EDITOR’S NOTE
Creative learning helps students develop the knowledge and skills needed for success. This Spotlight will empower you with details about a district’s DIY approach to creating a mobile STEM lab; ways to make science more relevant for students of color; counterintuitive findings about student motivation; the case for teaching real-world problem-solving; ten culturally responsive teaching strategies; and the grounds for bringing wonder back to the classroom.

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Susan Gilley’s education career has centered around helping teachers understand and integrate technology into the classroom.

But in the 2,850-student Harrison school district, just north of the Ozark National Forest in Arkansas, remote learning isn’t just about virtual instruction; it’s about bringing hands-on learning to students in person when they can’t get to campus.

For many of those students, the district’s GOBSmobile, a decommissioned school bus that’s been transformed into a one-stop mobile library, science lab, and digital classroom, was exactly what they needed to stay on top of their studies and connected to their schools, teachers, and peers during the upheaval of the COVID-19 pandemic.

The modern-day bookmobile, painted yellow and blue and outfitted with a STEM lab, reading nook for students, and a classroom for teachers, first hit the road in April 2021 and has served 2,700 students across the district’s 200 miles in its first year.

From Walmart parking lots and youth centers to local schools, the GOBSmobile—named after the district’s goblin mascot and short for “Greater Opportunities for Better Success”—provided book loans; science experiments and demonstrations; storytime for younger students; and reading materials and supports for secondary students’ Advanced Placement courses.

If students couldn’t come to school, Gilley, the district’s executive director of federal programs and instructional technology and the GOBSmobile creator, was determined to bring the lessons to them, in their communities.

“Mobile technology integration impacts students by reaching them where they are,” Gilley said.

It shows families that “the district realizes the impact of the digital divide,” she said. “Families can’t always travel to you, and [the] district needs to continually find ways to think outside of the box to help all learners and their families.”

Gilley, a 25-year education veteran, started as a business teacher but served as a technology coordinator in the St. Joe and Bergman school districts in Arkansas before moving to the same position in Harrison in 2011.

She has a do-it-yourself approach to solving education problems: Bring everyone together and use everything you’ve got.

On paper, the district, about 140 miles north of Little Rock, was in a better position than many of its rural counterparts when COVID-19 first shuttered schools in spring 2020. Eighty-five percent of families in Boone County, where Harrison is located, have access to broadband internet, and the district had already provided K-12 students with laptops and preschool students with touch pads.

In practice, however, students, just over half of whom come from low-income families, often had spotty internet connections.

Gilley and other educators worried that students would disengage without access to more hands-on learning, particularly in science, math, and reading.

The GOBSmobile emerged to make sure that didn’t happen.

“We were way far ahead of the game as far as 1-to-1 technology, which really helped us when COVID hit,” said Jay Parker, the principal of Harrison High School. “And a lot of that is due to Susan Gilley. She’s instrumental in seeing a vision, getting feedback, and then doing whatever it takes to overcome the obstacles that make most people give up and say, ‘Well, we can’t do that because of this.’ She finds a way.”
Immersive Learning Environments

So, the question is why? The answer is to give your students the best chance at making learning fun, understanding that problems are meant to be solved, and recognizing that failure is the only option if you want to get better at something. It all starts with that state-of-mind, and Inventionland Innovation Labs are a critical component to helping students, teachers, parents, and the community understand that creative and inspired learning is only the start of greatness in our children.

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Gilley, 59, had picked up on the bookmobile idea years before the pandemic, while attending a technology conference. But with standard bookmobiles averaging $200,000 for a new one, it seemed out of reach for the district. The widespread school disruptions at the start of the pandemic provided both the impetus to get a mobile classroom up and running and the manpower to put one together in-house.

She worked with Travis Graham, the district’s operations director, and the transportation department to retrofit a 2000-era school bus with a worn-out interior but working engine and frame.

Transportation workers, who were sidelined during the school closures, went back to work, ripping out the old seating and hardware. They scavenged shelves and materials from an abandoned junior high school, while Gilley worked with librarians to collect leftover books from elementary school libraries that had been updated. Local graphic design and welding businesses gave the bus’s interior a fresh coat of paint and a grill decorated with an open book on the exterior.

“Even as we planned, we just kept putting more stuff in it,” Gilley said. “I was like, I want this to be more than just books. I want students to be able to do everything on it.”

Gilley ensured the bookmobile was welcoming to students. A countertop spans the entire length, and it has separate work areas for science experiments, math puzzles, and art kits; six tablets loaded with Osmo coding games; and three laptops with an attached 50-inch flat-screen television that teachers can use to project lessons from a computer.

The other side has bright blue bookshelves, comfy pullout cushions for reading, and storage for free meals the district delivers to students during summer months. The bus also operates as a mobile hot spot for families with no or unreliable internet access, with Wi-Fi extending about 300 feet.

