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Editor's Journal

It's About the Students

When complex, mature institutions are failing, it's a lot easier to understand the causes of the failure than to know what to do. Even strong agreement about those causes may not be enough to motivate appropriate action. Few people would disagree that the US system of higher science, technology, engineering, and mathematics (STEM) education and workforce training is plagued with a number of systemic problems that compromise its ability to serve many of its students, the STEM enterprise, and society more broadly. Indeed, Alan Leshner and Layne Scherer note that since 1995 “over 20 studies and reports on graduate science, technology, engineering, and mathematics (STEM) education have come to that same conclusion: American graduate STEM education needs to be modernized.” And on the subject of education and training for biomedical researchers, Ronald Daniels and Lida Beninson similarly observe that for more than 20 years “reports sounded calls for action, and specified recommendations for reform. And yet, a great many of these recommendations went unaddressed. And the challenges endured, and in some cases, worsened.”

The essays in this *Issues in Science and Technology* by Leshner and Scherer, and Daniels and Beninson, are part of a thematically linked set of eight articles addressing some of the well-recognized weaknesses in the STEM education enterprise. Five of the articles are short, accessible spin-offs of recent consensus reports by the National Academies' Board on Higher Education and Workforce. Three others are by the presidents of universities that are trying to set a different course.

So what makes these perspectives different from all the other Cassandra-like warnings of impending doom that have come before? They are oriented toward solutions, rather than diagnosis.

At the center of these articles is a constituency that is too often forgotten in discussions of higher STEM ed reform: the students themselves. America's system of higher STEM education evolved into its current state largely building on assumptions, demographic realities, and workforce needs of the early Cold War period. With rapid growth of research funding directed mostly at a small group of leading research universities in the 1950s and '60s, the system was unapologetically elitist and exclusive. Most scientists were white and male, and so were most science students. Graduate training focused on preparing students for academic science careers.

These initial conditions are still powerful influences on academic STEM culture, despite radical changes to the social context for STEM in the subsequent decades. The civil rights and women's movements pushed back against notions of exclusivity and elitism defended by those already privileged. The expansion of industrial R&D relative to government-funded science changed the landscape of opportunities for students with STEM training. Exponential growth of the academic scientific enterprise itself outstripped the ability of public funding sources to keep up. Deindustrialization and globalization reduced pathways for upward mobility of workers through manufacturing jobs, thus placing a greater premium on higher STEM ed credentials for entering the workforce.

Yet in many ways, the norms, assumptions, and incentives of higher STEM ed remain as they were 40 years ago. Above all, the student experience remains hostage to a more-or-less Darwinian philosophy, where only the fittest should survive. Of course, it's easier to be fitter when the system was designed for you. As Leshner and Scherer observe in their articulation of an "ideal graduation education": "Particular attention would be paid to the needs of students from diverse backgrounds, and they would be educated in inclusive and equitable environments that maximize the probability of their success." The authors look especially toward federal and state funding bodies to adopt funding criteria that shift professional incentives toward maximizing student success.

Daniels and Beninson argue that the main obstacle to progress on reforming education and training for future biomedical researchers is the absence of any mechanism for coordinating among the many competing institutions involved. They propose a public-private Biomedical Research Enterprise Council that brings together players in academia, industry, philanthropy, and government to develop coherent strategies for addressing a system that is decreasingly able to meet the professional aspirations of many of its students and postdocs.

A pernicious long-term consequence of the commitment to exclusivity has been the marginalization of Minority-Serving Institutions (MSIs) that, as Leigh Miles Jackson and Tom Rudin explain, "enroll nearly 30% of all undergraduates in the United States. In terms of their contributions to STEM education, more undergraduate students (from all backgrounds) are enrolled in STEM fields at four-year MSIs than at four-year non-MSIs." These institutions should be the secret weapon of America's future STEM workforce, and their importance will only continue to increase in coming decades. They need more federal support, better leadership, and stronger partnerships with industry and, in some cases, with majority-serving universities.

Meanwhile, although many STEM fields have made great progress in terms of gender equity at the student and early- to mid-career level, the problem of sexual harassment has not been adequately recognized as one that adversely affects both careers and the quality of science itself. Frazier Benya explains why sexual harassment should be seen as a research integrity problem and proposes that academic efforts to deal with sexual harassment be integrated with programs to improve training and compliance in responsible conduct of research.

On another troubling front, Ashley Bear and David Skorton tell us that "fewer than 30% of employers

think that students are well prepared. More than 80% of employers feel that colleges and universities need to do a better job helping graduates gain cross-cutting skills and knowledge." It turns out (surprise, surprise) that the labor market actually prefers students who have broad sets of skills—not just narrow STEM training, but also strong writing, speaking, critical thinking, and cross-disciplinary integration skills. This means that colleges and universities really do need to get serious about incentivizing excellent teaching that takes seriously "the importance of a holistic, integrative education."

The good news is that many colleges and universities are experimenting with new ways of presenting STEM and other curricular material to emphasize engaged, critical, cross-disciplinary learning. There is a huge opportunity here to match innovation in education with the needs of a rapidly evolving workforce, and as with so many other aspects of the STEM education challenge, much of the solution will have to lie with incentives. Effective leadership will also be a part of that story, and John Bardo tells us how Wichita State University is teaming up with nearby businesses to help drive regional innovation and job creation; Freeman Hrobowski III and Peter Henderson of the University of Maryland, Baltimore County, explain what it means to get serious about minority-serving STEM education; and Richard Miller describes the groundbreaking approach to engineering education developing at Olin College.

In all, we'd like to think that this set of articles not only maps out much of the agenda for reform of higher STEM ed, but that it can catalyze the deep institutional change necessary to move from a system that needs to escape its mid-twentieth-century roots and embrace the challenges of a very different world.

Also in this issue, John C. Hopkins and David H. Sharp argue that the ability to credibly assess the performance of nuclear weapons in the US stockpile is being undermined by the lack of experimental data derived from nuclear tests of these weapons. They are decidedly not calling for a resumption of testing—a decision that could be made only after careful analysis of the foreign policy, environmental, safety, and economic context—but they make a compelling case that there is reason to question the robustness of computer simulations that predict how these aging warheads will perform.

And in a final note, we are introducing a new column, Sciences, Publics, Politics, by Matthew Nisbet, a professor of communication studies at Northeastern University. In this inaugural column, Nisbet explores the question of openness and accountability in philanthropy, as foundations prepare to spend \$4 billion over coming years to advance their agenda to reduce climate change.