ASHLEE CLARK WORKS WITH SOPHOMORE MARY MADISON BRADLEY DURING CLASS AT HER GREENSBORO, N.C., SCHOOL. CLARK WAS DOING ANIMAL RESEARCH IN GRADUATE SCHOOL BEFORE JOINING THE SCHOOL SYSTEM AS A CHEMISTRY TEACHER.
Students of Color Face Persistent Disparities in Access To Advanced STEM Courses

By Stephen Sawchuk

The proportion of students of color who take high-level math and science courses continues to trail that of their white peers—jeopardizing those students’ ability to master the knowledge they need to secure a college-preparatory diploma.

What’s more, the segregation of American high schools is a factor in students’ access to these types of courses. Schools that serve disproportionate numbers of black and Latino students offer fewer advanced math and science courses, such as calculus and physics, than do schools with more white students.

Those are some of the findings from a new analysis from the U.S. Department of Education’s Office of Civil Rights, which reflects data from the 2015-16 school year. Thanks to updates to the required elements, this analysis also presents a more nuanced picture of math and science offerings than previous years’ collections. The data reflects information submitted by nearly every public school in America.

White students made up 51 percent of high school enrollment that year, and comprised 51 and 58 percent of enrollment in physics and calculus, respectively. Black students comprised 16 percent of high school enrollment, but just 12 percent of physics enrollment, and 8 percent of calculus enrollment.

Latino students made up 24 percent of high school enrollment, but represented 16 percent of students enrolled in calculus and 19 percent of those in advanced mathematics. (That term excludes calculus but includes courses beyond Algebra 2.)

Algebra I: A Gateway Shut for Many Students

The data highlights gaps between white and Asian students and their black peers that open up even before they reach high school, in Algebra I, considered a fundamental “gateway” math course.

White students and Asian students were disproportionately likely to be enrolled in Algebra I in grade 8—and of those, 85 percent of white students and 74 percent of Asian students passed the course. But black and Native American students were all disproportionately likely to take Algebra I in high school—and they were overrepresented in those classes in junior or senior year, which would make it next to impossible to fit in multiple advanced math courses before graduation.
Native American students are just 1 percent of the overall high school population, yet they made up 2 percent of those enrolled in Algebra I in 11th and 12th grade—a damning statistic.

Research indicates that forcing students to take Algebra I before they’re ready can be harmful. But it’s not clear whether these patterns reflect well-founded policy or policy beset by racism.

“Is it because they’ve correctly assessed students’ ability and put them in the appropriate course? Or is it because there’s some amount of discrimination going on?” said Joshua Goodman, an associate professor of public policy at Harvard University’s Kennedy School. “I take this as a sign that there is a major challenge, though it doesn’t help pinpoint the root causes of the challenge.”

**School Composition Matters**

For upper-level math coursework, it’s likely that school composition has a relationship to what classes are offered: About 5,000 high schools, the data show, had high levels of Latino or black enrollment (defined here as schools with more than 75 percent black and Latino). And they offered advanced math and science at lower rates than other high schools.

The largest disparity was for calculus, which half of all high schools offered, but only 38 percent of these highly segregated high schools did.

Generally, research shows that taking more high school math and science courses improves the odds that students will go on to take them in college—though expanding the number of high school courses offered isn’t a guarantee that students will take them. That’s probably due to the differing expectations and within-school tracking that many students of color face, even when they are academically capable of succeeding in challenging courses.

The new data collection also contains new information on how those classes are being taught—for example, on the number of high school math and science classes taught by teachers with the appropriate certification.

But that data was not included in the Education Department’s initial analysis. (Because the data are self-reported by schools and districts, they can reflect data-entry errors and require cleaning, although the Education Department has instituted more of its own audits.)

---

**FIGURE 4: Percentage of high schools offering mathematics and science courses**

High Schools Are Adding More STEM Classes. It May Not Be Enough

By Stephen Sawchuk

“N o young person in America should miss out on the chance to excel in [STEM] fields just because they don’t have the resources.”

Remember this line? It’s from a 2015 speech by then-President Barack Obama. Or how about this?

“My administration will do everything possible to provide our children, especially kids in underserved areas, with access to high-quality education in science, technology, engineering, and math.”

That was from a 2017 promise by President Donald Trump to direct the U.S. Department of Education to prioritize STEM in its grant programs.

For more than a decade, politicians have raised concerns that not enough U.S. students are specializing in these subjects, leaving the country reliant on talent from overseas to fill engineering and tech jobs. All of that has led to a tremendous amount of attention on the “STEM pipeline” and how to improve it.

Now, new research suggests that one of the popular policy solutions—increasing access to STEM courses in high school—may be no panacea for producing more college students who take STEM classes or major in STEM fields, raising big questions about what needs to change in K-12 to improve outcomes in the field.

It finds that high schools with a greater menu of STEM classes did not produce students more likely to declare a STEM major in college—or to earn a degree in a STEM subject—at noticeably higher rates than their peers.

“The narrative out there is that there’s this pent-up demand for STEM coursework and there’s not enough access for kids to take these courses that they really want to take. But our study is just not consistent with that at all,” said Cory Koedel, an associate professor of economics and public policy at the University of Missouri and one of five researchers who conducted the study.

