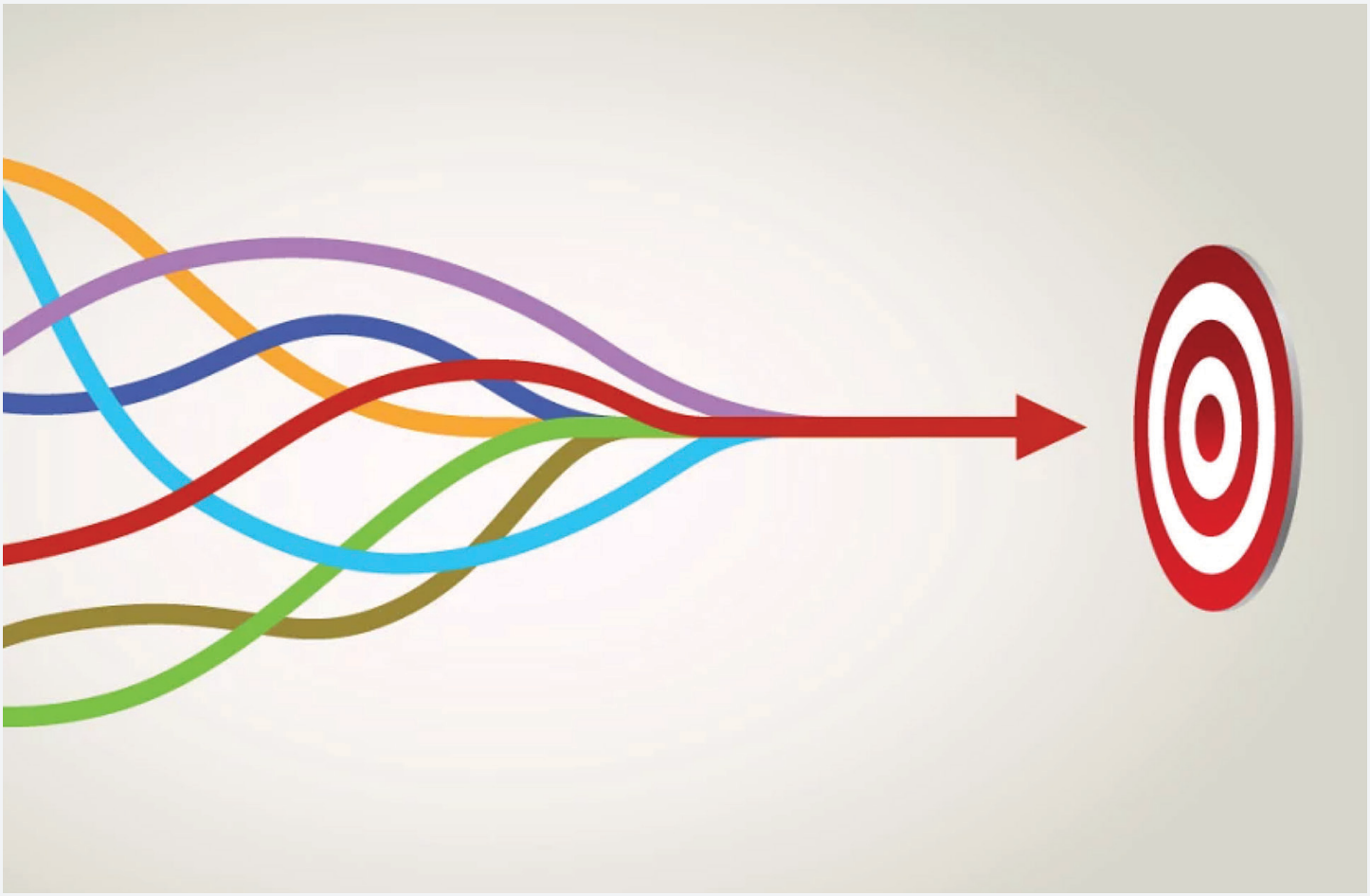
EducationWeek | SPOTLIGHT 2022



—DigitalVision Vectors/Getty

Inspiring Innovation Through STEM Education

EDITOR'S NOTE

STEM education continues to innovate for creativity, job security, and inclusivity. This Spotlight will empower you on ways to include more students of color; locate gifted students in unexpected places; expand career opportunities for students; unblock pathways to STEM; increase students with disabilities in STEM; and share programs designed to engage students and build confidence in STEM.

OPINION

Published March 2, 2021

How to Get More Students of Color Into STEM: Tackle Bias, Expand Resources

By Kevin Bushweller

The numbers are troubling. Only 7 percent of the people who earn STEM degrees are Black, according to federal data. That percentage did not change much at all between 2008 and 2018, but it did rise from 7 to 12 percent for Hispanic college graduates.

In the working world, the percentage of Black people working in the fields of science, technology, engineering, and mathematics drops even lower. Bottom line: There are very few STEM role models for students of color.

John Urschel is trying to change that reality through his own personal story and by talking to high school students of color around the country. Urschel, who is Black, is a former professional football player for the Baltimore Ravens and the author of *Mind and Matter: A Life in Math and Football*, which made the New York Times Bestseller list.

On track to wrap up a PhD in mathematics at the Massachusetts Institute of Technology the spring of 2021, Urschel is determined to get more students of color interested and achieving in STEM fields, especially math. While at MIT, he has been involved in the school's MathROOTS program, which works to encourage more females and students of color who are in high school to pursue studies and careers in STEM fields.