“Kids love the technology—the Osmo’s apps, the Chromebooks—but we also have a lot that’s not technology, like marble mazes and magnet building kits, the electric snap circuits, which are a big hit,” said Tracie Thomas, Harrison’s only high school librarian, who also doubles as a STEM teacher on the GOBSmobile two days a week.

“I think sometimes kids have access to [smart] phones and iPads, but to actually get them away from that and building and exploring stuff on their own—that is something they really enjoy and isn’t something they have access to at home.”

“Families can’t always travel to you, and [the] district needs to continually find ways to think outside of the box to help all learners and their families.”

SUSAN GILLEY

**A creative, cost-effective solution**

All told, the bus cost about $75,000 to build and operate this year, including $10,000 to staff it with a driver, a librarian, and a paraeducator.

The district also received a $20,000 state grant for take-home books and science-, math-, and literacy-project packs for students.

“I think this has been a ‘COVID lining’ in the pandemic,” Gilley said. “I want [leaders] to realize that it doesn’t really cost that much money to get something like this done because most districts probably do have a bus that they could use for this purpose.”

Charles Hodges, an instructional-technology professor at Georgia Southern University, who studies rural STEM education, said the mobile STEM and computer lab is an “evolution of the traditional bookmobile” that could boost students’ science and engineering engagement in rural areas.

“That’s a pretty good, creative solution because families in rural areas don’t always have the best internet access—or any internet access at all,” Hodges said.

Access to science opportunities can vary widely from school to school in districts spread out over hundreds of square miles, he noted, “so if funding for some of those cool technologies—like Osmo and little robots and things like that—if they don’t have enough to sprinkle them out across the county, then putting it in a mobile lab where they can drive it around and everybody can have some access to it, that’s a pretty creative solution.”

The remote learning projects, along with STEM and literacy lessons, have helped students weather the academic disruption and blunt learning loss over the summer and during remote instruction, Thomas said.

Gilley is building on the progress she made during the pandemic and plans to expand services to reach more students. High school students are learning to program robots and other science and engineering activities during school visits from the bus this semester. They will later serve as mentors for STEM activities to elementary school students.

With the bus’s classroom and Wi-Fi features up and running, Gilley has started working on plans to add solar panels to the roof and a side awning to create shade for outdoor classrooms. The district intends to expand summer activities to include wellness workshops, with free dental and hygiene supplies. It’s also using federal COVID-relief money to add Wi-Fi to all school buses, to create a fleet of mobile hot spots.

**A student-focused problem solver**

Gilley’s portfolio expanded during the pandemic to include directing federal programs, writing grants, developing teacher training, and even monitoring the district’s COVID-19 infection rates.

Her ability to wear many hats has earned the trust of staff members, who come to her with thorny problems, according to Thomas, the librarian.

“She actually does about four people’s worth of jobs ... and she is so kind and nice and easy to work with,” Thomas said. “I think those kinds of leaders are your best, because you’re not intimidated or scared to go to them and you can learn so much from people like that.”

That was the case when Parker, the principal of Harrison High School, wanted to help graduating seniors who couldn’t afford to buy laptops as they headed off to college.

He approached Gilley for help, and she came up with a workable solution for students.

The district replaces its 1-to-1 devices on a four-year cycle, so Gilley offered seniors the option to buy their school-issued laptops for $5, close to their fair market price. After all the seniors have the opportunity to buy a laptop, the remaining laptops are offered to the community for $10 each, with the proceeds going to cover the cost of devices for homeless students, who are able to keep their laptops for free.

The program has eased the digital divide—and angst—for graduates, Parker said.

“People say they make their decisions on what is best for kids, but then don’t always follow through with that being the continuous measuring stick,” Gilley said. “I am proud to say I feel more and more I am able to let that factor be the biggest part of any rubric for any implementation decision.”
Here’s How to Make Science More Relevant for Students of Color

By Ileana Najarro

Nina Hike used to consider herself to be a traditional high school science teacher. She gave lectures full of abstract formulas that rarely if ever tied directly with the lives of her students of color.

But following the murder of George Floyd in May of 2020, her then students had questions about racism and the national calls for social justice. So when Hike started teaching 10th grade chemistry at George Westinghouse College Prep in Chicago, in the fall of 2020, she felt it was time to shift gears and turn her science class into a space where students could explore the intersection of racism and science and, more broadly, how science is a part of their everyday lives.

“They want to understand it, they want to know more about it, and just being able to do laboratory investigations and kind of see the science come alive. I think that is what keeps the excitement going,” she said. “But then we’re connecting it back to what does this have to do with you and your family, your community, and just really trying to make those authentic connections to their lives, I think that’s what it’s really about.”

Making science class more culturally relevant is just one of the strategies K-12 science teachers are using to better engage students of color at a time when Black and Hispanic people remain underrepresented in science, technology, engineering, and math careers and national discussions continue on how to make education overall more equitable.