“I was surprised that it didn’t make any difference,” Koedel said. “We thought there would be a positive effect, but our results are just not consistent with that.”

The research appears as a working paper at the National Center for Analysis of Longitudinal Data In Education Research, or CALDER, and has not yet been submitted for peer review. (Economists usually put out papers like this for comments and feedback before they formally submit to a journal.)

Testing a Theory

The theory of improving course access makes a lot of sense: The idea is that many students who would take STEM classes can’t enroll in them at high school. To test the theory, the researchers analyzed records of more than 140,000 students entering Missouri’s four-year public university system, and connected back to the high schools those students attended.

The link between course access and future STEM outcomes turns out to be hard to study without capturing potential bias: What if some high schools, like those located in more advantaged neighborhoods, have more STEM courses simply because parents demand them? The new research handles this problem by comparing only those students who attended the same high school to one another over time, reasoning that changes in access are likely to be modest over time.
I
n the not-so-far-off future, STEM skills won’t just be critical for building high-paying careers, they’ll be crucial for securing pretty much any job at all. According to a 2017 study by McKinsey & Company, 30 percent of tasks across 60 percent of vocations are on track to be computerized. Prospects are also positive within other STEM specialties, with the following vocations projected to increase significantly: mathematical science (28.2 percent), biomedical engineers (23.1 percent), and environmental engineers (12.4 percent). Thanks to our increasingly STEM-driven economy, The World Economic Forum suggests that 65 percent of kids entering school today will wind up in jobs that don’t yet exist.

But despite widespread awareness about the demand for STEM-savvy talent, the U.S. continues to lag when it comes to supply. The nonprofit Code.org projects that there will be 1.4 million computer jobs by 2020, but only 400,000 computer science students equipped to fill them. Additionally, 2016 data indicates the U.S. had an estimated 3 million more STEM jobs available than qualified candidates to fill them, according to data from the New American Economy Research Fund. Bridging that gap requires an expansion of innovative STEM learning experiences to ensure more students have access to the opportunities that stimulate lasting interest in STEM and build adequate expertise.

And we can’t act fast enough. According to the 2015 National Assessment of Educational Progress, math proficiency among fourth- and eighth-graders in the U.S. dropped from the previous survey year, reversing a 25-year trend of upward momentum. Further, it’s estimated that three out of every four eighth graders in the U.S. fail to attain grade-level math proficiency by the time they graduate.

Continuing to build the STEM pipeline will require action on many fronts, and there are new and powerful approaches to teaching K-12 kids about math and science that can help drive this growth. The key: make STEM education – in every school – feel as innovative and exciting as the STEM careers that will follow it.

Over the past several years, a wave of initiatives in cities across the country have aimed to engage students in STEM subjects with hands-on, real-world educational experiences. Instead of reducing learning to “churn-and-burn” rote memorization and dry, uninspiring worksheets, these new project-based learning programs challenge students to actually make and build, through direct inquiry, collaboration and experimentation.

In public schools, from the cities to the suburbs, dedicated makerspaces give students sanctuaries for experimenting with high-tech tools like 3D printers, drones and sensors. And partnerships with leading institutions, like New York University and NASA, give students unprecedented access to learning experiences centered around subjects like robotics and space exploration.

New startup private schools, like the Portfolio School in New York, build entire curriculums around the belief that students learn best when education is personalized, experiential and interdisciplinary. AltSchool, which grew out of San Francisco, similarly prioritizes project-based learning, while leaning on technology to provide a platform for personalized learning and school operations.

Compelling evidence shows that participation in STEM-related clubs and activities can have a profound effect on longer-term STEM
engagement. A 2018 study, “Closing the STEM Gap”, published by Microsoft, surveyed more than 6,000 girls and young women on their interests in STEM, and found that girls who participate in STEM clubs and activities are: at the middle school level, more than twice as likely to say they’ll study physics in high school, and nearly three times as likely to say they’ll study engineering, and at the high school level, over 2.5 times more likely to say they’ll continue studying computer science in college.

Fortunately, there’s an increase in cases of non-school, business and community-based organisations working together to provide access to engaging teaching and learning experiences. An example is Remake Learning in Pittsburgh, a professional network of educators and innovators collaborating with this objective in mind. The Children’s Museum of Pittsburgh, one of more than 250 members, has a MAKESHOP® space that provides a variety of ways for children and families to make, play, and design using the same tools used by professionals in a field with skilled makers on-site to guide and assist. Another example, is the New York Hall of Science (NYSCI) Design Lab - a 6,300 square foot exhibition space designed to encourage hands-on, collaborative, problem-solving experiences that introduce learners of all ages to the fundamentals of engineering through design.

But these kinds of programs, while immensely valuable in supporting all kinds of learners, are not available to enough students. In some areas, budgetary constraints limit the deployment of project-based initiatives. In others, teachers lack the resources, skills or insights to effectively implement innovative approaches.