In a conversation with Assistant Managing Editor Kevin Bushweller and other reporters and editors at Education Week, Urschel talked about his journey from being a student whose 1st grade teacher initially misjudged his intellectual abilities and wanted to hold him back a year to a PhD candidate at one of the nation's top universities, tackling the highest levels of mathematics.

Following are some of the key insights from that conversation, edited for brevity and clarity.

—National Museum of Mathematics (MoMath)

Former professional football player John Urschel, the author of the New York Times bestseller *Mind and Matter: A Life in Math and Football*, is making it his mission to encourage more students of color to enter STEM fields.

In your book, you write about a situation when you were in 1st grade in which your teacher wanted to hold you back a grade because she saw you as a "typical minority student unable to keep up in a classroom setting." Yet when your mother insisted the school test your knowledge and skills, you were way ahead of your peers. How often do you think minority students face similarly biased assumptions?

Certainly more often than I would like. I visit a good amount of schools. I typically try to aim for the high school level. Even talking to parents of children in high school, they tell me these [similar] stories of when their kids were younger. It's important that when we look at a student that we really try to diagnose what their situation is based off the characteristics of what they're doing, not things like the color of their skin or the household they're born into.

When I was growing up, one of the most important things to my mother was that whatever I wanted to do, whatever I wanted to be, whatever I really desired, she really wanted to make sure that the only thing that could ever, ever hold me back would be a lack of talent, whatever talent means, a lack of work ethic, or just plain bad luck. She really was very adamant that she never wanted it to be because of the household I was born into, or a lack of resources.

Over time, you developed real confidence in your math skills. What message should educators be sending to all students, and especially to students of color, to build that kind of confidence?

I would say specifically in mathematics and STEM, one thing that is really important but somehow doesn't really come across as I would like it to, is that whatever you are doing in math, wherever you are at in math, you are at a given place. And that place you are at, meaning what you know and what you don't, doesn't say anything about your intelligence level or your ability to do math, and that getting better in math and in quantitative things takes work, it takes time.

What matters most in building that confidence?

What really matters is resources, what really matters is how much a child is nurtured and fed things. This is just my opinion, but I would say that, by and large, if I had to choose between giving a child a little bit more innate math talent or a little bit more resources, I think, really, resources is what is a very good and bigger predictor [of future success].

I like to think I am pretty good at math. But I am also very much aware that my ability in math was honed through countless, countless hours of very hard work, of struggling and

4 reasons it's time for school tech to graduate from makeshift to modern

A year of hybrid learning has shined a light through the cracks in education technology. Families with—and educators of—school-age children had to cobble together a learning environment that's more reliant on technology than ever before. And they have encountered significant challenges.

The state of the student

Access disconnection

Off-site and even some on-campus learning requires online access. Yet nationwide, millions of students simply don't have a way to get online—particularly learners in low-income households and rural areas. This disconnection creates a "homework gap" that hurts their education.[1]

15–17 million students don't have internet at home.[1]

Bandwidth bottleneck

Students have siblings. Families are taking turns hosting groups of learners. Parents are working from home. That's a lot to ask from a single residential internet connection. Students need speeds of 25 Mbps download and 12 Mbps upload to support activity by multiple, concurrent users.[2]

70% of students live in a multi-learner household.[2]

Online traffic jam

Teachers and students cannot always connect in a physical classroom. So one-on-one, small-group, and whole-group instruction takes place via online meeting tools, and assignments are posted to classroom sites. These concurrent activities push a lot of data across school networks.

85% of network traffic in remote learning is used for video.[2]

Down to the (hard)wire

IT administrators can't control students' connectivity quality outside school walls. Home construction, compatibility, router locations, and use of personal devices alongside school-issued ones all affect wireless connection strength—and often parents have already plugged the home Ethernet cable into their work laptops.

92% of students use Wi-Fi instead of a wired network connection.[2]

The struggle is real—for teachers, too.

2 of 3 teachers
say they haven't been able to do their jobs properly since they started to teach remotely.[3]

6 in 10 new teachers
have no training on how to teach a remote classroom.[3]

69% of district leaders
say their teachers need additional professional development to use technology more effectively in the classroom.[3]

Online teaching is a different skill set than live classroom teaching—not just in instructional technique, but also in technology expertise. It's hard enough to be an effective digital educator. But many teachers feel burned out—especially veteran teachers whose experience has all been in traditional settings.[4]

Upgrade your ed tech from makeshift to modern.

From newer devices to better connectivity, K-12 students and parents depend on schools to help close the learning gap. Equip them with the tech tools they need at home to succeed in the classroom.

Want to learn how you can deploy technology that supports all students in their education journey?

Read our ebook: *Blended learning and teaching in the connected classroom.*

[1] Alliance for Excellent Education and Future-Ready Schools, "Students of Color Caught in the Homework Gap," https://futureready.org/homework-gap/
[2] Consortium for School Networking (CoSN) and Chan Zuckerberg Initiative, Student Home Connectivity Study, Accessed November 2021, Spring 2021, https://emma-assets.s3.amazonaws.com/paqab/37cf06d0de533f59eb780f4ec065d766/Home_Connectivity_Study_Report_5.3.21_FINAL.pdf
[3] USA Today, May 26, 2020 "Back to school? 1 in 5 teachers are unlikely to return to reopened classrooms this fall, poll says," https://www.usatoday.com/story/news/education/2020/05/26/coronavirusschools-teachers-poll-ipsos-parents-fall-online/5254729002/
[4] Rand Corporation, Remote Learning is Here to Stay—Results from the First American School District Panel Survey, 2020, https://www.rand.org/pubs/research_reports/RRA956-1.html

4AA8-0661ENUS, November 2021

working through things, and lots of setbacks and lots of growth. And I think that is something that people don't realize enough.