Connect science class to the real world

Last year in Hike’s class, students studied the chemistry behind drug tests, discussed the disproportionate ways drug laws hurt Black people, and learned how marijuana dispensaries are disproportionately owned by white people. They learned about people of color’s scientific contributions. And they explored the chemistry of environmental contaminants to contextualize efforts by residents of Chicago’s South Side to keep a metal scrapyard from relocating to their neighborhood and further polluting their air.

Hike shared with her students that she grew up in the predominantly Black Altgeld Gardens community in the southeast side of Chicago where, beginning in the 1970s, Hazel Johnson, known as the “mother of environmental justice,” fought against landfills in the area that polluted the air, water, and land. Her students then looked up their own ZIP codes on the federal Environmental Protection Agency website to identify any nearby factories.

When students found neighborhoods where lead had been detected in the soil, for instance, they learned about the primary uses of lead and ways to remediate the soil using scientific processes to remove heavy metals.

“As teachers, we just have to be willing to be learners and be willing to look at the intersection of society, history, and things that are happening so that we can help them not repeat themselves,” Hike said.

Hike doesn’t expect all her students to pursue STEM careers. But she hopes they become lifelong learners who appreciate scientific inquiry and how it applies to the world around them. She points, for instance, to a student who took pride in being able to recognize chemical ingredients on the food labels in her local grocery store.

“You may not be paying attention to it, but science is happening all around you,” she tells her students.

Exposing students to real-world applications of science lessons and engaging their passions in doing so helps undo the phobia of science being too hard, said Jonte Lee, a physics and chemistry teacher at Calvin Coolidge High School in the District of Columbia.

For instance, if a student loves video games, teachers can show them the science, technology, engineering, and math that go into that game.

Even an integrated curriculum that connects science to other subjects can help, he added, especially considering how subjects tied to standardized tests, such as reading and math, tend to get more attention in elementary school than science does.

Systemic changes are also needed to further engage students

Yet while culturally relevant science classes may pique the interest of students of color in STEM subjects, deeper changes in how science is taught and tested may be needed. Science assessments, for one, must better match the type of curriculum, Lee said.
And students need more teachers of color—both in the sciences and overall. Lee noted that Black men, for instance, only make up 2 percent of the American teacher workforce.

That’s a problem because students who have opportunities to learn from people in STEM and science teaching who share their cultural background are better able to see a future for themselves in that space, said Sharon Delesbore, an assistant principal at Hightower High School in Missouri City, Texas, and the president of the Association for Multicultural Science Education.

But underlying efforts to diversify the science-teacher workforce and change testing and curriculum is the need to first care enough to build relationships with students of color, Delesbore said.

“I think what’s really important is that teachers actually need to understand their community,” she said. “If we already come into a situation and we already feel like the students that we’re servicing don’t have what they need in order to be successful, then that bias and that barrier is going to hinder how we communicate with our kids.”

Give students agency

In order to give her students more agency and a sense of belonging in the science field, Hike lets students design their own experiments, ask questions about instruction methods, and offer ideas on how to make the classroom environment better for learning.

To help science teachers address disparities revealed by the pandemic, the National Science Teaching Association late last year created a miniseries of webinars focused on creating equitable opportunities in a remote learning environment, said Alicia Conerly, the association’s division director of multicultural/equity in science education.

This year, the organization continues with another set of webinars on promoting diversity, equity, and inclusion in science and STEM teaching, which runs through December. Among the topics covered are: how to address social justice in science class, the importance of integrating science and language instruction to help English-learner students in particular, and what social-emotional learning looks like in science class.

While Hike experimented with topics like environmental racism last year, she continues to explore ways to better connect her lessons to students’ lives this year and beyond. In fact, some of her students will be presenting their findings on chemical contaminants in Chicago at a local university.

Motivating students can be a tricky, at times exhausting, business, but educators say it’s never been more important to get students engaged in their learning after years of disruptions.

At the annual American Educational Research Association conference here, global and national motivation experts from education, business, and other fields discussed what instructional approaches and student characteristics make the biggest difference in academic drive. In the process, they have raised questions about some educational truisms about the best ways to incentivize student engagement in learning.

Here are a few insights for teachers.

**Myth:** To motivate students for a difficult task, it’s important to make it fun and entertaining

Prior research has found people have a harder time keeping themselves motivated for a “serious” task, like comparing prices, than for a “fun” task like running a fantasy football team, even if, for example, both contain similar math requirements.

But E. Tory Higgins and Emily Nakkawita of Columbia University found that people’s persistence in continuing tasks was more closely connected to how well they fit what they considered the goals of the tasks themselves. Participants dedicated more time both to tasks framed and presented as important and those framed and presented as enjoyable. By contrast, they were less persistent when researchers added more enjoyable elements to tasks presented as important.

“The direct educational implication of this is, don’t assume in education that the best thing to do is to surround [an activity] with something enjoyable,” Higgins said. “It depends on whether someone considers the activity fun or important. If it’s considered fun, then adding something enjoyable surrounding the situation can inspire them to redo the activity—but if it’s important, [fun] actually will undermine it.”

“Myth:** A student who needs a bit of a push on homework just needs some advice from their teacher.

