   Digital games often introduce math problems in bite-sized chunks, allowing students to practice at their own pace. This gradual approach helps solidify basic skills while maintaining a sense of accomplishment.

For Middle School Students: Keeping Engagement Alive

Middle school students face more complex math concepts like algebra, geometry and probability. These topics can feel abstract and intimidating, but digital games help make them more approachable and relevant.

1. **Gamifying Complex Topics**
   Games for middle schoolers, such as Prodigy or DreamBox, transform abstract math into interactive puzzles or strategic challenges. For example, students might need to calculate angles to solve a geometry-based game or use algebraic equations to unlock a door in a virtual world.
2. **Encouraging Critical Thinking and Problem-Solving**
   Middle school math games often emphasize higher-order thinking skills, encouraging students to apply logic and reasoning.
3. **Incentivizing Progress**
   For middle schoolers, motivation can come from leaderboards, badges, or achievements built into the game. Many platforms allow students to set goals and track their progress, fostering a sense of ownership over their learning journey. As they achieve milestones, their enthusiasm grows, inspiring them to tackle even more challenging topics.

The Power of Digital Games in Both Age Groups

Regardless of the student's age, digital games cater to diverse learning styles, making math practice engaging for visual, auditory and kinesthetic learners. They also promote:

- **Personalization:** Platforms adapt to each student's skill level, providing tailored challenges that keep them in their optimal learning zone—not too easy or too difficult.
- **Freedom to Explore:** Unlike traditional assignments, digital games allow students to experiment and learn through trial and error without fear of judgment.
- **Positive Reinforcement:** Games celebrate effort and improvement, which is especially crucial for students who may have struggled with math in the past.

These tools empower students to see math as a skill they can conquer, one exciting level at a time—whether at the beginning of their math journey or deep into pre-algebra.

Real-Life Success Stories

Schools and educators across the country are seeing the transformative power of engaging, game-based learning. One school in New Jersey reported that students mastered nearly twice as many math skills when they started using Prodigy. In Georgia, teachers and administration saw increased student motivation and performance with Prodigy. Prodigy also helped teachers in West Belden improve student engagement with personalized math practice.

Math Enthusiasm Unlocks Math Achievement

Fostering enthusiasm for math in K-8 students is about more than just improving skills—it's about changing how students see themselves as learners. Math doesn't have to be intimidating or frustrating. With the right tools and approach, students can discover the joy and empowerment that comes from unlocking their math potential.

Ready to help students love math? Start by trying out Prodigy for free today—you might just inspire a lifelong passion for learning.

Published May 28, 2024

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

By Alyson Klein

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

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

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

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

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

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

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

F. Sheehan for Education Week + iStock / Getty Images Plus

> **"I think we can all agree that a math class that's only about worksheets would not be a very fulfilling or interesting math class."**
>
> **JULIA AGUIRRE**
> Faculty director of teacher certification programs, University of Washington Tacoma

Does using real-world problems motivate students?

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

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

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

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

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

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

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

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

"I think, really, these things can mutually support one another. And both are necessary," said Julia Aguirre, a professor and the faculty director of teacher certification programs at the University of Washington Tacoma. "I

think we can all agree that a math class that's only about worksheets would not be a very fulfilling or interesting math class."