A nation that only envisions filling less than one-third of the available – and ever more economically essential – computing, engineering, technology and science jobs by 2020 faces a real challenge. And though the barriers to greater access are not insignificant, there is a path to expanded opportunity - and ultimately building the workforce of the future. We must begin with simple steps: scaling what presently works in STEM education, building a culture of innovation among educators that starts with the exchange of ideas, insights and inspiration, and engaging communities and business to collaborate to enable access for all students.

Despite our growing reliance on technology, most of us have a passive – not active – relationship with the digital world. We are recipients of the benefits, not creators. But today’s teachers have an outsized opportunity to encourage students to reframe their relationship with technology, forever changing how they view new tools and innovation.

Teachers who can make science and technology fun and engaging can change the equation for kids who might otherwise steer away from STEM. It's within their power to foster curiosity, wonder and excitement, sparking a love of STEM in future engineers, coders and rocket scientists.

It isn’t always easy – and there certainly isn’t a one-size-fits-all approach that works for students across the board – but the best STEM teachers know when to make a surprising observation, lend a listening ear or offer a motivating remark.

We recently asked several STEM professionals how K-12 educators can stimulate interest in STEM subjects. Here’s what they had to say.

Let students choose their own adventures through open-ended challenges that solve problems in their everyday lives.

“I remember my 4th grade teacher assigned us a project to create something useful from trash. I took two 2 juice bottles with lids, poked 2 holes in each lid and used tubing to connect each bottle via one set of holes and the other was connected to a blood pressure pump ball to push air in. I used the pump ball to push air down the tube and displace water out of the first bottle and into the other. The impactful aspect of the project, was the open-ended nature of it. This challenged me to be creative, to think of a problem that needed to be solved and then to be resourceful in my solution. It’s precisely the same processes I continue to use today in my work.”

– Leah Wyman, COO at 3Doodler

Engage students in hands-on learning to develop confidence in their grasp of the language of science.
“Throughout elementary school, science lab was a fun time that presented a wide variety of engaging activities, in addition to the annual science fair projects, and our teacher reinforced the scientific method and experimentation all the way through. Coming out of that, the language of science and empirical thinking came very natural to me, and I continue to apply those skills for experimental design in my job every day.”

— Greg Wilson, Senior Engineer at GE Aviation

Give them a taste of mastery with projects that ask them to dig deep into a focused subject.

“My 10th grade chemistry teacher tasked us with an assignment to learn everything we possibly could about one element in the periodic table. This single, hands-on assignment enabled me to visualize properties and events at the molecular level; I was mesmerized by the endless possibilities I saw in these atoms. I think this type of hands-on learning is essential to inspiring young people in STEM careers, it certainly inspired me.”

— Shelly Hoffman, Research Scientist at Eccrine Systems, Inc.

Celebrate diversity of thought and approach.

“Generally, I preferred lessons where the solutions were not scripted or where there were many ways to solve the problem. Some teachers offered these kinds of experiences more than others who simply fed us problems that followed a procedure and you just go through the motions. That was less interesting and inspiring than being thrown into an unknown situation where I had to learn to navigate myself.”

— Davin Sufer, CTO at WowWee

Help them find opportunities to connect theory and practice.

“My high school physics teacher told me about a camp that Purdue was holding where we could learn about airplanes and the physics behind them. I signed up and loved every second of it. We built a balsa wood airplane and put it into the wind tunnels there. I remember telling my dad after one of the days of camp that the days had just flown by and I was having so much fun. For me, that’s when I knew I would go into aero engineering.”

— Jen Perez, Advanced Course Engineer, GE

Nurture communities of likeminded STEM enthusiasts.

“Getting to go to a STEM focused charter school for the last couple years of high school helped immensely. Being surrounded by other like-minded people my age made me feel like it was okay to be interested in those things. The teachers were all top notch, and usually had a STEM career from before teaching that they could speak to.”

— Joe Schlesinger, CTO at Acrobotics

As one STEM professional noted, “A STEM career isn’t the right fit for every person, but each student deserves the chance at a strong STEM foundation in order to make an informed decision about her/his future.”

The approaches outline above worked for these former students. Now, a new generation of teachers must rise to the challenge, building on these tried and true methods, adding their own and increasing the scale on which STEM inspiration is delivered to students.
short time periods and driven by enrollment and logistics, not issues like neighborhood wealth.

But the data showed that, for every one-unit increase in courses available per student, high school students’ cumulative coursetaking in STEM barely budged. What’s more, students with more access to STEM classes in high school were not more likely to declare a major in a STEM field or earn a degree in one.

And the data did not show any particular impact for more STEM courses within high schools with large numbers of students of color, which tend to lack access to more rigorous coursework generally.

Parsing Disappointing Findings

As with any study of this type, it’s hard to know what’s driving the findings. One possibility is that high schools are pretty scheduled places, so possibly students aren’t responding to greater access because their schedules are already full. (In other words, with more options, they are merely substituting advanced chemistry for physics, rather than taking both.)

A more depressing hypothesis: Maybe high school students just aren’t as interested in STEM as adults want them to be. If that’s the case, then efforts to boost student interest in STEM will need to start far, far earlier in their schooling life.

