

The US is in dire need of STEM teachers

Faculty attitudes, public perceptions, tuition, and state requirements are barriers to science majors entering the teaching profession.

Schoolteachers report career satisfaction. Jobs are plentiful. Pay is better than in many professions. Pensions are good. Yet for decades the US has struggled with acute teacher shortages, especially in physics, math, and chemistry. The shortage of math and science teachers was emphasized as far back as 1983 in the government report *A Nation at Risk: The Imperative for Educational Reform*. These days, COVID-19 is exposing and exacerbating existing strains in education systems. But even as the stresses of the pandemic are pushing some teachers to consider quitting, others are persevering and working for change.

Roughly 27 000 teachers are teaching physics in US high schools, according to the Statistical Research Center of the American Institute of Physics (publisher of *PHYSICS TODAY*). The shortfall in physics teachers nationwide is 15 000–23 000, says Michael Marder, executive director and cofounder of UTeach, a nearly 25-year-old science and math teacher preparation program at the University of Texas at Austin that is now replicated at 49 universities in 23 states. The range represents the additional numbers of teachers needed for 80% or 100% of high school students to take physics. By contrast, there is no shortage of biology teachers. (Marder explains his calculations in a 25 October 2021 blog post titled “How Bad Is the U.S. STEM Teacher Shortage?”)

In science, technology, engineering, and math (STEM) fields more broadly, the shortages in teachers in 2017–18 were about 100 000 in high schools and 150 000 in middle schools, according to Marder. To address the deficits and to make up for retirements and resignations in high schools alone, he says, the US needs to prepare an additional 10 000 STEM teachers annually for a decade.

But the number of certificates awarded for teaching STEM in secondary schools is decreasing. The trend is “alarming” in the case of university-prepared teachers, says Marder. He points to tuition hikes



MARK TWAN

TEACHERS-TO-BE learn research methods in a 2011 UTeach course at the University of Texas at Austin. The woman with the balloon is Gloria Ogboaloh, who for the past decade has taught math at a high school in Round Rock, Texas.

and ever-increasing state requirements as culprits. “The cost to get from an undergraduate degree to teaching is squeezing people out.”

Wendy Adams, a researcher at the Colorado School of Mines, is involved in increasing recruitment in STEM fields. According to focus groups and surveys she has conducted, more than half of college physics majors express interest in teaching high school, but the faculty assume students are uninterested. “Students sense that faculty don’t consider teaching a good career,” she says. It’s common, she laments, for the attitude among physics faculty to be, “Why would you waste your talents on teaching?”

Adams is the principal investigator for Get the Facts Out, a five-year, NSF-funded initiative that aims to boost the number of STEM majors who become teachers. It provides resources to counter negative perceptions and repair the profession’s reputation. In addition to the School of Mines, the partners are the American Physical Society (APS), the American Chemical Society, the American Association of Physics Teachers (AAPT), and the Association of Mathematics Teacher Educators. On its website, Get the Facts Out highlights attractions of teaching (see the box on page 27).

Conditions such as teacher pay, number of colleagues, class size, and auton-

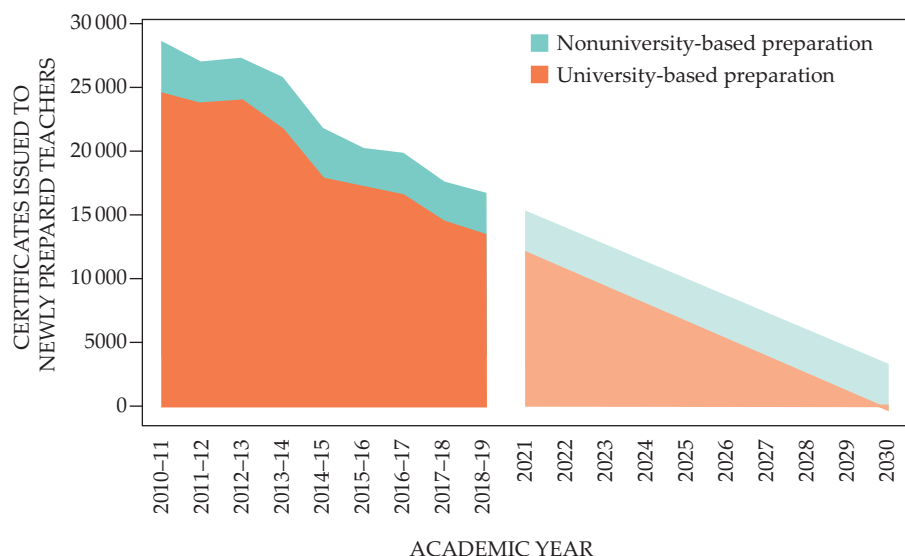
omy vary widely by district, state, school size, and rural versus urban location. For example, according to the US Bureau of Labor Statistics, the mean annual pay for secondary school teachers is \$86 900 in California, \$78 900 in New Jersey, \$58 040 in Texas, and \$46 100 in Mississippi. Salaries also vary within each state.

