PIONEER
EDUCATION

Engineering a Solution:
Elevating STEM Teacher Quality

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Executive Summary

The United States has been cultivating STEM talent for decades with great success, but that robust talent pipeline is threatened by a growing STEM teacher shortage. Left unaddressed, that shortage could curtail employment in STEM professions and the many related careers that increasingly require some degree of scientific and technological literacy.

While the STEM teacher shortage is a national problem, the effects are likely to be felt more acutely in a state such as Massachusetts with a high concentration of STEM jobs. This paper provides an overview of the causes of the STEM teacher shortage and offers three recommendations to address it.

Introduction: Teacher Shortages in Context

Fewer young people are going to college to become teachers. This trend is not new. The number of undergraduate degrees awarded annually in education peaked at approximately 200,000 during the 1970s. In 2018–19, the number dropped to less than 90,000. Two reasons for the decline stand out.

First, as the labor market has opened new opportunities for women, fewer are becoming teachers. In 1970–71, 36 percent of all bachelor's degrees earned by women were in education. In 2018–19, only 6 percent of all bachelor's degrees earned by women were in education. Second, STEM degrees and careers are luring would-be teachers away from the profession.[1]

These are good problems to have: The labor market should be wide open to women, and the United States has long needed more people to enter STEM professions, which lead to so many of the innovations that move our country forward. But without qualified individuals to teach our children everything from English language arts to technology and engineering, we are failing to adequately educate the next generation.

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Teacher shortages exist in every state, and the nature of those shortages varies by state and subject area. However, shortages are often most acute in the STEM fields. In California between 2011 and 2015, for example, the number of math and science teachers entering the classroom dropped by 32 percent and 14 percent, respectively.[2]

The U.S. also struggles to retain teachers, many of whom leave the profession within their first five years.[3] This means that in some places the teaching workforce is disproportionately mature, with a large percentage approaching retirement age.

The COVID-19 pandemic shined a light on these gaps in our teaching workforce. During remote schooling, parents glimpsed teachers who were not prepared to manage students or qualified to teach their assigned subject. What parents didn't know is that many of these teachers were forced to teach outside their areas of expertise because schools had no other options.

As of 2023, states employ thousands of emergency-certified teachers, people who are teaching without the training and credentials a state or district would typically require. Use of emergency certifications was emerging in some states before the pandemic but ballooned in 2020 and 2021.[4]

For instance, the Massachusetts Department of Elementary and Secondary Education (DESE) approved the use of emergency teaching licenses in 2020. A year later, those teaching temporary permits, waivers, and intern credentials increased by 23 percent in math and 51 percent in science.[5]

A given teacher's certification may not directly correlate to effectiveness, but these data clearly show the state has a thin and leaky teacher pipeline.

Moreover, federal COVID relief funds—which had been used to fill immediate vacancies, provide paraprofessional support, and bolster teacher-student ratios at a time of great learning

loss — are expiring this year. Experts warn school districts nationwide will face a fiscal cliff in 2024.[6] That means difficult decisions as budgets contract. Temporary programs will end, supplemental staff may lose their jobs, and more qualified teachers may leave the classroom if they lack support staff.

The STEM Teacher Conundrum

Building teacher pipelines and creating programs to retain teachers will take time, but states are already doing the work. New opportunities to expand and diversify teacher pipelines, such as federally registered teaching apprenticeships, are gaining traction.[7]

States like Massachusetts are building upon already robust alternative certification routes and teacher residency programs, which allow professionals with bachelor's degrees in fields other than education to teach while they receive training that leads to certification. Many states are supporting prospective teachers through programs that pay for undergraduate degrees and certification and/or forgive educational debt. Some states are setting higher minimum pay to make teaching a more attractive profession.

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These programs show promise, but states should also consider solutions that address specific teacher shortages. For example, requiring all teacher candidates to become certified in special education and/or English Language Learning would equip them to serve students with diverse needs.[8]

Exempting non-tenured teachers who serve certain populations, or teach in high-needs schools, from first-round layoffs in the event of budget cuts is a simple path to better teacher retention. Developing teachers with expertise in different subject areas, including STEM, may require different and more nuanced solutions, mainly because the U.S. has for decades provided incentives to increase the number of college graduates entering STEM fields.