The finding doesn’t mean that course access is a bad goal for policymakers to have; just that on its own it doesn’t appear to be doing all that much. Perhaps, the authors note, rather than adding a class here or there, schools need to more deeply revamp their offerings in those subjects.

They postulate that a “deeper, more stable STEM curriculum” that predates high school might have more of an effect, and suggest that policymakers also revisit how the subject is taught.

“For high school STEM policies to be effective at promoting postsecondary STEM interest and success, the norm of high school STEM instruction will need to change,” the researchers conclude. ■

Published January 24, 2018, in Education Week's Special Report: Getting and Keeping Good Teachers

N.C. District Trains Its Own STEM Teachers

By Madeline Will

Nearly every school district across the United States has struggled finding enough science, technology, engineering, or math teachers. Could one solution be for districts to recruit content-area experts and both train and license them themselves? That avenue has been an answer to a persistent STEM teacher shortage in the Guilford County school system in Greensboro, N.C. The 72,000-student district became the first in the state to open an in-house licensure program in 2008—and it’s still one of only a handful of districts across the country with such a program.

That certification pathway has allowed the high-poverty district, which has schools in both urban and rural areas, to hire dozens of STEM teachers. While critics warn that such approaches risk lowering the bar for teacher preparation, officials in Guilford say the teachers they train are bringing real-world STEM experience to the classroom.

“We knew our field, we knew our content, but we didn’t really know how to teach,” said Ashlee Clark, a chemistry teacher at Northwest Guilford High School, who went through the district’s licensure program in the 2015-16 school year. Before entering the program, she was doing animal research in graduate school.

“Initially, it was kind of scary for me because it was really a crash course” into teaching, Clark said. “Something that most people spend four years studying, we had to cram in one year.”

But the alternative-certification program is designed to ease those with STEM backgrounds into teaching through ongoing, timely instruction and mentorship that extends past a teacher’s first year in the classroom.

“The whole purpose was to provide a very, very strong multifaceted structure of support for alternatively certified teachers,” said Amy Holcombe, who was formerly the executive director of talent development for the district. Before the program existed, she said, the district’s alternatively certified teachers weren’t receiving much support. Holcombe saw her own father, who left a career in engineering to teach math in Guilford County, break into tears two months into the job because he felt overwhelmed and isolated.

While the district’s overall teacher attrition rate was between 10 percent and 12 percent, it was 34 percent for alternatively certified teachers, Holcombe said.

Now, she said, teachers who go through the program have a network of support. For the past three years, nearly all the STEM teachers who went through the program have stayed in the district for a second year of teaching.

Recruits interview with principals, and if offered a job, undergo an orientation for lateral-entry teachers—a term that encompasses qualified individuals who worked in or studied a non-education field—before they can enter the classroom. During the training, the district lets them know about their licensure options—which can include a university program leading to a master’s degree and a teaching license—but for many, Holcombe said, “our program is a perfect fit, because all they want is a license. They want to be able to teach—and teach right away.”

Those individuals start teaching and attend a class taught by district instructors one night a week. The classes are deemed “just in time” training, because the newbies learn tactics for classroom management, hosting a parent-teacher conference, and developing relationships with students as they need them on the job. On weekends, there are daylong sessions on special topics like diversity and equity or personalized-learning strategies. The new teachers in this program also receive regular on-site coaching for their first three years.

In the spring of the first year, there is a multiday retreat that goes deeper into pedagogy. Over five weeks in the summer, the teachers take in-depth courses focused on teaching and learning. The teachers must pass their Praxis exam within three
years of their teaching license being issued, but the district encourages them to pass before graduating.

As the program has grown, Guilford County has split it into two cohorts of teachers: those who want to teach liberal arts subjects, such as foreign language, that also are in short supply—and those who will teach STEM subjects.

Over four school years, 124 STEM teachers have enrolled in the program, including the current class of 25. Among the 31 teachers who started in 2014-15, 71 percent stayed in the classroom past their third year. Guilford County’s goal—made in partnership with 100Kin10, a national nonprofit that is seeking to bolster the ranks of STEM teachers—is to recruit and prepare 150 STEM teachers by 2020.

Guilford’s program is made up of recent college graduates who majored in a STEM field and career-changers. The former group is an area of active recruitment for the district. Guilford has a partnership with four historically black universities in the area—North Carolina Agricultural and Technical State University, Winston-Salem State University, North Carolina Central University, and Bennett College, a private women’s school. Holcombe said these partnerships allow the district to tie its diversity-recruitment goals to its need for STEM teachers.

“Guilford County schools is a majority-minority district, so the people that we’re hiring—the talent and leaders that we’re putting in front of our students—look like our students, which we feel is a very good thing,” she said.

District recruiters will go to the colleges’ STEM-related departments to ask students to consider a career in teaching. A couple of professors were so persuaded by the district’s recruitment approach that they left their universities to teach K-12, said Holcombe, who helped start the lateral-entry program and is now the district’s executive director of grants acquisition.

The challenge is that many of the students being recruited know they could earn more outside of K-12 education, she said.