Promote young students' natural curiosity and creativity

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

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

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

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

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

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

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

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

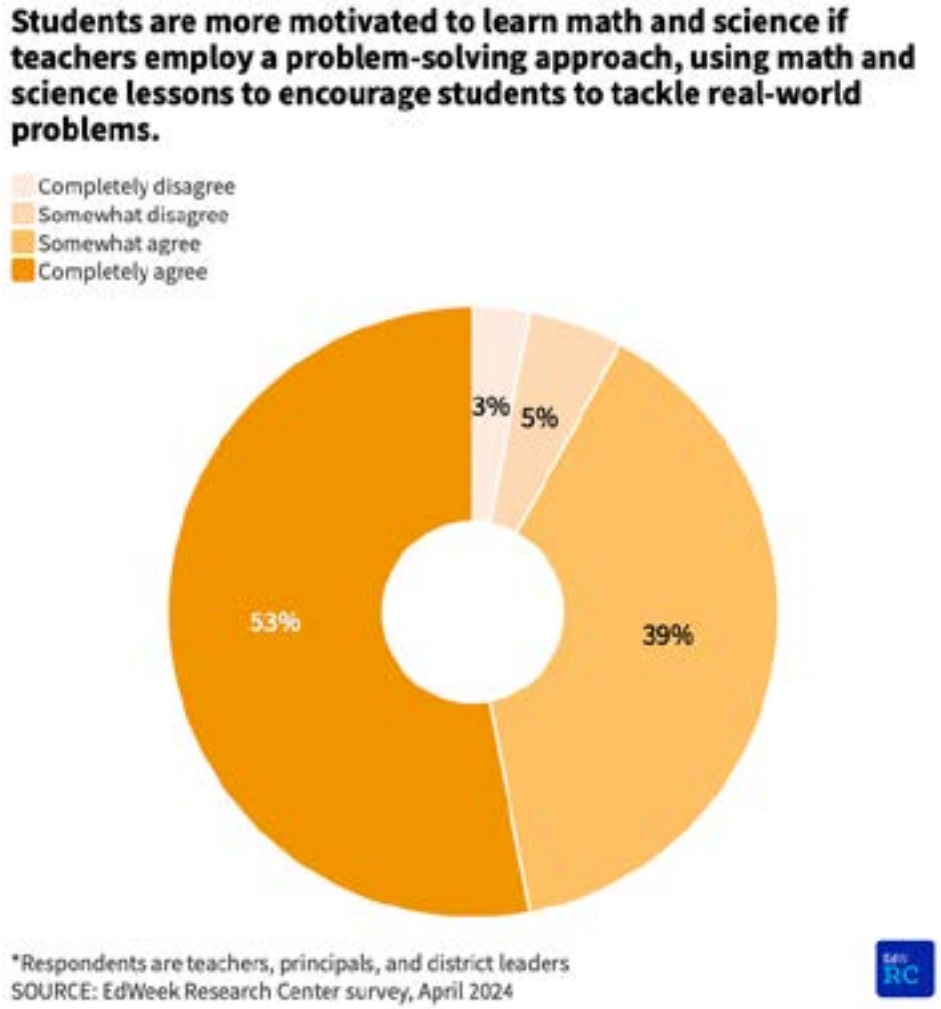
They'll spend the next few minutes comparing strategies for finding a solution. One student might have added 30 plus 15 and subtracted one, while another might have added 9 and 5, then 30.

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

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

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

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



Teachers need more training in the problem-solving approach

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

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

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

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

But she thinks that many teachers don't know how common procedures learned in math class

could be applied in the real world, so they struggle to make those connections for their students.

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

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

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

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

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

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

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

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

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

Additional Resource
View this article's charts

Sonia Pulido for Education Week

OPINION

Published December 10, 2024

5 Ways to Up Your Classroom Game, According to Larry Ferlazzo

By Larry Ferlazzo

1. We need to stop talking "motivating students" and, instead, starting thinking about "creating the conditions in which students can motivate themselves."

Soooo much time is spent discussing ways teachers can motivate students. Yes, it's possible to motivate someone for a short period of time—inspirational speakers do it all the time. But, just as most of our passion dissipates the day after hearing a rousing speech, our students' motivation will also likely take flight the day after our heart-to-heart conversation or after they've received points on the behavior chart.

Extrinsic motivation (like points on a behavior chart) might work for tasks requiring little critical or creative thinking. But it's a whole different ballgame when it comes to motivation for creative or critical thinking, which is what we need to do the most of in our classrooms.

That's where intrinsic motivation comes in, and researchers have found that creating the conditions for it to flourish requires supporting student autonomy (choice is one strategy), competence (increasing the odds of student success, for example, through providing scaffolds), relatedness (supporting students through group work is one way), and relevance (perhaps by challenging students to reflect on how they can apply what they're learning in the future).

2. Stop telling students what to do.

A new study has come out which basically finds that students will be more likely to use retrieval practice (pushing yourself to remember something that is not in front of you) as a study strategy if you explain the reasoning behind it and why it works.

Really, the far more important point this study makes is that our students, like us, are more likely to do something if we're shown it's in our self-interest to do so OR, even if it's not in our direct self-interest, we're more likely to do it if someone has taken the time to respect us by explaining a logical reason for their request.

Whether it's related to getting students to use retrieval practice, or getting English-language-learner students to reduce their use of Google Translate when writing, or encouraging students to choose more diverse small groups, our students deserve these explanations—even if is "harder" than just telling them what to do.