Between 2010 and 2019, the U.S. saw the largest recorded increase in individuals employed in science and engineering professions. The National Board of Science predicts employment in science and engineering is "expected to grow faster than overall employment through the 2019–29 period."[9]

Women are an important part of the growth of the STEM workforce. Between 1993 and 2019, the number of women with a bachelor's degree or higher working in STEM fields nearly tripled.[10] These data provide promise for the growth and composition of the STEM workforce, but what could they mean for K–12 education?

There is a symbiotic relationship between K–12 schooling and the labor market. When more students across all demographic groups enter college ready to study and succeed in technology areas, the STEM workforce grows more robust and diverse. But those outcomes require more qualified K–12 teachers, and fewer college graduates with STEM degrees are becoming teachers.

The number of STEM graduates of education preparation programs is falling precipitously, from just under 25,000 nationwide in 2010 to less than 15,000 in 2022. Anecdotal data suggest three factors:

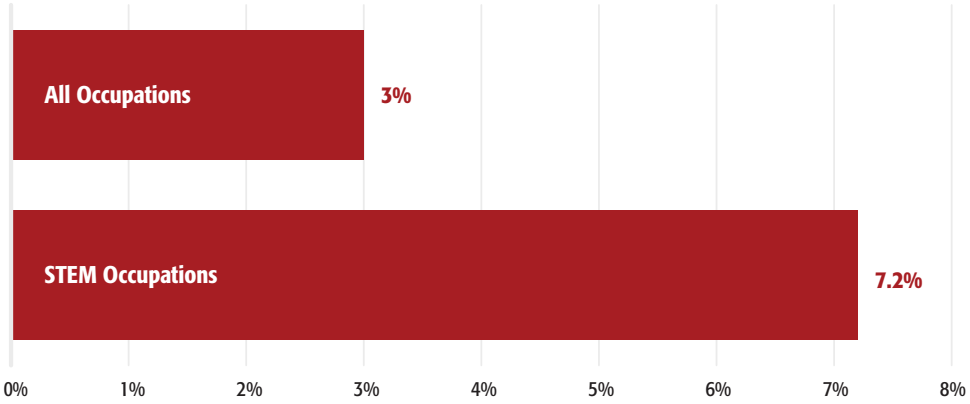
- STEM graduates command higher salaries in careers other than teaching
- University faculty are not likely to recommend teaching to graduates
- Undergraduates perceive teaching to be a high-risk, low-reward job that doesn't allow for work-life balance[11]

If the U.S. fails to produce STEM teachers in the coming years, growth in STEM professions could be curtailed, and states like Massachusetts may feel the impacts more acutely.

In the Bay State, "forty percent of all employment revolves around innovation industries, such as clean energy, information technology, defense, and manufacturing."[12] And, in the 2022–23 school year, according to the National Conference of State Legislatures, Massachusetts is just one of many states experiencing a statewide shortage of STEM teachers.[13]

The following chart shows relative, projected growth rates in Massachusetts for all occupations and STEM-only occupations.[14]

Massachusetts Growth Rate of Jobs: All Occupations vs. STEM Only 2018–2028 Projections



Source: Commonwealth Corporation analysis of Massachusetts Economic Research Department. Executive Office of Labor and Workforce Development Occupational Projections.

For decades, the U.S. has provided incentives to attract people to STEM degrees and STEM teaching positions. In 2022, the U.S. Department of Education dedicated $120 billion in American Rescue Plan funding, along with other federal funds, to launch *Raise the Bar: STEM Excellence for All Students*. In partnership with the nonprofit Beyond100k, the Department is identifying "key challenges to fully staffing schools with STEM teachers who reflect the diversity of their students and create classrooms of belonging."

The initiative also funds organizations like Data Science for Everyone to help with teacher training and science curricula. The program leverages the Smithsonian Institution, which will "support 20 education entities representing over 10,000 STEM teachers with the goal of ensuring a diverse STEM teacher pipeline."[15]

But Washington, D.C. can only do so much. Federal programs have a shelf life, and leadership changes in Washington could change funding priorities for K–12 education, including STEM. Plus, states remain the primary drivers of education policy.

Federal programs have a shelf life, and leadership changes in Washington could change funding priorities for K–12 education, including STEM. States remain the primary drivers of education policy.