Yes, but the student can be even more motivated by giving advice to other kids instead.
That’s because it’s easier to seek help for others rather than for oneself, and easier to learn from someone else’s failure rather than your own, according to Ayelet Fishbach, a professor of behavioral science and marketing at the University of Chicago and author of *Get It Done: Surprising Lessons From the Science of Motivation*. In a series of studies, Fishbach has found that children and adults are significantly less likely to be able to draw lessons from their failures than their successes, and are more likely to avoid activities they have previously failed or struggled in.

While most people seek advice when they start to work toward a goal, Fishbach found in one series of studies that they can be more encouraged to work toward goals like improving study habits or controlling tempers if they give others help instead.

“We are consistently motivated by giving other people advice ... and interestingly, people do not predict that they will be motivated by giving advice.”

**Myth: Getting students to set goals for themselves is the most important way to motivate them.**

To succeed academically over time, students must learn to motivate themselves rather than just relying on encouragement from teachers and peers, but Carlton Fong, of Texas State University, found some strategies students choose are more effective than others.

In a meta-analysis of more than 400 studies of children and adolescents, Fong studied six ways that students try to control their own motivation:

- Mastery self-talk, such as telling oneself you are competent or will perform well on a task;
- Interest enhancement, such as making a game of a task or aligning it with your personal interests;
- Warning yourself of the external consequences of not doing or succeeding on a task;
- Environmental control, such as setting up your work space to reduce interruptions; and
- Proximal goal-setting, or breaking down one long-term goal into smaller interim goals.

He found that while proximal goal-setting was associated with higher academic achievement for college students, there was no significant benefit seen for middle and high school students. Similarly, there was no academic effect for secondary students who tried to align their interests with an academic task to be more motivated.

By contrast, higher academic achievement was associated with students who tried to control their environment, tell themselves they had the capacity to perform well on a task and warn themselves about the consequences of not meeting their goals.

“I think an interesting point that we found was developmental differences, right?” Fong said. “Maybe with younger students the environment that they’re learning in is perhaps more structured, and because of that, it’s more dependent on the instructor. So you’re not maybe relying on too many motivation regulation strategies for younger students. But we also see that maybe postsecondary students are just perhaps more self-regulated in general and more aware of these issues.”

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**A Word to the Wise Is Sufficient, but Only for the One Giving the Advice**

In one University of Chicago study, middle school students were randomly assigned to either receive written advice from a teacher on how to study and remain motivated, or to write a letter to a younger student, giving their own advice on studying and staying motivated. While both groups of students studied longer in an online vocabulary program in the four weeks after the intervention, those who gave advice to younger peers studied longer than those who had received advice.

The researchers found giving advice provided more motivation than receiving it across several other areas, such as controlling temper, saving money, or keeping healthy habits, for adults as well as children.

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**EdWeek Update**

Stay on top of everything that matters in K-12

By Alyson Klein

The designers for Monte Vista Elementary School’s proposed outdoor classroom had some key questions to answer: What materials could they use while staying under the district’s $10,000 budget? How much square footage would work? How would they produce the scalable models the client wanted?

Those critical questions—which could have been considered at a local architecture firm—were part of just another math assignment in Robbi Berry’s 5th grade class at the Las Cruces, N.M., school. The prototypes the students created in class ultimately helped inform the work of the professional architects hired for the job.

And the project helped Berry’s students master some important 5th grade math concepts—such as adding and subtracting multidigit numbers with decimals. And the students did it without having to plod through boring math worksheets.

This problem-solving approach to teaching math to elementary school kids makes the subject much more intriguing and relevant, Berry and other educators say. It allows students to experience math the way it is used in real life, rather than as a pile of equations with no meaningful context.

It’s never too early to begin having kids learn math this way, experts say. Today’s elementary school students need to learn how to analyze, reason, and make complex decisions to improve their chances of success later in life, said Jo Boaler, a professor of education at Stanford University.

In the world of work, “it is not very useful to be somebody who has memorized methods to [answer] textbook questions, because the work that is in our world is very different from that,” she said. “In whatever job you go into, you need to problem solve, think critically, make connections between different areas. And we’re just not helping our students develop those kinds of capabilities” in most schools.

The benefits of a real-world problem-solving approach can stick with students for years, Boaler said. For a study published in 2017 in the Journal for Research in Mathematics Education, she followed a group of high school students who were learning math through real-world problem solving and another group—with similar socioeconomic characteristics—who were taught math in a more traditional way. (Boaler has not conducted similar research with elementary students.)

Eight years later, the students who had been exposed to the problem-solving methods were in higher-skilled jobs and more likely to be looking at upward mobility in their careers than those who were taught more traditionally. The ones who had learned the traditional way said they saw math all around them in their professional lives but felt that their K-12 education had left them unprepared to use it for professional success.