“What we’re competing against are students who are being given full rides to complete their doctorate in STEM areas. And what we’re offering them as an alternative is the opportunity to come work with K-12 students, teach in the classroom, work 60-70 hours a week for less pay than what they would be getting in a stipend from their university for going to school full time,” Holcombe said. “It’s a very hard sell. We really rely on people who have heart and passion and a calling for teaching STEM to students.”

The personal support that district recruiters give to students is a selling point, said Daylonda Lee, a biology teacher at Smith High School who went through the lateral-entry program in the 2013-14 school year.

She was originally a nursing major at North Carolina A&T State University, but when she became pregnant with her son, she started looking for other options. Teaching interested her, and a recruiter from Guilford County schools made sure she had the credit hours to graduate, let her try student-teaching, and helped her prepare for the interview process.

“I didn’t even know what lateral entry was,” she said. “Once I made that decision, they were supportive, they were helping me figure it out. It wasn’t like a stressor.”

Lee, who was named the district’s lateral-entry teacher of the year, is now pursuing her master’s degree to get a principal license. She credits the lateral-entry program with setting her up for a lifelong career in education.

“It was ... truly building that connection of how to be a great teacher, how to be effective,” she said.

Ensuring Quality

According to information collected by Stephanie Aragon, a policy analyst at the Education Commission of the States, Guilford County is one of just a handful of districts nationwide that certify their own teachers without a university partnership. The San Francisco Unified school system has a similar one-year credentialing program focusing on training teachers in shortage-area subjects, including special education and bilingual education.

In the 2017 legislative session, Arizona and Kentucky, which have both struggled with teacher shortages, passed bills paving the way for district-sponsored certification. And in Minnesota, a bill that would have overhauled the teacher-licensing system and allowed school districts and charter schools to participate as alternative-preparation-program providers was vetoed by the state’s Democratic governor, Mark Dayton.

“As policymakers, it is our obligation and responsibility to ensure that long-term, professionally credentialed teachers have received the highest-quality preparation,” Dayton wrote in a letter explaining his veto of the bill, which was opposed by teachers’ unions.

And in October, the charter schools committee of the State University of New York’s board of trustees, one of two charter authorizers in the state, approved a new rule that will allow some charter schools to train and certify their own teachers. That move received strong opposition from some of New York’s top education officials,
as well as the state’s major teachers’ union, which filed a lawsuit to block it.

The chief concerns of critics of these types of programs are that they could lower the bar for entry into the teaching profession, and that because training is focused on local curricula and practices, it may be too narrow.

Such programs need state oversight, with a focus on results, said Elizabeth Ross, the managing director of state policy for the National Council on Teacher Quality, a Washington-based think tank that advocates for teacher-preparation reforms.

She said districts need to make sure they’re considering how much these programs cost, how effective the graduates are in the classroom, and the impact on student achievement and growth.

“There are pieces of [Guilford’s program] that are very promising and attractive,” Ross said. “One of the risks is that we see programs like this start to proliferate without a good sense of the impact they are having on schools and students and the community.”

The district’s Holcombe said program graduates tend to be successful in the classroom, because of the tailored support they get. The district conducted a study a few years ago and found that teachers who went through Guilford’s lateral-entry licensure program had higher value-added scores in Algebra 1 (known as Math 1 in North Carolina) and middle school math than counterparts prepared in a traditional teacher-prep program or a different alternative licensure program. Lateral-entry teachers tied with their counterparts in value-added scores for biology.

“When we teach the preparation curriculum that they’re receiving from us, we know exactly what literacy priorities we have in the district, our approaches to teaching lots of different subjects. We can teach our own pacing guides, our own approaches to lesson planning,” Holcombe said. “Whereas the university has to teach more generally because they have students who could end up anywhere, we know where our teachers are teaching.”

---

### COMMENTARY

*Published May 23, 2018, in Education Week's Special Report: STEM Education: Opening Gateways to Learning & Careers*

**Should We Worry About the Gender Disparity in STEM?**

Research suggests there’s more to the STEM gender gap than just bias

By David C. Geary and Gijsbert Stoet

The Australian government recently appointed a Women in Science Ambassador to promote girls’ and women’s engagement in STEM and in medicine. This is one of many programs that have been implemented around the world to promote girls’ interest in these fields and women’s pursuit of them as careers. These programs are based on the incorrect belief that girls and women are severely underrepresented in science, technology, engineering, and math. Similar numbers of women and men earn STEM degrees in the United States and have done so for decades.

What is correct is that men and women choose different types of degrees. Women are overrepresented in psychology and the biological and social sciences, and have now achieved parity in medical school and dominance in veterinary medicine. With the exception of chemistry, women are underrepresented in the physical, mathematical, and computer sciences as well as in engineering.

In other words, women who are interested in science tend to gravitate toward non-organic STEM fields that deal with living things and men to fields that deal with inorganic or nonliving things. The gender difference between interest in people or living organisms versus machines and tools has been observed for decades, is quite large, and influences occupational choices. Given this, women’s and men’s choice of different scientific disciplines is not at all surprising.