Helping states recruit teachers for STEM courses might be easier than finding professionals qualified to teach in other areas, such as special education. States and districts only need to look to the public and private organizations around them that may be filled with baccalaureate-holding STEM professionals.

Policymakers may not need to entice these professionals to shift careers, which can often mean taking a pay cut. Instead, they should consider the potential return on investment of forming public-private partnerships that sponsor STEM teacher training and place qualified STEM professionals in classrooms, even for short periods of time.

Three Approaches to Recruit and Retain STEM Teachers

Endow STEM Chairs in High School

1. **Elementary and secondary systems should invite corporations, state government agencies, and philanthropists to endow chairs for K–12 STEM teachers.**

A September 2022 article in *District Administration* identified the 10 hardest school positions to fill—five of which are in STEM education.[16] The potential for higher salaries in corporate, nonprofit, and government sectors is one challenge district leaders and principals must address. District and philanthropic leaders invest millions to recruit, retain, and reward STEM teachers. These efforts yield positive results and should continue, but they are short-term investments and subject to changes in funding priorities.

A long-term investment strategy for STEM teachers requires changing the funding and benefits for such positions. Elementary and secondary systems should take a page from the higher education investment playbook and invite corporations, state government agencies, and philanthropists to endow chairs for K–12 STEM teachers.

Virginia provides an example. In 2007, Rolls Royce announced plans to invest $500 million to build a manufacturing plant in the state, providing jobs and funds to endow professorships, graduate fellowships, and centers at Virginia Tech and the University of Virginia. University officials leveraged their partnership with Rolls Royce to garner millions of additional dollars from the public and private sectors.[17] K–12 schools received some funding, although K–12 was only a small element of Virginia's economic development master plan.

It is time that Massachusetts—with a strong higher education system and talent pipeline—recognize that our K–12 system provides the oxygen for our higher education brain trusts. State and local leaders should include K–12 systems or individual school districts in portfolios to attract and retain businesses, asking those businesses and their investors to endow STEM chairs in schools and districts.

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Endowed STEM chairs could encompass:

- Using endowment interest to offer STEM teachers higher salaries
- Ensuring teachers and students have state-of-the-art technology
- Funding professional development for teachers during the academic year
- Providing paid externships for STEM teachers during the summer

States and school districts would need the right partners to invest in and manage endowments. Any endowment should include guidelines to ensure that women and people of color are considered for STEM chairs. And guardrails should ensure that the workforce demands or interests of the sponsor never supersede school or district interests in a sound curriculum, overall academic excellence, and teacher autonomy and creativity.

This approach will not solve the overall STEM teacher shortage, but it's a long-term investment strategy that could influence how policymakers and district leaders think about compensation for K–12 educators and provide models to replicate in other areas, including the arts, civics, humanities, and social sciences.

Experts-in-Residence Program

2. **States and districts could invite STEM organizations to lend their professionals to schools and districts, allowing employees to become STEM teachers for a semester or a full year.**

This model exists in higher education, where current and former CEOs teach in business schools and lawyers and judges dedicate time to teaching law students.

Harvard's University Office of Technology Development, for example, created an Experts-in-Residence (XIR) program to equip university faculty and researchers with a better understanding of how their work relates to the commercial marketplace.[18]

The program gives faculty access to entrepreneurs, venture capitalists, R&D experts, and other real-world experts outside the university. Researchers and resource builders exchange ideas to gain new understanding and even develop new ideas at the university and in the marketplace.

School districts could partner with local economic development agencies to select a group of STEM companies that in turn select employees to serve as experts-in-residence, helping teachers develop new ideas and providing real-world and hands-on experiences for students.

Experts-in-residence programs would be voluntary for the experts and free to schools and districts. For instance, each expert in residence could commit to work with a STEM teacher for one academic year while receiving their regular salary from their employer, who would relieve the expert of some day-to-day duties and guarantee their return to their job and work conditions at the end of the year.

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Executives-to-Educators Program

3. **States should consider how to better support individuals who may want to teach in a high-needs STEM field but are unwilling to give up a reliable income as they train full time and earn a teaching certification.**

Some existing models work to solve this problem. The U.S. Department of Defense's Troops to Teachers Program equips military personnel and veterans to become K–12 teachers.[19]

Florida and Indiana allow otherwise qualified professionals who hold bachelor's degrees to enter classrooms under a temporary license.