3. Schools are mysteries, not puzzles.

Security expert Gregory F. Treverton originally developed the frame of puzzles and mysteries. Puzzles can be solved through logical analysis and have a clear conclusion. Mysteries, on the other hand, contain many ambiguities with lots of moving parts that have to be identified.

Treverton suggests that many problems are not solved and, in fact, are made worse because we all tend to have a bias toward approaching challenges as puzzles instead of mysteries and miss important information and opportunities.

I've previously written for EdWeek about what this looks like in classroom management, but I think it holds true for just about every aspect of day-to-day work involved in running a school, how education researchers approach their work, and all aspects of education policy.

4. Power is not a finite pie.

During my 19-year community-organizing career that took place prior to my 23-year teaching career, this idea was central to our work in negotiating with decisionmakers: If we get some power from you, that doesn't mean you get less because power is not a finite pie. If we get some power, then the size of the pie itself increases in size with more possibilities and opportunities created for everyone.

The same holds true with schools and the power dynamic between the district central office and principals; with principals and their school's teachers; and, yes, with us teachers and our students.

There are many ways we teachers can share power with our students, and many connect with creating the conditions needed to support intrinsic motivation. What do we have to lose if we try some of them out?

5. Emphasize assets, not deficits.

Who among us does not occasionally complain about the shortcomings of our students, their families, and, in my case, my basketball teammates? And it's safe to say they all do the same about us!

We're all human, but it's a good bet (supported by research) that our lives would be better, and our teaching would be more effective if we, instead, focused on the assets others bring to the table.

Whether it's focusing on the multiple languages and resilience many English-language learners bring to the table instead of their lack of English skills, or looking at all the teaching opportunities in the "mistakes" students make in their work, I suspect we would all be in a better place if we teachers spent more time being, as journalist Jo Napolitano said, "talent scouts instead of deficit detectors." ■

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

OPINION

Published December 6, 2024

Teachers, Here's How to Make Science and Math Relevant in the Classroom

By Larry Ferlazzo

Helping students see how what they are learning in school is relevant to their lives, hopes, and dreams enhances motivation.

It can also be challenging to teachers who are tasked with covering a lot of content, especially in math and science.

This series will offer some instructional strategies that might help ...

'Phenomena'

K. Renae Pullen has been an educator for over 20 years. Currently, she is the elementary science specialist for the Caddo Parish public schools in Shreveport, La., and is a member of the board on science education for the National Academies of Sciences:

Science is everywhere. It is a body of knowledge, a way of thinking critically, and a set of practices that allow us to make sense of the natural world. Science literacy is important because it can afford students career opportunities in the future and empower them to make informed decisions and solve problems. It can also encourage them to be lifelong learners and always be curious about the world around them. No matter the age, all students deserve the wonder of science. How can we bring beauty and relevance to the science classroom?

Imagine a science classroom where students are actively engaged in learning as they investigate science concepts and explore real-world problems that matter to them. This vision can become a reality through phenomena-based learning. Phenomena are the observable events in nature that students can investigate and design solutions to.

For example, consider elementary students' understanding of chemical and physical changes. Traditionally, students' learning would center on memorizing vocabulary about states of matter and reading about chemical and physical changes to answer questions. With phenomena-based learning, students could learn about the Statue of Liberty. When the Statue of Liberty arrived in the United States in 1885, it was shiny and reddish-brown, similar to a new penny. Today it is green. Students could wonder about the phenomenon of why the statue turned green. They could ask questions, conduct investigations, and engage in other science and engineering practices as they make sense of the phenomenon.

When students are presented with real-world phenomena, for example, how canyons form, why people become resistant to antibiotics, or how we can protect ourselves from natural hazards, they are more likely to actively engage with learning and connect to their own lives.

Centering phenomena motivates students to engage in the same behaviors as scientists and engineers. Student learning transforms from passively learning about a topic to actively figuring out how and why things happen. This can lead to a deeper understanding of complex science ideas and allowing students to apply their content knowledge and disciplinary practices to local or global phenomena.

The first step to using this approach in the classroom is finding compelling phenomena students want to explore or design solutions to. A good phenomenon is puzzling, interesting, and compelling. It should be relevant to students' lives and complex enough to sustain exploration.

Provide students with opportunities to make sense of the phenomenon, investigate it, and communicate their findings. Websites like Phenomena for NGSS can provide teachers with examples of phenomena that could be used to support meaningful science learning. By carefully selecting and presenting phenomena, teachers can create a dynamic learning environment where students are empowered to be curious and clear; real-world connections are made as they take ownership of their learning.