How can educators help kids—especially those who typically shy away from STEM fields—learn to embrace that hard work in areas like math, science, technology, and engineering?

I think that's a tough one, especially the concept of difficulty, because I do believe there is a sweet spot for every person, given their age and where they're at, and also the type of person they are, between work and reward. This is an important thing that you need to make sure you get right. I am working on things for days and days and days, and I don't see a reward for a while. That's OK for me. That's not OK for a 7- or 8-year-old.

But the bigger thing I would say is a slight shift in focus on what the goal is and what is important. Too often, the importance and the goal get focused on getting the right answer. But getting the right answer has never really been my focus on things. The goal is to try to truly learn something.

You were a high achiever in football as well as math, playing for Penn State in college and the Baltimore Ravens in the National Football League. How are math and football complementary?

I would say that the thing about football that was really important for me and helped me, in math and just in general in life, is just the feeling of being part of a team. Seems like this is pretty universal: No matter what you want to do, no matter what you want to be when you grow up, the thing that is almost universal is that you are going to have to work with other people, you're going to have to work with other people for prolonged periods of time, and your success is inherently tied to other people.

Any parting advice for educators?

I would recommend making sure parents have access to educational materials that show them what their child is learning, what they're covering, and how these things work. That's something that could be really helpful. When a parent just sees a homework sheet, it can be quite difficult if they don't have the resources to understand how certain mathematical concepts are being taught. ■

Published December 12, 2019

Mining for Gifted Students in Untapped Places

By Corey Mitchell

When Cellini Eastman searches for potentially gifted students, she defies convention.

Eastman bypasses the impeccable report cards and off-the-charts test scores—there are already programs set up for those students.

She wants to find bright children who don't stand out in a traditional classroom.

"I don't look at what they ... have, I look at what they need," Eastman said.

The children Eastman works with in a weekly after-school program are part of an experiment, the Baltimore Emerging Scholars program. A partnership between the district and the Johns Hopkins Center for Talented Youth, the program is designed to mine untapped potential in Baltimore, a school system where student test scores are nearly two grade levels below the national average.

At 21 schools across the city, the program introduces 2nd, 3rd, and 4th grade students to above-grade-level lessons on architecture, engineering, and astronomy.

—Steve Ruark for Education Week

Jeannine Disviscour, the lead teacher of Moravia Park Elementary School's Gifted and Advanced Learning program, teaches 2nd graders about early architecture last month. The class is part of the Johns Hopkins Center for Talented Youth's Emerging Scholars program.

Most of the schools, which serve large numbers of Black and English-learner students, rank among the bottom quarter of schools in the state of Maryland.

When the program began in 2014, the organizers had to convince principals that there were potentially gifted students in their schools.

The principals "would say, 'This is great and really exciting ... but we don't have any of those kids in our school,'" said Ashley Flynn, the associate director of research and special initiatives at the Center for Talented Youth, a gifted education program for school-age children around the globe.

"That dialogue has changed and people are recognizing that there's academic talent and that it comes in different shapes and sizes," said Flynn, a former Baltimore high school math teacher. "It may not look the way that they're used to."

Effective talent-development programs train teachers to work as talent scouts, spotting children who may not have the motivation or support they need to excel academically in traditional classrooms, said Del Siegle, the director of the National Center for Research on Gifted Education at the University of Connecticut.

But more often than not, teachers instead serve as deficit detectives, weeding out the students they assume won't be a good fit because they have less-than-stellar achievement test scores, don't pay attention in class, or are English-language learners, Siegle said.

"You need someone who can say, 'Look at the interesting questions this kid asks, there's something going on in that brain up there,'" he said. "It's really hard to pick potential. Without giving kids opportunities, the talent won't surface."

'She Wants Us to Be Smart'

The science, technology, engineering, and math-based classes in the Emerging Scholars program are interdisciplinary, weaving in lessons on reading, writing, and social studies, but the instructors have latitude in how they teach.

Schools determine whether the 25-week-long classes—all taught by Baltimore city schools teachers—are held before or after school, or as pullout classes during the day.

At Moravia Park Elementary on Baltimore's east side, Jeannine Disviscour selected Awaicha (pronounced o-ay-shah) Tafah, the French-speaking son of Cameroonian immigrants, because his classroom teacher marveled at how quickly he processed information, especially in math.

A 2018 study from Siegle's national center found that few school districts offer programs to identify and recruit potentially gifted students who don't perform well on traditional measures.

—Steve Ruark for Education Week

Moravia Park Elementary School 2nd graders Awaicha Tafah, left, and Courtland Young, second from left, take part in the early architecture class, which is taught during the school day at Moravia.

Some of the students at Moravia Park have failed math, struggled with phonics, or been labeled as "problem kids" because they do not focus in class.

Despite their struggles, Disviscour or another teacher saw something in them.

On a recent morning, Disviscour kneeled on the carpet in her architecture class to console a teary-eyed 7-year-old struggling to spell "parallel." At the same time, she encouraged Awaicha to lead his classmates on a scavenger hunt for shapes.

The constant movement and inquiry are by design. Disviscour aims to keep the children engaged and asking questions, challenging the teacher and classmates.

"She gets to teach us that she wants us to be smart," 2nd grader Aubrey Chestnut said.

Racial Imbalance

The Center for Talented Youth sought out the partnership with the city schools because certain students—mainly Black and low-income—had largely been shut out of its programs, which benefit academically talented students in all 50 states and more than 90 countries.