More than one right answer, more than one right method

While those tasks make sense for 5th graders, kindergartners—and even preschoolers—can learn math through problem solving, Boaler said. She pointed to a lesson she created, called “foot parade,” in which children see pictures of the feet of different types of animals and are told to select as many creatures as they need to reach a particular number of feet. A cat and a bird, for instance, would be a total of six feet.

In the Howard County public schools in Maryland, elementary school math classes typically kick off with a problem-solving exercise, such as a discussion of a level-appropriate “target” number. For instance, students have a few minutes to brainstorm as many equations as possible to reach the number 147. Correct answers could be 100 plus 47, 823 minus 676, or other combinations of numbers. Students then share their answers in groups.

They must collaborate and recognize there are usually multiple ways to solve a problem, skills people in the working world exercise every day.

The goal is to expose “kids to different ways of thinking, without telling kids, ‘here’s the different ways you have to think,’” said John SanGiovanni, the district’s elementary math coordinator.

These math problems often have multiple correct answers, and multiple pathways for getting to a solution. That’s exciting for kids, Boaler said. “One of the things that has
[turned] off so many kids [to math] is that [they] think it’s a subject with one answer and one method,” she said.

Whether the math problems are as intricate as Berry’s outdoor classroom challenge—or simpler, like Howard County’s “target number” exercise—the underlying goal is to “create interest and wonder,” and help students unlock the concepts behind operations like addition, subtraction, multiplication, and division, SanGiovanni said.

What’s more, the problem-solving approach gives teachers the opportunity to introduce students to all kinds of possible careers.

Berry’s students, for instance, wear all sorts of professional hats to tackle math problems that she makes up based on real problems people face in the working world.

They’ve been event planners tasked with coordinating transportation to a wedding with 76 guests and four cars that can hold differing numbers of passengers. They’ve designed a house for a very picky client—played by Berry, doing her best posh lady voice. The house had to be built to certain specifications: a particular range of square footage, number of rooms, and sizes for those rooms.

The strategy gives students insight into how professional mathematicians think, Berry said. “Real mathematicians [see] a problem in the world, and they use math to solve it.”

When students veer off in the wrong direction, it’s a chance to learn, Berry said. “Mistakes grow our brain, we celebrate them,” she said. Going over a misstep is “when we have the best conversations.”

If a kid gets tripped up, Berry will ask the student privately if they are OK sharing their process with the class as a “favorite mistake.” If they aren’t, Berry will still share their work, but pretend the blunder was her own.

**Should teachers throw out their worksheets?**

Teachers using the real-world problem-solving approach can present the problem without initially giving instruction in the operations they might use to solve it, such as multiplication, Boaler said. That’s the reverse of how it’s done in a typical classroom where teachers say, “Here are your methods, now do some questions that practice them.”

Flipping that traditional process on its head means giving students a rich problem first. Then, once they’ve given it some thought, a teacher can introduce methods that might help students find a solution.

“At that point, kids are interested. They’re...
like, ‘Oh, yeah, I need that method.’ Whereas, when you show them the methods first kids are like, ‘Why? Why am I doing this?’” Boaler said.

SanGiovanni agrees with that perspective, to a point. But in his mind, the occasional worksheet still has its place. “Ten [math] problems on a paper from time to time, it’s probably good for maintenance of a skill,” he said.

Plus, he emphasized that most kids won’t be able to learn all they need to know just by solving a big problem, he said. “There has to be some explicit instruction about some of the math,” he said. “You can’t just discover it all.”

**The problem-solving approach can be problematic for some**

Teaching math this way can be a lot to ask of teachers, students, and even parents.

Many teachers learned the subject through more traditional methods back in their student days, such as practicing math problems on worksheets before applying that knowledge to real world situations. They’re skeptical that young kids can learn this way, SanGiovanni said.

“Some of our teachers [believe] that you can’t solve this huge problem or this really cool problem, because you don’t know how to add three plus four yet, or better yet, you don’t know how to do it quickly,” he said. They say they “don’t feel like I can take the time” for the real world problem-solving approaches.

It’s also tough for some teachers to give up control, said Latrenda Knighten, a mathematics instructional coach in Baton Rouge, La.

“It is scary because you don’t know what answers you’re going to get,” she said. Children may get frustrated with the open-ended process, or a class discussion may veer off topic if every kid is encouraged to talk about the problem in their own way.

Another big hurdle: “There isn’t always access to good materials that frame lessons in [real world] problems,” SanGiovanni said.

While Boaler and others have created excellent resources, he said, “you teach kids for an hour and a half of math every day,” he said. “That means you need 180 lessons, or 180 [real world] problems. And I know that some of those problems could be two or three days. But just the sheer volume isn’t there.”

Teacher preparation programs often don’t help prospective educators teach math through rich problem solving, particularly at the elementary level, he added.

District and school administrators may also push back against the approach. They worry students taught this way aren’t going to perform well on standardized tests, though those assessments increasingly measure students’ problem-solving abilities, Knighten said. “If we allow children to really internalize the concept, so that it sticks, you’re going to see [good test scores] because they’re going to make sense of it.”