'Deeper Than Changing Names In Word Problems'

Neven Holland is an educator, Ph.D. student at the UCLA School of Education and Information Studies, a contributing writer for Edutopia, and has proudly served as a tenured elementary teacher in the Memphis-Shelby County schools in Tennessee. He is also a 2022 Tennessee state finalist for the Presidential Award for Excellence in Mathematics and Science Teaching:

Think back to a mathematics lesson that left you in awe about how it connected to your everyday life and made mathematics seem actually cool and, perhaps, beautiful. Unfortunately, for too many students, including myself, it's difficult to recall many. We can all probably remember at least one math lesson where we didn't know why we were being forced to learn it. Instead of seeing the beauty of mathematics as something we engage in each day, it becomes just a subject full of steps and tricks to remember that are divorced from reality.

Making math relevant is much deeper than changing names in word problems. Instead, it means providing opportunities for students to develop a deeper mathematical understanding and connection to new learning through real-world application. Let's not forget that in the context of mathematical practice, application is a core component of rigorous mathematics instruction. Therefore, it is vital for students to not just work through mathematical procedures like multidigit subtraction in isolation but apply this concept in a real-world context.

The best strategies I've used to make sure math learning is relevant to the lives of my students has been striving to be conscientious of what is trending in the media like TikTok and youth culture, being knowledgeable of the social context of the city and neighborhood where I taught, and simply asking students through surveys or informal conversations what they are interested in and what they want to learn about.

For example, in her original concept of culturally relevant pedagogy, educator and researcher Gloria Ladson-Billings explored utilizing hip hop to make subjects like math more relevant and engaging. Understanding where young people are drawn may provide an on-ramp to make math more sensible and logical for teachers to tailor their curriculum.

In an earlier piece I wrote, I discussed the importance of incorporating the local context of school into my lessons. This approach forms a link between what's familiar and new learning, thereby making it less likely for attention spans to waver. Combining this approach with asking students what they're interested in learning about in math often ignites sparks of curiosity, wonder, and motivation to persevere when the math becomes harder.

Making mathematics relevant has never

been an easy task for me due to past teacher preparation, but the process is fun! It requires intentional planning and meticulous attention to detail, where the curriculum serves as a vehicle for the real magic to unfold.

The act of making math relevant should not be viewed as a gimmick or an extra task. Indeed, one could teach an effective lesson with zero relevance that enables students to remember the steps to solve a problem. However, what elevates a math lesson and makes it stick in later grades and post-graduation is providing experiential learning opportunities for students, which is a foundational aspect of solid teaching.

'Math Into Action'

Cindy Garcia is an elementary educator with 18 years of experience. Cindy currently serves as a districtwide instructional specialist for elementary mathematics in the Pasadena, Texas, school district. She previously served as campus mathematics coach and bilingual 3rd grade teachers in the district. Twitter/X handle: @CindyGarcia/TX:

One way to help students see what they are learning in math is relevant to their lives is to select or create tasks in an applicable context.

For example, during a unit that focuses on the four operations, teachers can use word problems that incorporate students' interests. If the class has a lot of students that like playing basketball, then the word problems can involve balls, points, stadiums, seats, uniforms, teams, etc.

Providing opportunities to put the math into action can be effective in enabling students to see that math can be used in real life. Instead of just solving a written word problem, they can work together to apply, create, and communicate about the math.

For example, during a lesson on elapsed time, teachers can guide students to make note of events and keep a schedule. The data they collect can later be used to generate questions and as the source for classroom discussions. When students bring samples or create examples of the math, it will help them take ownership of their learning.

During a measurement unit, students can bring empty containers to show different capacities. For instance, they can bring a milk jug for a gallon, a bottle of water for 500 mLs, or a to-go coffee cup for 12 ounces. During a unit on data analysis, students can stream their favorite movie or show in order to create a data set that can be used in a classroom lesson. The teacher can display the examples that students bring or create on a focus wall or bulletin board for all students to make real-life math connections.

Integrating what is being taught in math with other subject areas is helpful in order for students to understand the importance of what they are learning in the math classroom. When sequencing lessons or pacing out units of study, determine if there is a time when a cross-curricular connection can be made. It's a great opportunity for integration if the science unit on plants and the math unit on measurement are scheduled to be taught around the same time. During the math lesson, students can learn about standard linear measurements and using a ruler. Then, during the science lesson, students can apply what they have learned to measure the height of plants using a ruler. ■

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