Leaders there decided the key to finding a more diverse pool of students was not testing more children or lowering the bar for participation; it was finding another way to identify them.

"Our focus is on those kids who have the strength in academics that we just have to try and uncover," said Amy Shelton, the center's interim executive director. "How do we really serve these kids in Baltimore city in a way

that pushes as many as possible to reach the highest level of potential?"

At the end of each Emerging Scholars session, instructors write evaluations for each student that gauge whether they are ready for traditional CTY programming. Seventy percent of Baltimore Emerging Scholars students are deemed Center for Talented Youth-ready. This compares to only 3 percent of Baltimore schools students qualifying through above-grade-level testing.

The bar for participation is high. Johns Hopkins uses above-grade-level tests, such as the SAT and the School and College Ability Test, that measure math and verbal reasoning abilities.

In the Emerging Scholars program, each school also sets its own selection process for the program, with most relying on staff recommendations or teachers' intuition.

But data show similar scores on some cognitive measures, such as those for processing speed and spatial skills, for students who complete the Emerging Scholars program with high evaluations and those who come to CTY by more traditional paths.

Johns Hopkins and Baltimore are not alone. School districts across the country have struggled to address the racial imbalance of their gifted learning programs.

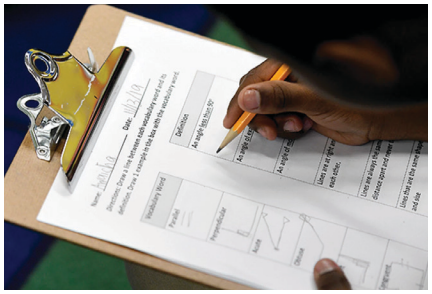
In New York, 70 percent of students are Black or Hispanic; yet white and Asian students represent more than 70 percent of students in the city's gifted programs.

The disparities in the Baltimore schools aren't as stark but still exist. While nearly 80 percent of the school system's students are Black, Black students represent slightly less than half of the students classified as gifted. District data for the 2019-20 school year indicates 57 percent of students classified as gifted are Black.

"These programs have tried to be more equitable," said Donna Ford, a distinguished professor at Ohio State University's College of Education and Human Ecology. "They're not there yet. They are by no means there yet."

To bring the demographics of identified students closer in line to the overall makeup of their districts, educators must do four things, Ford said: address educator bias that leads to the underreferal of Black, Latino and low-income students; review screening procedures to ensure all students are evaluated; use qualifying tests that are less linguistically and economically biased; and, most importantly, improve outreach to families from underrepresented groups.

"We can educate and enlighten them



—Steve Ruark for Education Week

Second grader Awaicha Tafah, works on his architecture assignment in the Emerging Scholars program. Students who show academic potential in the program can be referred to the Center for Talented Youth at Johns Hopkins University.

about ... how their children could and should qualify [for programs]," Ford said.

'Let's Feed Them'

The Center for Talented Youth staff train the program instructors, warning them to expect pushback and frustration when students struggle with the above-grade-level material.

"Students will be pushed in ways that they have not been pushed in the past," Flynn told teachers during a training earlier this year.

At another Baltimore school, Gwynns Falls Elementary, on a fall afternoon, Eastman guided students through a lesson on engineering design: developing a step-by-step guide to making a sandwich.

David Edwards and Tayler Logan sat at a table, working through the task. The 8-year-olds alternated between eureka moments and eye rolls.

With the Emerging Scholars curriculum, "the kids can actually grapple with the material and don't have to worry about time constraints," Eastman said.

Eastman said she also taught David, a methodical thinker, and Tayler, who's quick on her feet, in the Emerging Scholars summer program. The two are, by traditional measures, average students in the classroom, she said, but they crave challenge.

The typical Emerging Scholar is "a kid who has not been challenged, has not been valued enough prior to this," said Dennis Jutras, the coordinator of gifted and advanced learning for the Baltimore schools.

"In many ways, in many cases, this is the first time this student is being seen, given a voice and is being allowed to flourish." ■

Published May 22, 2018

Reviving the Manufacturing Sector, Starting In Middle School

By Benjamin Herold

Today's Ohio teenagers were born into an era of manufacturing collapse.

Between 2000 and 2010, the state lost more than 40 percent of its jobs in the sector, according to federal labor-market data. Families and communities were scarred, creating an indelible impression among many that manufacturing is a dead-end field.

But that's not the full story.

"Manufacturing is changing dramatically," said Emily DeRocco, the education and workforce director of Lightweight Innovations for Tomorrow, or LIFT. "We want young people to understand that there are actually exciting jobs available."

Her group is one of 14 "innovation institutes" aiming to bring government, industry, and academia together to support technology-related research and education in advanced-manufacturing fields such as clean energy, lightweight materials, and robotics. The groups all fall under the umbrella of Manufacturing USA, a national network of public-private research institutes created under the Obama administration.

Indeed, Ohio's manufacturing economy has rebounded modestly, adding about 81,000 jobs since 2010. That means new career opportunities for today's students—if they develop the necessary skills.

Many of these new positions aren't the rote or dangerous jobs typically associated with the sector, said Heather Sherman, an outreach worker at the Ohio STEM (science, technology, engineering, and math) Learning Network, which partners with LIFT. Robots, not humans, now dominate work on the assembly line, Sherman said. Today's students must be prepared to code, monitor, and repair them, a more demanding set of skills.

Umanga Chamlagai, left, Adeboye Adeagbo, and Samuel Taylor work on the details of their video game design during an educational technology class at Woodward Park Middle School in Columbus, Ohio.