Teachers get grief from parents, too, SanGiovanni said. “A lot of parents say they want their kids to be able to think and reason. They just don’t want it to look different from the way they learned,” he said.

Berry is quick to point out the real-world problem solving approach was not the way the subject was taught when she was a student. That, she said, is largely why she grew up hating math and now makes it her mission for students to love it by the time they leave her classroom.

“Sitting in a seat, just doing problems out of a textbook, or me walking the kids through step by step on how to do a procedural. That, to me, is not authentic learning,” she said. “I don’t want them just to be test takers. I want them to be productive citizens when they leave me.”
Educator Insights

Educators all over the world are searching for new ways to innovate the classroom to inspire creativity. The following excerpts are taken from articles written by educators on the subject.

“Collaboration should be a part of every day instruction. 21st century skills ask students to be able to work with others, and educators need to understand that collaboration is a skill that all students need, regardless of the path they choose for their future. With so many connections happening for us on the internet and in person, working with others is a necessary skill.

“Many teachers organize the classroom to allow for both whole group instruction, as well as small instructional spaces, where students can work alone or in small groups. However, one thing teachers should do is make sure they get student input into where the physical classroom space is concerned. This collaboration between students and teachers helps students understand the important part they play in the classroom experience.

“If teachers are not inspired when they walk into their classroom, their students probably are not inspired either.”

“If teachers are not inspired when they walk into their classroom, their students probably are not inspired either. Being an educator offers us a reciprocal benefit because our students definitely make an impact on us, and that is easily done when we create a respectful and creative learning environment.”

-Peter DeWitt, Education Week
Intent means very little if results are not achieved, so who better to hear from than the educators actually using Inventionland Innovation Labs in their schools with their students.

Connoquenessing Valley Elementary School Innovation Lab

"Now they (parents & community members) have buy-in and we get a lot more support which builds the school and builds the community up."

-Dave Keibler, Principal

Leechburg Elementary School Innovation Lab
“Creation Nation” Leechburg High School Innovation Lab

“What we love about the new space is the kids are super excited about learning. They’re excited about the new space. They’re excited about the new equipment. And when kids are excited, they really do learn better.”

“I’ve had the opportunity to observe the very same kids in a traditional learning environment and then to see them come here and just thrive in this environment has been an amazing experience.”

-Tanya Sherbondy, High School Video Production Teacher

“We put in Inventionland Innovation Labs and our attendance and test scores are up 54% in our High School.

-Tiffany Nix, Superintendent

“I find that the students’ creativity level has risen, as well as students just enjoying being here and enjoying doing projects. Their projects — they seem to be more immersive.”

-Shayle Prorok, Applied Arts Teacher
The context of a story can be a culturally rich backdrop to present scientific problems and concepts.

Autumn Kelly
Education Week

OPINION
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Ten Culturally Responsive Teaching Strategies for the Science Classroom

By Larry Ferlazzo

What are specific ways educators can make teaching science more culturally responsive?

When we talk about making school culturally responsive, science is not usually the first subject that comes to mind. But that doesn’t mean it can’t be done.

Teachers Autumn Kelly, Tara C. Dale, Mandi S. White, and Anthony Nesbit share their suggestions.

Making science ‘relatable’

Autumn Kelly is a Washingtonian and a happy member of the D.C. public school system with graduate degrees from the Harvard School of Education and Johns Hopkins University:

Science starts with a journey of discovery. Connecting culturally diverse students to a body of knowledge that can promote safe interactions with the natural environment, good health, and a chemical and biological understanding of the world around them will enhance their life outcomes. Students from diverse backgrounds, particularly Black students along with other racial minorities, are underrepresented and poorly served within the scientific community. As teachers, we can break this cycle by promoting and incorporating culturally inclusive methods as we present science content.

Use Stories and Personifications of Diverse People and Life Experiences

The context of a story can be a culturally rich backdrop to present scientific problems and concepts. Using a historical, current, or fictional character that shares the same ethnicity of life experience of your students will enhance their willingness to engage in science instruction. Invite local professionals in the scientific field from local hospitals, laboratories, or pharmacies to share about their journey in the sciences as a minority student.

Connect to the Community

Classroom research and problem solving in the sciences should focus on culturally relevant elements in the students’ local or broader community. For example: If there is a specific disease such as high blood pressure or diabetes that disproportionately affects individuals of certain ethnic or racial backgrounds, use these elements in examples and research topics for students to learn about the principles of science. Have students interview or watch YouTube footage of individuals facing health or science problems that affect their communities. Have students understand disease and treatment statistics from local hospitals and clinics to connect them to ways that science can solve problems in the local world around them.

Break Down Knowledge Barriers: Create Safe Places for Background Questions

Many students have not had the benefit of early formal or informal exposure to the language, vocabulary, and methodology used in the scientific fields of chemistry or biology. When these students attempt to learn concepts and ideas in these areas of science, they are hesitant to try because they lack an understanding of the foundational principals within these areas of study.

