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Transforming Opportunity to Support STEM Success for All

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Research suggests countering compounding societal disadvantages is like trying to walk up an escalator that is going down rather than up. In fact, it may be more like walking up a series of escalators going the wrong direction.

This is often the experience of students in Science, Technology, Engineering, and Mathematics (STEM) fields from working-class and poor families, particularly when from racially minoritized communities. While achievement through adversity is typically celebrated, too often, universities fail to recognize those students who are shut out of STEM fields as a result of the challenges they face.

Over the past 15 years, my colleagues and I have investigated the mechanisms in place to broaden participation in STEM fields. These studies have focused on women and students across genders who are from underserved and underrepresented communities, and have found that university leaders have the opportunity to lower the barriers to high-paying, economically transformative degrees for students by working to align high school and university course preparation, adjusting university-required introductory courses, and confronting the culture of intentionally "hard" grading in STEM. Mounting research evidence from our own work and extensive studies beyond our own (referenced below) points to the merits of enhancing curricular on-ramps during and before college, and limiting financial constraints that can hinder STEM opportunity.

Curricular On-Ramps During and Before College

The curriculum for STEM students is, by nature, challenging and cumulative. While this is certainly by design, there has been limited consideration for how reasonable the requirements are that are being made of incoming students. These requirements, meant to encourage rigorous study, instead serve to block entry to STEM fields to those with more limited resources, including women, those from low-income families, and minority students.

There are numerous examples of compounding racial inequalities in education. For one, whereas just over 18% of White, non-Hispanic students completed calculus in high school, only 10% of Latinx students and 5.7% of Black students do so. When students enroll without this background experience (attainable for *free* in public high schools), they then have to pay tuition to catch up in college and sometimes wait to take key courses in their major. In turn, they start college with academic and financial deficits in comparison with their peers who have this experience.

Then, incoming students have to survive the too often exclusionary, large lecture-style "weed-out" courses that are typically requirements in order to proceed to formally enter the major. There are signs that these gateway courses can be vastly improved—in some states, developmental education reforms have allowed students to either bypass developmental coursework altogether or enroll in it concurrently with credit-generating gateway courses in their major, with positive results found in states like Florida. But while there are promising alternatives to traditional lecture-style gateway courses, where students with less high school training are known to struggle, this structure mostly remains in place, barring many underserved students from the potential transformative economic benefits these high-growth, high-salary degrees offer.

Financial Constraints and Considerations for STEM Programs

Underserved students must also often contend with financial limitations that make the challenge of managing their schoolwork even more difficult. The structure of STEM programs can reinforce this dynamic, particularly as STEM courses are often considered—and reinforced to be—"hard" majors, and students typically earn

lower grades in these courses than those in other fields, with chilling effects for students who are the first-generation in their families to be college enrollees.

This serves no purpose other than reinforcing a perceived "specialness" of STEM disciplines and further chilling talented, deserving students out of the field who could earn higher grades in other and often still mathematics-related disciplines that don't haze their students with intentionally lower grades than elsewhere across campus. Importantly, this has consequences for students on merit-based and other forms of financial aid, which faculty, staff, and administrators may not consider when doling out C's and D's regularly to bright students who may not have the opportunity to devote 10-15 hours per week to each coding or lab-based STEM course. Problematically, if they do earn a not atypical C average in these majors, or switch out to less punitive majors as many students do, they can risk losing their financial aid, time and money spent, and not be able to earn a degree at all.

In fact, this is a pressing issue, as most of today's college students work 20-40 hours a week while enrolled in school. These jobs can and often are a means to support themselves and their families, as Pell grants and other financial aid has increasingly not fully met students' basic needs, not to mention their academic costs. In my study of engineering undergraduate research students, an Afro-Latina interviewee explained that she was working for pay to support herself at school, doing her classes, and felt like her major field requirements did not leave room for anything else. Such students may change their major away from STEM or stop out of college all together. These challenges are real among today's students.

Recommendations

In order to best support STEM students, and especially, to help underserved students thrive in these programs and open the door for high-paying careers, university leaders should take deliberate steps forward to adjust the course requirements and supports that are in place. By considering the following opportunities, real change can be instigated for those who need it most.

1. **More coordination between K-12 and state/university policymakers to align secondary and postsecondary course preparation in science and mathematics, for students from all backgrounds and schools.** Courses such as physics and precalculus that functionally serve as pre-requisites for college STEM majors should be available and, when appropriate, be required in U.S. high schools.
2. **Lower the entry point for postsecondary majors in high-demand, high-earning technical fields**. Universities should consider offering alternatives to the traditional lecture-style gateway course, including interventions with clear benefits for equalizing opportunity to learn *and* improving teaching quality.
3. **Reconsider grade penalties for STEM majors**. There is no need to reinforce the notion of "hard" majors. Rather, universities must confront and adjust the practice of purposefully suppressing grades, which runs counter to efforts to increase and broaden STEM participation and degree attainment.

Science and mathematics degrees can help students step on to a rising escalator. But these programs too often come with unreasonable expectations and financial barriers that make them unattainable. That is why, today, senior scientists and technology leaders do not reflect America. To change this, we have a compelling interest in fixing the broken escalators, to make pathways to opportunity rise, in the right direction.

Key takeaways:

- While stakeholders are interested in broadening access to STEM training and success, pathways are too often hindered for students from underrepresented and minoritized backgrounds.
- Coordinated efforts to align secondary and postsecondary course expectations could enhance students' access to opportunity.
- To enhance access, it is important to structure the availability of both advanced STEM courses prior to college and offer wider on-ramps in college for those students without this earlier training and who risk financial aid loss associated with STEM grading norms relative to other fields.