—Maddie McGarvey for Education Week

That's why LIFT and a wide range of partners across the Midwest are investing in K-12 education, with a focus on developing students' math, science, and technology knowledge, beginning in middle school.

One of the groups' biggest efforts is a competition called MakerMinded. About 90 schools in Ohio and hundreds more in Michigan and Tennessee have joined in, taking students on field trips to local manufacturers and using MakerMinded's online platform to find learning activities for classrooms and after-school clubs. Schools earn points by logging various activities, with state leaders earning public recognition and prizes such as programmable robots at the end of each school year.

The idea is to use a combination of academic learning, hands-on experience, and exposure to relevant industries to lay the groundwork for students to eventually pursue advanced-manufacturing careers.

Even some skeptics of decades' worth of warnings about a STEM worker shortage expressed enthusiasm about the group's approach. "There is a lot to like about this kind of data-driven approach to connecting educational activities with the world of current and future careers," said Michael S. Teitelbaum, a senior research associate at the labor and worklife program at Harvard University.

And why start in middle school?

"That's where students begin to have more opportunities to select courses," said DeRocco of LIFT. "It's also a place to capture their creative spirit and reintroduce them to fields that have changed significantly from the jobs their parents may have lost."

Here's how three Ohio middle schools are experiencing the 2018 MakerMinded competition:

Woodward Park Middle School

Christopher Daniel teaches three classes not often associated with middle school: STEM, computer science, and automation and robotics.

Each is offered as part of Woodward Park Middle's association with Project Lead the Way, a national nonprofit that provides schools with curricula and training focused on hands-on learning that can be applied in the workplace.

"I believe my job is to get my students interested in STEM and have them follow up when they get to high school," Daniel said. "I throw them in feet first, then let them explore."

A veteran of the U.S. Army who served in the Persian Gulf in the 1990s and then the National Guard before becoming a teacher, Daniels said he's grateful to the U.S. Department of Defense for "thinking enough of middle schoolers to give them these opportunities."

For his 8th graders, that means building their own machines, including designing and constructing their own racecars out of pasta and Lifesavers.

Daniel's 7th graders are coding their own apps.

And students in his 6th grade STEM class are taking part in a "trash slider challenge," in which the goal is to use recycled materials to build a vehicle that can transport a two-liter bottle of fluid down a ramp without spilling anything.

Many of those activities have been tied to MakerMinded challenges, Daniels said.

He's also used a number of the group's instructional materials—for example, a video that shows how the processes students are using and the types of mechanisms they're creating are actually applied in real advanced-manufacturing industries.

But even if they weren't undertaken in the name of workforce preparation, such experiences would likely be worthwhile, said Michael Teitelbaum of Harvard's labor and worklife program.

"Advanced manufacturing is growing, so labor-market demand may be robust," Teitelbaum said.

"But knowledge in math, science, and technology is likely to benefit all students, no matter what career they pursue."

Alliance Middle School

Polymers might not seem like the most exciting topic for a guest lecture at a middle school.

But when STEM teacher Juliann Trevorrow brought in a University of Akron expert on the topic (basically covering any substance, such as plastics, made up by linking together smaller chemical units), her students were transfixed.

It helped that the guest brought in Shrinky Dinks, the popular 1980s toy that lets children mold and decorate large flexible plastic sheets, then bake them in an oven to shrink and harden.

"There's just a natural curiosity that comes from doing these kinds of hands-on [projects] and then looking back on the process, which middle school students don't always get to do," Trevorrow said.

The experience was just one of dozens of MakerMinded-eligible activities that Trevorrow and her students have done. And it was right in line with what the organizers of the competition had in mind.

"At the end of the day, manufacturing is all about materials," said Emily DeRocco of LIFT, the federally funded lightweight-materials innovation institute behind the competition.

In its research-and-development work with industry, LIFT focuses on such efforts as finding ways to reduce the weight of military airplanes or make naval ships stronger through new welding techniques.

At schools such as Alliance, DeRocco said,

LIFT hopes to help middle schoolers see that fun experiments requiring them to figure out the best resources to make something is actually the foundation for those kinds of high-paying advanced manufacturing jobs.

"We are absolutely dedicated to bringing materials science back into the classroom," she said.

Graham Middle School

St. Paris, Ohio, is a rural area surrounded by cornfields, with little local industry outside of farming.

But that doesn't mean that a wealth of high-tech career opportunities shouldn't be available to his students, said Chad Lensman, the principal of the local middle school.

"We're very intentional about planning for our kids' future," he said. "We have classes in engineering, design, aeronautics, medical science, and computer science."

For Graham Middle, the MakerMinded competition has been a way to expand and extend many of the activities that were already taking place, while also injecting an element of fun and earning some outside recognition.

Among the school's efforts that earned points on MakerMinded's online leader board: A field trip for 75 students to a nearby Honeywell plant, where students learned about manufacturing lights for various kinds of airplanes.

Lensman's focus is on one of MakerMinded's most ambitious activities: designing an outdoor STEM classroom. The school was already planning on building a greenhouse and apiary, as well as cultivating a small working farm. The competition prompted school leaders to let students take the lead on making it happen.

"We said, 'Here's the land you have to work with, and here's where the beehives and buildings will be located. You take care of the rest,'" said assistant principal Nick Guidera.

At Graham Middle, the hope is that such efforts will not only provide rich learning experiences now, but also prepare students to succeed after K-12—whether that's in the rapidly diversifying STEM workforce around Dayton, Ohio, about 45 minutes away, in college, or in the military.