One way to support these students is to create a “safe space” in the classroom where students can ask anonymous questions about vocabulary and terms during course instruction. This can be done virtually through an email address sent to the teacher where students can send questions they need to ask, a phone number to the teacher where students can text questions, or done on a whiteboard or Post-it note area in the classroom teaching space. The teacher can designate a time during the class period to address these areas of academic need prior to students working on class projects or assignments. This support creates an authentic dialogue of understanding between the student learner and the instructor.

Connect to Personal Experience

Help students connect their life experiences to learning science. Question students to find out if they know anyone with a disease or health experience that is being studied in the science class. Teachers can share first-person accounts from YouTube or other sources of culturally diverse people who might be facing science-based challenges. Empowered by science instruction using these strategies, students can connect new knowledge to personal experiences.

Making science a relatable feature in the lives of culturally diverse students involves integrating culturally relevant elements into daily instruction.

Looking ‘through the lens of assets’

Tara C. Dale is currently a high school science teacher and instructional coach. Mandi S. White works as an academic and behavior specialist who was a classroom teacher for nine years prior. They are co-authors of the book, The Science Teacher’s Toolbox:

Culturally responsive teaching isn’t a specific set of strategies to be used within classrooms. So, then, how is it achieved? Culturally responsive teaching is a shift in mindset that motivates
how we plan for every aspect of learning and overall classroom experiences. It is student-centered and focuses on high achievement for all learners. Culturally responsive classrooms can increase student engagement, a student’s sense of belonging, and academic achievement.

**Highlighting Student Experiences**

The classroom becomes enriched for everyone when students are looked at through the lens of assets and not deficits. For example, when students are raised in rural agricultural communities, they likely have a deep knowledge of the natural world and its many interactions. These students are assets in the classroom because they may provide a unique perspective that can be leveraged as they and their peers are learning about agriculture, ecology, earth science, and biology.

An example of student diversity enriching our classroom occurred during a lesson about invasive species (introduced species that cause harm to the environment and/or human populations). Knowing that two of our students were from Uganda, we chose to teach about the harm of the Nile perch in Lake Victoria. Prior to the lesson, we met with both students and their parents to learn why the British government decided to introduce Nile perch to the lake. The history of this case study differs greatly depending on who tells the story. The ecologists and biologists explain that it was an ineffective solution because they knew that Nile perch would overpopulate and destroy the lake’s ecological balance. The government officials justify their decision by explaining that the lake had been overfished and the only way to avoid an economic depression was to populate the lake with a large, fast-reproducing fish species that would support the fishermen and their families.

Neither of the families made their living through fishing, but both had family members or friends who fished commercially. Through these discussions, we were able to document both sides of history, which were then presented to our students. After listening to the audio tapes (while also reading the manuscripts), students participated in a debate. Half of the class posed as scientists and the other half as government officials who were responsible for their country’s economy.

By knowing about our students and honoring their unique experiences and cultural differences, all of our students benefit. Student uniqueness is an asset and never a deficit.

**Highlighting Student Interests**

When the Flint, Mich., water crisis first surfaced in the news, many of our students had questions about how such a crisis could happen in the United States.

We designed a biology unit examining the lead contamination in Flint, not simply as a case study of how lead affects children but also as a study of how society and science are connected. We began by providing students with a glance at the cultural and economic makeup of Flint. Forty percent of the population was living below the poverty line, and 57 percent of the residents were African American.

Then we defined “environmental racism,” which is a term that was coined in the 1970s that refers to environmental injustices that harm people of color.

To help students understand the connection between society and science and to provide an example of how “environmental racism” exists, we provided them with two articles: one written by a local Flint resident and another written by a Flint politician.

Although the two authors told a story about the same event, they had two very different perspectives regarding the safety of the water today. Local residents insisted their water was not lead-free, but the politicians resolved that the contamination has been corrected and the water is safe to drink.

When presenting a story to students, it’s important that they don’t receive the subtle message that both sides are equal. To avoid this perception of equality, we led a class discussion about whether each side had the power in this case study: the politicians or the residents? Then we discussed the impacts of the pollution, asking how the residents were affected and how the politicians were affected.

Students then debated if the residents should trust the politicians’ message that the water could be safely consumed.

**Highlighting Student Voices**

Students are encouraged to participate in discourse every day in the science classroom in a variety of ways, such as discussing their personal experiences and backgrounds, planning and executing scientific experiments and outcomes, debating hot topics within a field of science, and many more. Through these activities, diverse opinions emerge, which allow for students to increase their understanding of each other and different backgrounds.

Another way to build this community of learners is through cooperative learning (e.g., jigsaw, think-pair-share, and round robin). Cooperative learning lends itself to what is known as the contact hypothesis. The contact hypothesis centers around the idea that prejudices are naturally reduced when diverse groups of people are required to work together. Thus, by creating diverse groups of students within our classroom, students are being exposed to other cultures and learning from each other. This can break down the prejudices that occur in order to solidify a classroom of respect and acceptance so that all learners feel supported and safe.