The teaching profession

Gay Stewart has spearheaded successful teacher recruitment programs through APS’s PhysTEC program at West Virginia University (WVU), where she has been for nearly eight years, and at the University of Arkansas, where she previously spent two decades. Arkansas built up to producing five physics teachers a year on average while Stewart was there, and about three WVU physics majors a year go into teaching, she says. But, she notes, the most common number of teachers that college physics departments produce is zero.

One graduate of Stewart’s program is John “Charlie” Rea, who has been teaching high school physics since 2005 at a public high school in Fort Smith, Arkansas. Before becoming a teacher, Rea was a glassmaker. “I made more money, and I solved interesting problems,” he says, “but it didn’t feel like a calling. Teaching does.”

Rea and other teachers say they like



DROPPING PRECIPITOUSLY is the number of certificates awarded in the US for secondary school teaching in science, technology, engineering, and math. The right-hand plots show the projected descent if the situation is not reversed. The numbers for certificates from university-based and nonuniversity-based preparation programs are additive. (Courtesy of Michael Marder, based on Title II data from the US Department of Education.)

getting to know the students and seeing them grasp new concepts. They like the experiences and challenges that come with each new batch of students. They like the unpredictability of each day and being kept on their toes. They like talking and thinking about science, and they like the satisfaction of making a difference in people's lives. Many of them like the camaraderie and collaboration with other teachers. They also like that teachers will always be needed and that jobs are relatively easy to come by. They like their pension plans and the flexibility of their summers. Some say the work-life balance is an attraction of the profession.

The difficulty of achieving work-life balance is also among the factors some teachers say they dislike about their jobs; many put in long hours on evenings and weekends. Teachers commonly cite grading as an unappealing part of their responsibilities. And some are frustrated by legislators dictating what and how they should teach.

Many teachers say pay is not a reason to enter—or exit—the field. But to augment their salaries, more than half of teachers take on extra paid work at school, and about 20% of high school and middle school teachers have a second external job, according to the National Center for Education Statistics's 2017–18

survey of teachers and principals. According to the survey, extra duties at school bring a yearly average of \$2800 for middle school teachers and \$3800 for high school teachers, and outside work yields \$6000 and \$6400, respectively.

Bree Barnett Dreyfuss is in her 17th year of teaching physics at a large public high school in Pleasanton, California. She's paid to work part-time with AAPT and APS on STEP UP, a program that works to increase the number of women majoring in physics. And although money was not her motivation for chairing her school's science department, the accompanying stipend doesn't hurt. "I know teachers who tutor, garden, run clubs, and coach sports teams," she says. Other teachers report side gigs as educational consultants, technical writers, and Uber or Lyft drivers.

Pandemic pandemonium

In much of the country, in-person school resumed in fall 2021 after more than a year of remote and hybrid teaching. A common observation among teachers is that behavioral problems are up and attention spans are down. "My juniors have the emotional maturity of ninth graders or middle schoolers," says Jessica Watts, who has taught physics for more than a decade at both public and private schools.

"Teachers are not trained to catch them up in mental and social well-being, but it's expected of us."

Fostering group projects has become more difficult, teachers report. "Behaviors this year are significantly harder to manage," says Melissa Kovar, who teaches physics at a public high school in San Francisco. "There are more fights at school, more shouting, more standing up." Rea concurs: "A ring of kids was throwing fireworks at each other in the hallways. I never thought I'd see something that brazen."

Schools in higher-income areas tend to see fewer disruptions. "We don't have a lot of behavior issues," says Barnett Dreyfuss. "The main one is cheating." Teachers in wealthier areas also encounter more pressure from students and parents to raise grades.

Coursework is posing problems this year too. In the AP physics class that Rea is teaching, for example, some students have never seen the quadratic formula. "That blew my mind," he says. "I'm dealing with 11th- and 12th-grade motivated kids. If they were all missing the same knowledge, it wouldn't be a big deal. But I can't even discern who is missing what." In required classes where kids may be less motivated, it's worse, he adds. On top of the uneven learning gaps, this year both students and teachers have missed school because of COVID-19.

