

To Make Science and Engineering More Diverse, Make Research Socially Relevant

Science and engineering disciplines sometimes struggle to connect research with social benefits and to retain diverse students.

Solving one problem can solve the other.

Imagine two high school science, technology, engineering, and mathematics—STEM—competitions: one where teams are challenged to build a hurdle-jumping robot, and one where teams build a robotic arm for people with disabilities. What differences might you expect? Not only will the materials and assessments differ, but more importantly, so will the people who choose to join one contest or the other. The former will likely attract those interested in tinkering with machinery and the latter may be more appealing to students interested in helping people in need. This prosocially oriented group is likely to include more young people who are historically underrepresented in STEM.

There is a body of research behind this thought experiment. A survey of over 300 undergraduates found that Black, Hispanic, Indigenous, and multiracial students who perceived the research they were involved in as altruistic were more than twice as likely to express an interest in pursuing a research career in STEM compared to white students. In a double-blind, randomized study, more than a thousand introductory biology students were randomly assigned to write short

essays, either on how the content of their biology course was relevant to their lives (the intervention group) or simply to summarize the course material (the control group). Those asked to connect biology to their own lives went on to earn higher grades at the end of the course compared to those assigned the alternate writing task. Within the former group, Black, Hispanic, and Indigenous students who were the first in their families to attend college expressed the most motivation to help others. The effect of this intervention on performance was weaker for white students from college-educated families. A recent study my colleagues and I conducted found that women students and faculty were more interested in STEM entrepreneurship training to convert their research into commercial products and services if the training was framed as applying science to tackle societal problems, rather than as applying science to commercial ventures alone. (Men did not show a special preference for social good in the study, instead responding similarly to messages about social good and commercialization.)

These and other studies lead to a consistent conclusion: students who see the pursuit of STEM as

having a broader social relevance—namely, contributing meaningfully to disadvantaged communities—are more likely to persist in it, especially if they belong to groups underrepresented in STEM degree programs and the STEM workforce.

Let me be clear: I am *not* saying that only people who have been historically excluded from STEM are motivated to pursue paths that are socially meaningful, altruistic, and promote community. Nor am I saying that appealing to these motives alone is sufficient to broaden participation in STEM. I *am* saying that connecting STEM to social justice is an underutilized tool that can diversify participation, encourage persistence, and promote research that improves people's lives.

Besides being motivated to pursue a life of meaning, human beings seek belonging and a sense of competency. Fulfilling the need to belong and feel competent in STEM fields can be elusive for people from groups that have been systemically excluded from STEM education and STEM professions. Research shows that when

environment influenced people's health in her Black and brown working-class community and how engineering can bring tangible solutions.

When she started college, Cielo struggled in some STEM courses. She believes her vocational-technical high school experience, which focused on hands-on training more than classroom learning, provided an uneven foundation in advanced science and math. Two things kept her going: connections with two faculty mentors who strengthened her sense of belonging in STEM, and the deep meaning she derived from her work combining environmental science, engineering, and health.

After graduating from college, she was accepted into the graduate program in civil engineering at the University of Massachusetts Amherst. Her work, in partnership with a Hispanic urban agriculture organization, draws attention to the disproportionate impact of environmental disasters on low-income Latino communities. One of her projects examines how contamination in the Connecticut River spreads into

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these students step into STEM spaces where there are few people like them, they often feel awkward and out of place. Some may also feel like imposters. When the going gets tough, many people, especially beginners, reach out to others who share their background to find camaraderie and share their struggles. Absent that, they may attribute their experience of struggle to inadequate skills that are fixed in nature, rather than skills that grow through the normal experience of learning.

In life, there is a complex interplay between the need to belong, to feel competent, and to pursue something meaningful. Feelings of competence and meaning can enhance a sense of belonging. So too, belonging and doing something personally meaningful can increase persistence, resulting in greater competence over time.

Bringing theory to life

Cielo Sharkus, a PhD student in civil engineering, embodies how this could work. Cielo's entrée into science and engineering started at her vocational technical high school in Worcester, Massachusetts, with a project on water contamination in the nearby Merrimack River. It became an "aha" moment—showing her how the local

surface and ground water to pollute urban farms, and how engineering might mitigate these problems. The virtuous cycle formed by linking science and engineering to meaning, belonging, mastery, and social good is obvious in Cielo's life.

I have spent more than 20 years researching barriers to participation in STEM and using that knowledge to develop interventions in the real world. As director of faculty equity and inclusion in the College of Natural Sciences at UMass Amherst from 2014 to 2020, I worked to improve the climate for underrepresented faculty in the sciences, promote feelings of inclusion, and increase faculty retention. It became clear to me that undergraduate and graduate students flocked to faculty who explicitly connected their research agendas to social good and to whom students could relate interpersonally. I could see this because I was working across many science departments on a large campus. Had I been at ground level, immersed in my research lab or department, this pattern would have been easy to miss.

I realized that if STEM faculty could elevate research topics connected to social justice, they would attract women, racial and ethnic minorities, those

from working-class backgrounds, and other groups underrepresented in STEM. This one magnet could accomplish two goals: address social problems while also diversifying who pursues science, engineering, and computer science.

Some three dozen coffee conversations with STEM faculty on campus convinced me that there was a critical mass of people at UMass Amherst who saw their research as motivated by equity. These faculty members understood that their research would benefit from a multidisciplinary perspective—learning from and collaborating with colleagues in other disciplines. What they needed was a way to meet and share their work with researchers in complementary disciplines. They also needed access to small research grants to test-run collaborative ideas and generate preliminary data that could be used to apply for larger external grants.