For officials in the statewide STEM learning network, which supports the MakerMinded competition, that's exactly how the process should work.

"The end goal may be advanced manufacturing," said Heather Sherman, an outreach worker with the group. "But that line of thinking is what gets us there." ■

Published May 22, 2018

Unlocking STEM Pathways For All Students

By Stephen Sawchuk

What do you think of when you hear the word "gateway?" Is it a promising image, perhaps an invitation to a lush garden? Is it a foreboding one, conjuring up the image of a heavy lock on a rusting door?

That's the double-edged nature of gateways, and in this special report, *Education Week* aims to explore both facets as they relate to students' progression through science, technology, engineering, and math in K-12 schools and into their futures.

Gateways can swing open, giving students opportunities to master the ability to think logically, reason, model solutions to problems, and troubleshoot, all of which are in demand among employers both in STEM fields and, increasingly in non-STEM ones.

Or gateways can shut and lock, cutting off the ability to acquire those skills and putting students at a disadvantage, perhaps for the rest of their lives.

Despite its reputation as a field flush with opportunity, even STEM can pose dead ends for students, such as the traps of remedial math education or course sequences that don't lead to high-paying, satisfying careers.

In one sense, the problem with defining high-quality, flexible STEM pathways in K-12 education begins with the looseness of the term STEM itself. Too many advocates use it glibly, implicitly giving it the suggestion of limitless promise and opportunity. But a close look at labor-market data suggests it's not as simple as that.

Not even federal agencies, for instance, agree on what counts as a STEM job, which makes it that much more challenging to settle on the preparation students need and the steps that K-12 educators should take to backmap the courses and experiences that fill in the gaps.

And outside of the core STEM jobs, exemplified by mathematicians and engineers, there's a wider range of required skills, training, and compensation in the fields. Take, for instance, the fastest-growing job in America, that of a solar-panel installer, which paid a median wage of $39,490 in 2017, according to the U.S. Bureau of Labor Statistics. Does that gig require working knowledge of applied math and science? Sure. Is it what the experts touting STEM jobs have in mind as a high-paying, high-opportunity job? That's a tougher question.

> "There's solid agreement, for example, that students' early experiences with science and math in school are crucial. But the elementary teachers who are most likely to provide those experiences report feeling shakier in teaching them.

Long before the jobs conversation ever comes up, K-12 educators have struggled to define how they can improve students' chances of success in STEM fields. There's solid agreement, for example, that students' early experiences with science and math in school are crucial. But the elementary teachers who are most likely to provide those experiences report feeling shakier in teaching them.

That's why one Alabama school has made STEM the centerpiece of its K-2 programming. Leaders there provide on-the-job training for teachers of the youngest children—and asks them to gradually take on more responsibility as they grow more knowledgeable and confident in their skills.

Sometimes, the work of opening up STEM gateways takes partnerships. For example, automation may have hollowed out the supply of old-school manufacturing jobs, but now there's a resurgence in advanced manufacturing jobs that pay good wages—

and demand higher skills, such as the ability to oversee complex machines and processes.

To make sure the next generation of workers has those skills, local industries and K-12 leaders are working together to introduce the technologies in middle school.

New Debates, New Solutions

Perhaps inevitably, high school is home to some of the most ferocious debates about STEM preparation, particularly about how to structure the required sequences of courses that will ultimately funnel students to those fields.

At the zenith of most sequences stands calculus, long reserved for the elite and virtually a requirement for entry into a top-tier university. It's also one of the courses in which disparities between wealthy and disadvantaged students, as well as between white students and students of color, are rampant. And yet research suggests it's not a terribly good signal of future STEM success.

So, some researchers ask, is there an opportunity to build a new pathway that doesn't replicate those problems? In today's data-rich world, they suggest, maybe the gateway class should be statistics: being able to understand and interpret the numbers underpinning algorithms, surveys, and research in economics and many other fields.

It's not as outlandish an idea as it may seem: In an April 2018 report, National Council of Teachers of Mathematics also points to statistics as a topic that students should explore in far greater depth by the time they complete high school. And it, too, calls for more varied, but equally rigorous, pathways for all high school students.

Perhaps the most challenging puzzle of all are those young people for whom STEM has become a seemingly insurmountable barrier to future success. Unable to complete degree requirements, they struggle in the "black hole" of remedial high school or college math, trying again and again to master algebra.

Now, for those students, there's new hope: A set of classes that teach how to think of math as a specific kind of logic, a model for understanding the world. Increasingly, such approaches are influencing the way high schools think about accelerating students with weaker skills.

The gateways we've identified in this report are hardly the only ones that exist in the vast and nuanced landscape of STEM. But the challenges they pose to access to, and persistence in, STEM are real. We hope this special report gives you some ideas about where to find solutions. ■

—Getty

OPINION

Published July 27, 2020

Why Are Students with Disabilities So Invisible in STEM Education?

By Joe Schneiderwind & Janelle Johnson

In the United States, we lament the lack of diversity in STEM fields *and* in teacher education, but many of our actions as educators continue to "weed out" students from nondominant communities and those who are differently abled. Society, parents, and other students need to understand that students with disabilities are as capable of academic achievement as any other student given the proper accommodations that allow for success. This is an issue that should not be limited to the silo of disability studies—it is one that must be recognized by all teachers.

Students with disabilities are less likely to complete high school than other students, but why?