Nationwide, a shortage of substitute teachers has led to teachers having students from other classes added to their own and to substitutes being in charge of multiple classes at once. Some school districts have raised pay for substitute teachers. And some are pleading with parents to step in. A 14 January email from the Austin Independent School District, for example, promised up to \$225 per day, depending on qualifications and local rates of COVID-19.

Marketable skills

The extra demands on teachers during the pandemic has some considering quitting. "I know several," says Hannah Seyb Ensmann, who teaches at a large public high school in Indio, California, about 200 km east of Los Angeles. "Some of them left because of the pandemic. They realized it was not good for their mental health."

For her part, Seyb Ensmann had planned to earn a PhD in astronomy, but after observing that graduate students "didn't

look happy,” she became a teacher. She attributes her intentions to stay in the profession partly to being a fellow of the Knowles Teacher Initiative, which provides math and science teachers with extra funding, professional development, and networking.

At first, teaching online “was like being a new teacher all over again,” says Cheryl Harper, a 33-year veteran of teaching high school physics in Greensburg, Pennsylvania. “But I’ve put so much into it, and I’ve learned so much about technology, there is no way I’m going to give up at this point.”

Barnett Dreyfuss notes that a lot of skills that teachers have are marketable. “We can speak and present, we can coalesce information. We can make curriculum that is clean and easy to read. These are résumé-building skills.” It can be difficult to hire physics teachers, she adds. “They can earn much more in industry.”

Anne Goshorn has taught physics and engineering in public schools in central Texas since 2004. She switched to online teaching when COVID-19 hit. But then, in the fall of 2020, her school insisted she come back in person. Because her own children were still attending elementary



HIGH SCHOOL SENIORS test an automatic cornhole bean-bag thrower they designed for Cheryl Harper’s engineering class at Greensburg Salem High School in Greensburg, Pennsylvania.

school remotely from home in a neighboring district, she quit her job. After a year off, she is now teaching AP physics part-time in her kids’ school district.

The pandemic prompted Dean Baird to retire in 2021, two years earlier than he had planned, with a roughly \$500 a month cut to his pension. He’d been at the same school in Sacramento, California, for more than three decades. The challenge—and fun—had always been, “How can I use my creativity to coax these kids along?” he says. “If you are not sex or food, they are not interested. I have to reel them in and show them how cool physics is. Seeing kids understand things made me happy.” The connection with students disappeared when his classes went online, he says. “I had never worked so hard to be so ineffective. I got beaten down by having to do four physics preps every day remotely. I got crushed by it.”

This is Watts’s last year teaching. “It’s a great job. It doesn’t feel like work when you are with students,” she says. But the pandemic has revealed “how little value I had” in the eyes of the school administration. For example, her current private Catholic school in Texas called teachers back into the classroom before vaccines against SARS-CoV-2

were available, and she was told her contract would be rescinded unless she showed up in person. “We felt replaceable,” she says. Her plan now is to earn a doctorate in education, with a focus on teacher retention in private Catholic schools, and then to “fight the battle to change the system at a higher level.”

Problems as possibilities

For all the exhaustion that teachers feel this year, some hold out hope that the cracks exposed by the pandemic will lead to improvements. The availability of food, internet, academic help at home, and other inequities in education and beyond are exacerbated by the pandemic. The importance of teachers and the demands placed on them have become more visible. Teachers hope for more respect and higher pay. Some are exploring different methods of teaching and grading.

Seyb Ensman has been experimenting with “standard-based” grading, in which students are evaluated on what they have learned, rather than on the work they’ve turned in. The students can choose how to demonstrate their knowledge, as long as they follow the given rubric. The approach is fairer to a broader range of students, she says. But switching curriculum and grading procedures is time-consuming, says Barnett Dreyfuss. “I’d love to do more. Students like it. They feel you are investing in them, and they focus more on learning and less on grade grubbing.”

Toni Feder **PT**

Get the Facts Out wants you to know that*:

- ▶ Teachers in the US rate their lives better than do people in other occupations—save physicians.
- ▶ Midcareer teacher salaries range between \$60 000 and \$100 000.
- ▶ Most teaching jobs have better retirement benefits than other jobs you can get with the same degree.
- ▶ Student loan forgiveness programs and scholarships are available for math and science teachers.
- ▶ You can get a job almost anywhere in the US or abroad as a science or math teacher.
- ▶ More than 78% of high school science teachers are still in the classroom after five years.
- ▶ About half of all science and math majors report an interest in becoming a teacher.
- ▶ Grades 7–12 science and math teachers get paid more than most college teaching faculty.
- ▶ Research shows that classroom teachers have a greater impact on student learning than all other aspects of schools.

*These statements have been edited for style and clarity.