Fired up by this insight, in 2017 I created the Institute of Diversity Sciences with start-up funding from the chancellor, provost, and dean of natural sciences at our university. The institute's mission is to connect

compared to their well-off counterparts. Teams are eligible to apply for our grants if they have faculty coleaders from at least two STEM disciplines; if they include students on their teams, providing them with mentored research opportunities; and if they can articulate how their project connects STEM to social justice. Winning teams use the preliminary data collected with our funding to pitch a bigger version of their project to external funders.

Third, we nurture diverse cohorts of students in STEM through professional development programs. We draw on a statewide network of industry professionals and STEM educators in high schools, community colleges, four-year colleges, and universities. This enables coordinated professional development and resource sharing, and it strengthens the community of people and organizations across the state committed to diversity and inclusion in STEM fields.

The Leadership Academy is one example. Each summer, we bring together students majoring in computer science and engineering from diverse backgrounds

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STEM research to social justice in three ways. First, we serve as a matchmaker, bringing together people from different fields with similar research interests to share their work and exchange feedback. We initially did this by launching two multidisciplinary seminar series—one on health equity and another on learning equity—that convened faculty and graduate student researchers across the natural sciences, social sciences, engineering, computer sciences, health sciences, nursing, and management sciences. We have since added a third seminar series on environmental justice.

Second, the institute incentivizes multidisciplinary research collaborations. Each year, we award three to five grants of up to \$15,000. Grantees examine many equity-oriented topics, including whether automation in cars hampers drivers with attention deficit hyperactivity disorder; whether heavy police surveillance accelerates biological aging in African Americans; how biodiversity in urban spaces affects human well-being; and whether natural disasters are more likely to damage roads and drains in socially vulnerable communities and, as a result, disrupt essential services in these communities

online. Students learn about workplace culture, its unspoken norms, expectations, hiring practices, and leadership opportunities. They practice professional skills—such as negotiating effectively—that complement their growing technical skills. They learn about a broad array of careers from visiting speakers who expand students' networks and build mentoring relationships with industry professionals. We follow these students for one year to learn how the program affects their career outcomes. Another program, funded by the Alfred P. Sloan Foundation, aims to diversify on-ramps from undergraduate to graduate degree programs in engineering and computer science.

The result of all our activities at the Institute of Diversity Sciences is a diverse group of students, early-career natural scientists, social scientists, health scientists, engineers, and technologists—plus more senior scholars who engage in mutual mentoring. This helps all participants develop a sense of belonging, gain mastery and competence, and pursue work that has purpose and personal meaning to them.

At UMass Amherst, 39% of faculty in the College

of Natural Sciences identify as female; less than 25% in engineering and computer science do so. Less than 10% identify as Black, Hispanic, Indigenous, or multiracial. This is not too different from what is seen in the overall US STEM workforce. By comparison, the people who choose to participate in the Institute of Diversity Sciences are far more diverse in terms of race and gender. Among the 740 UMass Amherst affiliates of our institute, 66% are female and 33% are people of color. I believe this is because we connect STEM research to social justice.

Another example of this approach can be found in work at the University of California, Davis, School of Medicine, which is banned by state law from considering race in admissions. Along with various other efforts to increase access, the school has emphasized medicine for social justice—and now runs one of the most diverse medical schools in the country. According to *STAT*, almost half of the current class comes from Black, Hispanic, and Indigenous populations.

In light of the June 2023 Supreme Court decision that seriously weakened affirmative action in higher education,

A bigger barrier is that most funding agencies offer programs that support basic science or biomedical research, while other programs aim to diversify talent pathways through mentoring and professional development activities. No funder that I can find supports multidisciplinary STEM research that tackles disparities as a way of *both* attracting diverse talent to the STEM enterprise *and* solving social problems. This powerful idea falls in funding agencies' blind spot.

Accordingly, most efforts to broaden participation in higher education focus on initial recruitment efforts or providing early support and training. Although recruitment and support are both important, a missed opportunity is the content of the topics being studied, that content's connection to real-world issues, and the identities of people who study it.

How to scale STEM for social justice

I would like to partner with other institutions to build a hub of similar institutes at colleges and universities across the nation that connect STEM to social justice in their own ways. A little over a year ago, I was contacted by a faculty

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institutions need alternative strategies to fulfill their missions of diversity, equity, and inclusion. Although the court's decision significantly limited affirmative action, the ruling allows, and even encourages, colleges and universities to consider other factors to increase diversity on campus—for example, by building programs where race itself is the subject of study. Our approach centering STEM topics connected to social justice offers one creative solution for institutions to live up to their missions while adhering to the law of the land.

Barriers and blind spots

I have some hunches about why this type of initiative hasn't been built at other universities. Many natural and computer scientists consider the social good implications of their work after a project has been completed, rather than building it into the research from the start. Disciplinary differences in jargon can also obscure a common interest in social good. For instance, colleagues in the natural sciences and engineering often use the words "access" and "equity," whereas social scientists often say "social justice" to describe the same phenomenon.

member at the University of Wisconsin–Madison who had been searching for an institute like ours to use as a model to build something of their own in Wisconsin. Every example they found at other universities was focused on either mentoring or STEM education—not research. A few initiatives that were research-focused were housed within a single department (usually psychology) and not broadly multidisciplinary.

I want to hear from colleagues at more universities and funders who are interested in joining this effort to build a coordinated national network of institutes like ours at the University of Massachusetts. Together with cross-university collaborations fueled by entrepreneurial funders who see an opportunity, we can learn from each other, build capacity, and scale impacts of our collective efforts toward solving societal problems. There is a jigsaw puzzle of social good and broader STEM participation just waiting to come together with the right partners.

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