There are certainly many social and societal factors that serve as barriers, but school and classroom practices are contributing factors as well. Elementary students with disabilities tend to be tracked away from pursuing advanced academic endeavors. These students are systematically "hidden" from general education and forced into separate classrooms, different programs, and alternative schools. School funding formulas based on standardized assessments incentivize schools to do just that since students with disabilities tend to receive lower scores on these high-pressure exams.

Research has shown that 10 percent of students entering postsecondary education have some type of self-identified disability, but there is stark disproportionality of students with disabilities enrolled in advanced coursework in high school. In secondary education, few students with disabilities take AP or IB or enroll in STEM classes or programs. Students with disabilities account for about 12 percent of the student population in secondary school but only 1 percent of the students in Advanced Placement courses. Further illustrating the disparities apparent in STEM fields, high school students with disabilities acquire approximately the same number of credits in English as other students but far fewer credits in math or science. This underrepresentation can lead people to assume that students with disabilities are less capable, particularly in STEM-related fields, and the students

themselves may begin to believe they are less qualified, feeding a cycle of low expectations and underperformance.

Research shows the impact of social upbringing, the media, and self-reinforcement on students who are statistically not "supposed" to do well—they tend not to, and this is referred to as the *expectancy effect*. The expectancy effect leads to lower test performance, less interest in pursuing studies in science and mathematics, and reduced effort to pursue counter-stereotypic skills, among other things. Most studies on expectancy effect focus on racial and ethnic minorities or women in STEM fields, but it is logical to assume the same damaging effect on students with disabilities. Peña performed a thorough search of peer-reviewed articles published in four of the top academic journals. It was found that only 1 percent of published work in these journals had to do with disabilities; and, while published work on students with disabilities has decreased in the last two decades, college admissions of students with disabilities have increased. Recognition of an issue in academia tends to be reflected in the amount of published works on the subject, and this poses a serious concern in recognizing the difficulties that these students will endure. Further, research on students with disabilities tends to group them as a whole rather than separating them into those with intellectual or learning disabilities and those with other disabilities, which can have significant effects on the outcomes of research as it pertains to education.

Blind Spots in STEM Education

When we began writing this blog we realized the research literature on this area was extremely thin. One helpful 2012 publication by Moon et al. is titled "Accommodating Students with Disabilities in Science, Technology, Engineering, and Mathematics (STEM)." The authors write that "teachers, instructors, and professors are frequently unable, unprepared, or otherwise ill-equipped to recognize and address the needs of students with disabilities. As a result, course content may be inaccessible." If students cannot access opportunities that feed into a STEM pipeline, they are essentially invisible. Students with disabilities therefore remain underrepresented in STEM fields, and a need exists to help uncover barriers that students with disabilities encounter in STEM laboratories, for example. One out of 10 students in postsecondary education *identify* as having a disability, and we know many other students who do *not* report having a disability because of the stigma it carries. The combination of the lack of accurate numbers of students with disabilities and the overall invisibility of this issue make it urgent to address.

Blind Spots in Teaching and Teacher Education

Federal policies that recognize the rights of students with disabilities were an important step and meant teachers could not legally ignore these students. But many educators don't seem to fully understand what students with disabilities need. While there are educators who do specialize in working with exceptional learners, training for teachers who do *not* work in special education can be limited. Tools and approaches like Universal Design for Learning are helpful in supporting differentiation in order to help all students. But they do not necessarily help classroom teachers recognize their own potential bias about the ability of students with disabilities that lower their expectations of students' academic potential.

And what about *teachers* who have disabilities? Section 504 of the Rehabilitation Act and the ADA pertains to both students and teachers; students have the additional support of education laws like the Individuals with Disabilities Education Act (IDEA). Employees are protected by Section 504 and the ADA so long as they can perform essential functions, but how well do these policies actually support teachers who have disabilities? If we consider that only 35 percent of individuals with disabilities who are qualified for a position are actually employed, the lack of specific resources pertaining to teachers with disabilities is troubling.

As Joe says: "I face an extremely difficult and progressive physical disability myself, so one could say that I have a soft spot in my heart for students who face any challenges fated to them in the form of a disability. I am fortunate in the fact that my disability was not noticeably prohibitive until after achieving a graduate education, but this makes me think back and realize how little I knew about, or was exposed to, anybody with a disability. Students with disabilities deserve every opportunity that I had as an able-bodied student, and I don't believe that is being afforded to them." —Joe Schneiderwind

Conclusion

Important societal transformation is happening with growing awareness of racism and seeking out actions we can take to change the equation. Individuals with disabilities also suffer the effects of discrimination, and there are actions we can and must take to dismantle the systemic barriers to educational opportunity for all our students. Principals can actively recruit teachers with disabilities and let them know they are welcome and will be supported in the workplace. Prior to implementing anything new or different, teachers can ask students with disabilities what they think would be helpful or what has been helpful in the past. This would help prevent falling into the same trap of promoting what the teachers *think* would be helpful without quantitative or qualitative data to support these accommodations. In this age of technology, there are many available tools to assist students with disabilities. Referring more specifically to physical disabilities, make sure to learn about and provide students and families access to technology programs and related hardware such as Dragon NaturallySpeaking, MathTalk, Vocola, Equatio, and Google Speech to Text, all of which allow for access to what able-bodied students take for granted—the beauty and simplicity of paper and pencil. ■

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OPINION

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Working With the Likes of Lego, Disney, and Lucasfilm to Engage Students in STEM

By Rick Hess

FIRST aims to engage students in science, technology, engineering, and math (STEM) by holding robotics and building competitions sponsored by the likes of LEGO, Lucasfilm, and Disney. Launched in 1989, FIRST now partners with more than 200 companies in the Fortune 500 and has 320,000 volunteers working with 650,000 students across 110 countries. I had the chance to chat with Erica Newton Fessia, vice president of field operations at FIRST, about their work.