States and districts could also create relationships with departments of commerce, small business offices, and chambers of commerce to create executives-to-educators programs. STEM employees could train to become certified teachers through an accelerated evening and/or online program while keeping their day job. Public and private partners could cover training and certification costs for STEM professionals and match them with open positions. Once a candidate completes the program, they could immediately move into the classroom with full certification.

Context Matters

Public private partnerships such as those above aren't new. For example, a global network of P-Tech schools, created by IBM, leverages partnerships "among K–12, community college and industry … to provide students with hands-on academic, technical and workplace experiences … across a range of STEM fields."

P-tech schools can leverage staffing arrangements like those described here, but P-tech doesn't provide opportunity at scale — it's currently used only in 206 schools across the United States.[20]

Models like P-Tech could be more widely available if U.S. schools thought about staffing in innovative ways across school types. Non-district schools, which have more operational autonomy, may find them easier to pilot.

School districts in most states have little flexibility when it comes to assembling staff. Onerous requirements for teacher certification discourage practicing professionals from giving their time in K–12 settings. Collective bargaining agreements dictate hiring preferences and salary. Policies that give districts the autonomy to hire otherwise qualified professionals with a provisional license could address this barrier, especially in high-needs areas, like STEM. Districts could likewise negotiate for exceptions to a standard collective bargaining contract where teacher shortages exist.

Charter schools, which often enjoy autonomy that district schools don't, could be perfect for

implementing some of the ideas above. Charters often have greater discretion in hiring and pay and many are organized around distinctive themes that could be attractive to nonprofit and private entities seeking a partnership. Indeed, many charter schools already partner with industry, technical institutions of higher learning, hospitals, or healthcare systems.

In some states, vocational-technical schools have autonomy similar to charters and many focus on preparing students in STEM fields. States should ensure that regulations for voc-tech schools allow them the flexibility they need—in hiring, staffing, and educational practices—needed to implement innovations.

Conclusion

The United States has been cultivating STEM talent for decades. Now is the time to encourage that talent to enter the nation's classrooms. To begin to chip away at teacher recruitment and retention problems, states should be willing to try new approaches and look beyond educator preparation programs for teacher talent.

The Commonwealth of Massachusetts is rich in educational institutions. People come from around the globe to learn at our colleges and universities. As such, Massachusetts should be a net producer of teachers, yet shortages exist in almost every district in the state.

The stakes are high for our students. A failure to solve general teacher shortages means fewer qualified adults teaching our children. The stakes are also high for our economy. Massachusetts has built a vibrant community of STEM-based businesses, but it has taken decades to build that robust and diverse STEM workforce. Without teachers to educate the next generation, that workforce could dwindle.

There is no one solution to teacher recruitment and retention; rather, states should consider multiple, complementary approaches, which should include some of the innovative private/public partnerships outlined here. Massachusetts can and should lead the way in innovating to ensure we have high-quality educators now and in the future.

The United States has been cultivating STEM talent for decades. Now is the time to encourage that talent to enter the nation's classrooms. To begin to chip away at teacher recruitment and retention problems, states should be willing to try new approaches.

Endnotes

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Gerard Robinson is a professor of practice in public policy and law at the Frank Batten School of Leadership and Public Policy and the School of Law at the University of Virginia. As a Fellow of Practice at the Institute for Advanced Studies in Culture at the University of Virginia, Robinson has written about K–12 and higher education, public policy, economic mobility, after-school programs, and race. Examples include his coedited books *Education for Liberation: The Politics of Promise and Reform Inside and Beyond America's Prisons* (2019), and *Education Savings Accounts: The New Frontier in School Choice* (2017), and research reports funded by the Chan Zuckerberg Initiative and the Charles Stewart Mott Foundation. He also cohosted *The Learning Curve* podcast, in which he and Dr. Cara Candal discussed educational topics with scholars, practitioners, entrepreneurs, and 13 Pulitzer Prize winners.

From 2017 to 2020, Robinson was Executive Director of the Center for Advancing Opportunity (CAO), a Washington, D.C.-based research and education initiative. From 2011 to 2012, Robinson served as Commissioner of Education for Florida. Prior to that, he served as Secretary of Education for the Commonwealth of Virginia. Between 2005 and 2010, Robinson was a program director and later the president of the Black Alliance for Educational Options in Washington, D.C.

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