Another way to build a community of respect is by honoring the beliefs of all students and cultures. For example, in some Native American cultures, students are not permitted to be present for dissections. In order to create an environment that is accepting and respectful of this belief, we find a safe space for them to go and work during this time. We also invite them to teach other students about the history and basis of their traditions. We can make these kinds of modifications in advance because we make an effort to know our students and their backgrounds.

Culturally responsive classrooms shift
the focus away from the teacher and onto the students. When students can relate to the content while sharing their experiences with others, they can feel respected and safe. These positive feelings can increase student engagement and offer all students social and cognitive benefits.

‘Funds of knowledge’

Anthony Nesbit began his teaching career in Seville, Spain, teaching English. He has taught Spanish and English to speakers of other languages for more than 20 years. He holds a BA in Spanish and an MA in TESOL. Currently, he teaches English-learners in grades K-12:

One of my favorite books is Seedfolks, by Paul Fleischman. The book is a frame story about a community garden created out of a vacant lot by a group of immigrants in Cleveland. Each person brings just a little bit from his or her culture to make the garden unique and special. My favorite chapter in that book is titled, “Gonzalo.” In it, Gonzalo, who is caring for his “tío Juan” (a recent arrival from Guatemala), discovers that his uncle is a master gardener. Gonzalo treated him “like a baby.” He often said that he doesn’t know English and gets lost in the city. But, in the garden, Gonzalo’s uncle can show his knowledge.

Perhaps, if science educators incorporated more of the students’ funds of knowledge into the science curriculum, science would be more culturally responsive. Just as tío Juan found himself at home in the garden, our students might find themselves more at home if science teachers incorporated more of the background knowledge that their diverse students bring to the science class. For recently arrived students, this could include things such as geographical references or pictures and names of species of plants and animals endemic to students’ native countries. I will never forget the excitement of one of my students recognizing and describing the blossoms and fruit of the cacao tree in the interlanguage of English and Spanish. I think this excitement and later engagement happened because of the relevant example of the cacao blossom that was incorporated into the explanation of the life cycle of a plant.

Additionally, students need to see themselves as scientists to make science more culturally responsive. If educators seek out diverse science role models, this may help break down barriers and beliefs that students from marginalized backgrounds can’t do science. The internet is a great resource for connecting with scientists from all backgrounds. The site: skypeascientist.com, matches minority scientists with minority-dominated classrooms to give students role models that “look like them” or come from a similar income group.

Finally, making science more culturally responsive is going to involve a larger systemic change in the way science educators assess students. Too much of science knowledge is based on “just the facts.” Until science educators have a system that evaluates science knowledge based on what students can create using science, rather than just the facts they know, then the ability of a large portion of underrepresented students to do science will go unrecognized.

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

Why do school-age kids seem to be less curious than preschoolers?

We don’t encourage students to ask the same kinds of questions they did when they were younger. Here’s something I wrote recently about the topic for Character Lab as a Tip of the Week:

A few weeks ago, my 3-year-old granddaughter Frances asked, “Why don’t cardinals migrate?”

Frances’ question surprised me, both because she knew enough to ask it and because I had no idea what the answer was. When I failed to find explanations on my cellphone, Frances got bored with me and wandered off, asking others how to make red paint.

Preschoolers love thinking about possible explanations of interesting things. They feel free to wonder about anything and they do so with joy and creativity.

But by kindergarten, most children stop asking how or why questions. Research shows that most schools are set up to discourage this sort of wide-eyed wondering and that most adults, including teachers, underestimate children’s interest in how things work. Pressured to get good classroom scores on tests of bare facts, and burdened with large classes, teachers ask all the questions and test mostly facts.

Fortunately, there’s no reason we can’t all be lifelong wondered. I’m 69, but I still experienced the same thrill of discovery I had as a child when I searched on the internet for an answer to Frances’ question about cardinals. I learned that migration is related to diet, temperament, and keeping warm. Cardinals don’t migrate because they have ample food, are aggressive, and flocking together in winter months helps keep them warm while their molting provides insulation. I also learned that male cardinals are bright red because they eat carotenoid-rich plants.

I’m eager to see Frances again and share these insights over several conversations that package information in digestible bites while
also encouraging further investigations.

By embracing children’s acts of wondering, you become partners in discovery. Thanks to Frances, I now “see” cardinals differently. I envision the especially red ones as stuffing themselves with berries and imagine carotenoid particles coursing through their bloodstreams and somehow ending up in their feathers.

Don’t ask young people questions where a simple yes or no response is easily available. Do encourage how and why questions. Listen closely to what young people really want to know and what they find most rewarding to learn about. And if they report a new fact, you might wonder about it with them. By joining in the learning process, you will find countless opportunities to explore and delight in the richly colored world all around you.

Frank Keil is a professor of psychology at Yale University and the author, most recently, of Wonder: Childhood and the Lifelong Love of Science.
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