—Rick

Rick: So, what is FIRST?

Erica: FIRST was founded in 1989 by Dean Kamen, the inventor of the first portable insulin pump and many other innovative medical devices, who envisioned a world where young people dream of becoming leaders in science and technology as much as they do in sports and entertainment. Our mission is to inspire that interest by engaging young people in exciting team-based research and robotics programs that build well-rounded students with STEM capabilities and complementary life skills. FIRST teams complete our annual international challenges while operating under the FIRST Core Values, which encourage high-quality work, respecting the value of others, and helping each other while competing.

Rick: FIRST has some pretty high-profile partnerships, including with Disney, LEGO, Apple, NASA, Google, and more. How did you go about partnering with these iconic brands and how do these partnerships affect the work you do?

Erica: These partnerships are key to accomplishing our mission. With demand for technology and digital literacy skills growing, industry leaders increasingly recognize the critical need to develop STEM talent and to bring young people of all backgrounds into the workforce in order to close the STEM gap—the gap between the number of STEM jobs available and the number of those qualified to fill those roles, as well as the gender and racial gaps in STEM careers. Many of our partners also connect to our Core Values and the ways FIRST inspires collaborative, innovative, well-rounded global citizens. They see it in the talent and engagement of employees who are FIRST alumni.

With these partnerships, we're able to expand and sustain access to STEM learning for more students. This includes providing additional scholarships and grants, providing funds for equipment, bringing our programs to new regions, and using employee volunteers to support team creation and events.

Rick: I understand you have multiple programs. Can you tell me a bit about what these are and how they work?

Erica: Essentially, our three programs are designed to engage students and build confidence in STEM at any level, and any student can get involved. FIRST LEGO League, which has three divisions by age group, is directed toward students in Pre-K through eighth grades and provides them with real-world problem-solving experiences through hands-on learning using LEGO technology. For example, our teams are finding new ways and places to play and stay active, so our FIRST LEGO League Explore teams in grades two through four are building and coding a LEGO Education WeDo 2.0—an award-winning LEGO kit that provides an easy-to-use programming set—to power a model of a LEGO device or robot that they designed. FIRST Tech Challenge is targeted for students in grades seven through twelve and teaches students how to design, build, program, and operate robots to compete in head-to-head challenges through an annual floor game that includes autonomous and driver-controlled elements. FIRST Robotics Competition is our flagship program for high schoolers. Larger teams of students build and operate industrial-size robots to compete in three-team alliances in an annual field game that challenges them to work together to move game pieces and earn points around a large field—it's the only sport where every kid can go pro.

Rick: How does someone create a team for each of these programs?

Erica: Building a team is essentially the same across all programs: Recruit at least two team members and two coaches to help facilitate. We also offer "Class Pack" versions of our FIRST LEGO League and FIRST Tech Challenge programs that are designed for in-classroom learning for 30 or more students and multiple teams.

Rick: What are the costs for your participants?

Erica: FIRST believes that all kids need equitable access to opportunity, relevant mentorship, and engagement. While costs vary by program and level of participation, all costs are assumed by the team as a group. Registered teams receive access to FIRST fundraising tools and resources, including local, regional, and national grants and sponsorships provided by many corporations. Most teams' registration costs are covered by their school and sponsors, and they may do additional community fundraising for supplies and travel fees, like many school sports and clubs. High-school-aged participants are also eligible to apply for over 80 million dollars in exclusive college scholarships that range from 500 dollars per year to four-year full-tuition scholarships, depending on the scholarship provider.

Rick: How do you all think about evaluating whether what you're doing is successful?

Erica: We are committed to rigorously evaluating our programs to ensure we are advancing the FIRST mission. One big way we measure impact is through a rigorous longitudinal study conducted via Brandeis University on the impact of FIRST participation, which continues to show positive impacts on STEM-related interests and career paths six years after students enter our programs. Both male and female alumni declare majors in STEM at greater rates compared with their peers, with 69 percent of alumni declaring a college major in engineering or computer science by year three of college. For young women particularly, 79 percent of female alumni declare a STEM major, compared with 51 percent of their peers.

Rick: FIRST has partnered with Disney, Lucasfilm, and LEGO to host a contest in which kids use LEGO bricks to create Star Wars holiday-inspired builds. The role of these powerful brands might lead skeptics to ask whether this is just a marketing ploy. How do you think about such concerns?

Erica: Our mission is to inspire and excite kids to explore STEM-related activities. When inspiration happens, education follows. Sponsors like Disney, Lucasfilm, and the LEGO Group play a critical role in helping to broaden awareness of FIRST to new audiences and increase access to our programs around the world. During a challenging year for all of us, especially students who saw their school year disrupted in many ways, we partnered with Lucasfilm and the LEGO Group to provide a fun family activity that also encourages kids to explore their creativity and use their STEM skills such as innovation, collaboration, and the engineering design process. Storytelling with Star Wars characters and building with LEGO bricks are engaging entry points for anyone to explore creativity and innovation and develop new skills.

Rick: What advice can you offer parents who want to help their kids stay engaged and motivated while they are learning from home?

Erica: Our education director has shared some great advice that resonated with me as a parent: Be the lead learner in your home. Especially with STEM, we may not feel confident in our own skills—but we don't need to have the answers. Embrace what you don't know by asking questions and exploring the answers with your kids. Show them that STEM learning and fun can be found everywhere. ■

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