What is surprising is that many programs to increase girls’ and women’s engagement in STEM are partly based on an uncritical assumption that the underlying causes include social factors, such as stereotype threat or implicit bias. Stereotype threat occurs when one is confronted with situations that trigger negative stereotypes (e.g., “women are not as proficient at math as men”) that, in
To Hook Students on STEM, Start With Their Parents

Parents are an untapped resource, research suggests

By Judith Harackiewicz

There’s a fair amount of hand-wringing about how to get students interested and engaged in STEM subjects. We do know that the pipeline leading to STEM careers begins to leak in high school, when students are faced with decisions about taking advanced mathematics and science classes. Decades of research show that a key factor motivating adolescents to pursue these advanced courses is the perception of utility value. Essentially, if a student perceives that taking a calculus or physics class will be useful in daily life or in a future career, the student’s motivation to take that optional class will increase. My own research with my colleagues also demonstrates that understanding the future value of the subject matter can build student interest and improve performance.

More recently, my research colleagues and I examined the role of parents in communicating utility value to their children. It turns out, it’s critical. Teachers, parents, and peers can all contribute to students’ perception of value. But parents, who are often an untapped resource, can play a crucial role in their children’s learning and motivation because they know what interests them.

In 2007, my research colleagues Chris Hulleman, Janet Hyde, Chris Rozek, and I began a multiyear longitudinal study to test the effectiveness of an intervention aimed at encouraging conversations about utility value between parents and their teens.

The parents of 87 10th graders received a colorful, glossy brochure (“Making Connections: Helping Your Teen Find Value in School”). When the students were in 11th grade, the parents received another brochure (“Helping Your Teen with the Choices Ahead”). Parents were

A future career, the student’s motivation to take that optional class will increase. My own research with my colleagues also demonstrates that understanding the future value of the subject matter can build student interest and improve performance.

More recently, my research colleagues and I examined the role of parents in communicating utility value to their children. It turns out, it’s critical. Teachers, parents, and peers can all contribute to students’ perception of value. But parents, who are often an untapped resource, can play a crucial role in their children’s learning and motivation because they know what interests them.

In 2007, my research colleagues Chris Hulleman, Janet Hyde, Chris Rozek, and I began a multiyear longitudinal study to test the effectiveness of an intervention aimed at encouraging conversations about utility value between parents and their teens.

The parents of 87 10th graders received a colorful, glossy brochure (“Making Connections: Helping Your Teen Find Value in School”). When the students were in 11th grade, the parents received another brochure (“Helping Your Teen with the Choices Ahead”). Parents were
Every day, advances in science, technology, engineering and mathematics (STEM) are transforming our lives, from how we heal to how we communicate to how we travel. And the need for educated, inspired people who can drive progress in those areas shows absolutely no sign of abating.

That’s why STEM initiatives for kids – from coding and robotics workshops to local science fairs – are so important. Tomorrow’s groundbreaking advancements will be created by today’s K-12 and university students. Engaging them in STEM fields early on, sparking inspiration and feeding both the anticipation and expectation that they can change the world can make a real difference in people’s lives and our future.

We caught up with a few STEM professionals to find out what initially drew them to the field – and how their education is now helping them change the world.

Who or what most inspired you to take the leap into STEM?

“Probably my father. Being an engineer and very handy, his influence was a big factor. I always played with Legos like many kids, but my Dad was always building, fixing, inventing things around the house and for his various business ideas.”

– Davin Sufer, CTO at WowWee

“The thing that really got me interested [in STEM] was an Oceanography summer class. It started a love of everything to do with the ocean, which not only led to becoming a certified SCUBA diver, but eventually I decided what was really interesting were the deep-sea exploring robots, which focused my efforts toward becoming a roboticist.”

– Joe Schlesinger, CTO at ArcBotics

“My Biology / Chemistry teacher Mr. Barrows constantly inspired me to strive for more, not only to learn more about science, but to make the leaps to get to conclusions. Most importantly, he encouraged me to realize and be comfortable with the idea that failure was sometimes a necessary step on the path of success.”

– Maxwell Bogue CEO at WobbleWorks, Inc.

What kinds of play were most instrumental in sparking your passion for STEM as a child?

“I would come up with better ways to do everyday activities as a small child, such as how to prepare a sandwich in as few steps as possible, or create inventions such as an empty pill bottle tied to a piece of yarn, repurposed into a necklace which could store and transport candy. I was lucky enough to have plenty of encouragement from my family. They never told me I couldn’t do something academically or creatively.”

– Leah Wyman, COO at 3Doodler

“How does your work in STEM change the world?

““To me, engineering is a systematic way to solve problems, ranging from pipeline replacement to satellite creation. It is a way to improve human life.”

– Mark Tse, Senior Operations Manager at Wobbleworks, Inc.

“The field of analytical chemistry blends chemistry, mathematics, and engineering to develop techniques to make sensitive chemical measurements. In my current job, I get to build microscale architectures to help us address challenges in making chemical measurements with small volumes generated by sweating, which can help improve medicine, industry, and sport.”

– Shelly Hoffman, Research Scientist at Eccrine Systems, Inc.

“STEM courses in college taught me a valuable lesson about how important doing my own projects was. So, I made sure to keep that hands-on focus going after college by founding Makelt Labs, New Hampshire’s first makerspace. Now, hundreds of makers and STEM students take advantage of our classes or use our workspace for projects ranging from prototyping to fabrication every year.”

– Joe Schlesinger, CTO at ArcBotics.
also given access to a password-protected website. But families in the control group received none of the resources. All the parents and their teens were interviewed during the summer after 10th, 11th, and 12th grades. Eighty-six percent of the parents said they shared resources with teens. In 82 percent of the families, at least one parent logged into the website. We followed the teens through age 20, five years after the intervention started, when most were halfway through college.

Teens whose parents received the experimental intervention perceived math and science to be more valuable and important, obtained higher scores on the math and science ACT test, and actually enrolled in more math and science classes in 11th and 12th grades. These results are remarkable because they suggest that a relatively modest intervention with parents can influence important academic outcomes for their teens.

Our five-year follow-up suggests that these changes can be long-lasting and have a significant impact: Greater high school preparation (taking STEM courses and having strong ACT scores) was associated with increased STEM career pursuit at age 20. We also saw an increase in students’ STEM career interest and the number of STEM courses they took in college. These findings are the first to demonstrate that a brief motivational intervention with parents can have large effects on high school STEM preparation, as well as downstream effects on STEM career pursuit five years later.

Theoretically, this research contributes to our understanding of value transmission and interest development. Practically, it suggests that teachers and parents can make important contributions to students’ math and science learning and motivation by focusing on its current and future value. The intervention developed and tested here is cost-effective, and policymakers and district and school leaders might consider ways to involve parents in promoting STEM motivation.

Judith Harackiewicz is the Paul Pintrich professor of psychology at the University of Wisconsin-Madison.
STEM education by persuading students to start solving problems via science. Sony’s KOOV Educator Kit is an all-in-one coding, robotics and design kit that combines digital coding with physical building to teach the next generation of problem solvers and innovators.

Reflecting Sony’s commitment to both technology innovation and quality science, technology, engineering, art, and math (STEAM) education, KOOV is designed to help cultivate students’ collaboration and problem-solving skills, which have become critically important in 21st-century learning. KOOV was created to make STEAM learning tools accessible to all students. By using inclusive colors, a shareable design and the goal of building a foundation for future STEAM learning, KOOV serves as a ready-made, easy-to-use resource for teachers, students and parents.

Designed for children ages eight and up, the KOOV Educator Kit allows students to build on core concepts that they will learn over time and create increasingly complex robots as they go. Once a student masters the basic concepts and skills, they can use their imagination to create an infinite number of robotic combinations.

The KOOV Educator Kit includes the KOOV App, which features more than 50+ hours of easy-to-follow educational content via its Learning Course. The KOOV Learning Course offers a great starting point for students to begin learning key concepts in coding, building, and design. This educational course introduces the different electrical components that KOOV uses and provides students with an overview of how those parts work and how to use Scratch-based coding to control them.

The KOOV Educator Kit also comes with 20+ pre-designed, pre-coded “Robot Recipes” ranging from simple structures to complex animals and vehicles. These recipes enable students to start building right away and quickly develop the skills needed to create their original robots. The Robot Recipes showcase what can be done with KOOV, giving young learners the inspiration they need to move ahead and make their unique creations from scratch.

What I love about KOOV is that it is flexible enough for students to use for independent study or in a structured setting led by an educator. One KOOV Educator Kit can accommodate up to five students. The Educator Kit offers curriculum-aligned lesson plans, step-by-step teacher guides, and student progress reports. Also, KOOV provides class management features to give educators the tools to quickly implement KOOV-based learning into any classroom. The KOOV Educator Kit is a must-have for STEM educators everywhere. If I were still in the classroom, I would be using it.

Conclusion

The engagement of U.S. children in STEM education is imperative to fill an estimated 9 million jobs in the industry by 2022. Time can only tell how many STEM careers will be created in the years that follow. However, it’s up to everyone to ensure that American students are prepared to compete for those spots.

With the commitment of parents, teachers, and communities, we can offer a more inclusive and effective STEM education to children. While improving STEM education may seem like a lofty goal, products like the KOOV Educator Kit are up for the challenge. It’s now up to us to make the changes necessary to realize a vision of better STEM education for American students.

ESSA Is a Big Piece of the STEM Equity Puzzle

Three steps for smarter STEM education

By James Brown, Anand Vaishnav, and Jacob Waters

Earlier this fall, President Donald Trump called on the U.S. Department of Education to direct at least $200 million in competitive grant funding toward expanding science, technology, engineering, math, and computer science education. Though the administration hasn’t detailed exactly how they would implement the funds, the announcement builds on a growing nationwide commitment to STEM education.

The president’s directive also parallels similar moves by dozens of states to prioritize STEM education despite flat or declining state education budgets. High-quality STEM education not only has the potential to foster curiosity and creativity in students, it is critical for U.S. economic growth. But both words and plans are insufficient without follow-through. To best promote student success in STEM, we need both adequate funding and implementation of smart and equitable policies by all states and the District of Columbia.

And states (and their educators) still have a lot of work to do. Take training, for example: U.S. employers report having difficulty finding qualified STEM workers. According to the STEM literacy nonprofit Change the Equation, job postings in STEM occupations outnumber unemployed workers by nearly two to one. We need to do better in creating a pipeline or retraining the unemployed.

Additionally, access to STEM education is deeply inequitable—and that is reflected in schools and in the workforce. Change the Equation reports that low-poverty high schools are four times more likely to offer Advanced Placement computer science classes than high-poverty high schools.

It is also well documented that people of color and women are significantly underrepresented in science and engineering occupations. This lack of diversity and a stark gender divide cannot continue, especially when the opportunities are there if we guide students toward the right pathways to reach them. It starts by giving all young people ex-
posure to enriching STEM experiences to develop their interests.

So what are states doing to address this? The Every Student Succeeds Act provides more flexibility to states than its predecessor, the No Child Left Behind Act, did. Under ESSA, states can spend federal education dollars and measure school performance and accountability to support STEM education. In a recent report for the education policy organization Education First, two of us—Anand Vaishnav and Jacob Waters—analyzed 25 state ESSA plans (17 submitted for the federal April deadline, as well as eight draft plans), and found that many states are taking advantage of that flexibility to address STEM learning.

In particular, 17 states are incorporating student performance on state science assessments into their accountability systems; 17 states are including career- and technical-education indicators in their accountability systems; and 10 states are prioritizing STEM in their federally funded after-school programs through the 21st Century Community Learning Centers program.

The vital role ESSA plays in putting states’ STEM commitment into action is clear. With Trump signaling a funding directive to STEM education, he also shouldn’t forget about the importance of continuing to fund ESSA at 2017 fiscal levels, at the very least, particularly the sections that support training and development for effective educators (Title II) and provide student supports (Title IV). Both of those sections, which the Trump administration has proposed cutting, have major implications for STEM education.

With sufficient funding in place, states need to implement these policies in a way that promotes student success, especially for low-income students and students of color. States should:

- **Direct more resources toward at-risk students.** States that use student performance on science assessments in their accountability systems will have the data to determine which districts, schools, and students need additional support for STEM learning. Giving at-risk students access to resources like curriculum, laboratory supplies, and highly effective STEM teachers would be a huge step forward. After all, equity means giving all students what they need—not giving them the same things.

- **Build STEM career pathways in career- and technical-education programming.** Though building STEM skills is useful in itself, states should coordinate with local industries so that students of all backgrounds can easily transition into a career after graduating from CTE programs. For instance, Tennessee has a strong model that directly connects its CTE programming with high wage-growth occupations in the state, providing career opportunities for students who most need them.

- **Use high-quality after-school providers that give students new opportunities and experiences.** Informal learning experiences—such as hands-on experiments and trips to museums—can help students develop a lasting passion for STEM. Unsurprisingly, low-income students are far less likely to have those experiences. States should prioritize funding for after-school providers that provide effective STEM instruction while giving students opportunities they are unlikely to have elsewhere.

In an environment where resources are limited, the federal government, states, districts, educators, and families need to come together to get STEM right. Our students, and our country, deserve nothing less.

James Brown is the executive director of the STEM Education Coalition, an alliance of education, business, and professional organizations that advocates policies to improve STEM education. Anand Vaishnav is a principal, and Jacob Waters is the manager of thought leadership at Education First Consulting, a national education policy and strategy firm.

Copyright ©2018 by Editorial Projects in Education, Inc. All rights reserved. No part of this publication shall be reproduced, stored in a retrieval system, or transmitted by any means, electronic or otherwise, without the written permission of the copyright holder.

Readers may make up to 5 print copies of this publication at no cost for personal, non-commercial use, provided that each includes a full citation of the source.

For additional print or electronic copies of a Spotlight or to buy in bulk, visit www.edweek.org/info/about/reprints.html

Published by Editorial Projects in Education, Inc.
6935 Arlington Road, Suite 100
Bethesda, MD, 20814
Phone: (301) 280-3100
www.edweek.org
Get the information and perspective you need on the education issues you care about most with Education Week Spotlights

The Achievement Gap • Algebra • Assessment • Autism • Bullying • Charter School Leadership • Classroom Management • Common Standards • Data-Driven Decisionmaking • Differentiated Instruction • Dropout Prevention • E-Learning • ELL Assessment and Teaching • ELLs in the Classroom • Flu and Schools • Getting The Most From Your IT Budget • Gifted Education • Homework • Implementing Common Standards • Inclusion and Assistive Technology • Math Instruction • Middle and High School Literacy • Motivation • No Child Left Behind • Pay for Performance • Principals • Parental Involvement • Race to the Top • Reading Instruction • Reinventing Professional Development • Response to Intervention • School Uniforms and Dress Codes • Special Education • STEM in Schools • Teacher Evaluation • Teacher Tips for the New Year • Technology in the Classroom • Tips for New Teachers

VIEW THE COMPLETE COLLECTION OF EDUCATION WEEK SPOTLIGHTS

www.edweek.org/go/spotlights