

The National Academies of **SCIENCES • ENGINEERING • MEDICINE**

With sponsorship from the National Science Foundation, the National Academies of Sciences, Engineering, and Medicine is convening a public symposium to explore ambitions for the future of undergraduate STEM education and identify steps for achieving them.

Prior to the symposium, the National Academies held an idea competition to engage stakeholders with diverse perspectives. Entrants submitted a statement or video addressing some aspect of the symposium's focus: *What should undergraduate STEM education look like in 2040 and beyond to meet the needs of students, science, and society? What should we do now to prepare?*

Entries were evaluated based on their potential to contribute to and advance discussion at the symposium. Entries were also judged on originality and future orientation. Below is one of the winning submissions.

"Undergraduate STEM Education Re-imagined: Transcending Boundaries, Forwarding Inclusion, Making the Invisible Visible"

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What should undergraduate STEM education look like in 2040 and beyond to meet the needs of students, science, and society?

Undergraduate STEM education in 2040 should look like the realization of diversity, equity and inclusion. Diversity, equity and inclusion will not only be realized by those who participate in undergraduate STEM education (faculty and students), but will be reflected in how STEM education is conceptualized and approached. The STEM disciplines will no longer see themselves as separate from each other and rest in discrete departments (silos), but will reflect the true nature of STEM which is transdisciplinary. In 2040, one's participation in STEM will not be predicted by one's race, gender, cultural background or gender; but rather one's desire to become active, contributing and viable members of the STEM community. The current mechanisms that are used to "weed students out" of the STEM pipeline will be replaced with channels that help them flow seamlessly through the STEM canal without the barriers, obstacles and challenges that many students face today.

Ensure that all students enter university STEM classrooms prepared emotionally, academically and socially to fully participate in STEM education. Apprenticeships that give students hands-on, real world experiences that foster their learning of STEM content will be incorporated and will provide an understanding of the various **contexts** that can shape their thinking about how to solve problems that transform their communities. STEM classrooms are robust learning communities where students have access to scientific labs, various learning tools, innovative technology, active learning, and caring professors who not only teach STEM content but teach students. STEM

undergraduates graduate from college prepared to enter the workforce or pursue graduate that have a depth and breadth of meaningful knowledge, skills and competencies that are used to benefit them and their communities.

Undergraduate STEM courses will become transdisciplinary epicenters of creativity and innovation. STEM by its very nature is transdisciplinary, and will be even more so in 2040. Hence, the undergraduate STEM curriculum will no longer be structured in silos, but will be transdisciplinary and organized around dominant societal issues that have the potential to yield insights from the STEM disciplines. Further, undergraduate STEM classrooms will be places where students study and practice innovation and creative thinking. Courses will center on answering the question: What is the nature of creative thinking and how do we apply this creative thinking to forward innovation and solve societal problems?

Access to STEM will be viewed not as an endeavor for the “special” students who have been deemed as a “STEM person” but as a civil right granted to all students. STEM education must be viewed as a viable pathway for all students. As a civil right, undergraduate STEM classes will be places where students can interrogate race blind perspectives, policies and practices that unintentionally or intentionally lead to inequitable STEM related outcomes. Students will explore how these race neutral perspectives have had detrimental consequences, and they will be educated as to how they can address these systemic inequities. Also, all stakeholders will engage in systemic analysis of STEM policies and practices to determine the differential effects of these policies on minorities and other marginalized groups. To this end, undergraduate STEM classrooms will be grounded in an understanding of social justice, racism, inequities that will require a radical change in the way STEM education is conceptualized, implemented and evaluated.

For African American students, undergraduate STEM education will cease to be a gauntlet that kills off their creativity, brilliance and humanity but rather a place where they will be welcomed and celebrated for the unique perspectives, skills, talents and competencies that they bring to the classroom. Deficit based narratives and the pedagogies built on these narratives will cease. Persistent inequitable achievement patterns that plague k-12 STEM education will no longer manifest itself as the underrepresentation of African American students in STEM majors.

What should we do now to prepare for this 2040 vision of undergraduate STEM education?

Embedded in the above vision, is some recommendations as to how we can achieve this vision:

1. Make access and opportunity in STEM education a Civil Rights Issue
2. Abandon disciplinary silos and embrace a transdisciplinary approach to undergraduate STEM education
3. Dismantle the weed out culture of STEM and adopt a culture that supports, nurtures and honors all students and essential and valuable participants in the STEM enterprise
4. Train undergraduate STEM education faculty in ways that support them to effectively teach STEM content but also the context of STEM education, specifically how this context

contributes to the marginalization of certain students and the impact of this context on how they should approach their instructional practice

5. Implement perspectives and practices that embrace a race visible pedagogy (RVP) which centers the racialized experiences of learners in the STEM curriculum
6. Partner with industry, business and community and other stakeholders to insure that undergraduate STEM education is informed by real world issues and problems so that students are able to address these issues powerfully
7. Transform who we are and how we think about STEM education. Do the deep work to dismantle inequities, become inclusive and embrace equitable, even if it challenges our deeply held ideas about STEM education and who should participate

Four potential Symposium Topics

Radical Changes in Knowledge and Discovery

- *How should undergraduate education change as discovery in both academia and industry increasingly demands knowledge and skills from many disciplines?*
- *What administrative, financial, and pedagogical models best support convergent learning and also address overarching concerns such as privacy, security, and ethical behavior of people and systems?*

Achieving Equity and Meeting Future Students' Needs

- *How can we anticipate future students' needs and provide a quality education for all students?*
- *What blend of learning environments, technologies, and other tools are most and least effective for helping first-generation and low-income STEM students succeed? Do different approaches work differently for different groups?*
- *What would it mean to design changes based on an equity and social justice mindset from the start?*

Changing Learning Pathways

- *How should the STEM education system adapt to new learning pathways, with individual students' [educations] increasingly spanning multiple institutions, instructional modes, credentials, and phases of life?*
- *How can we consider learning in contexts other than formal settings and for different cultures, ages, or levels of instruction?*

The Changing STEM Workforce

- *How will automation, AI, the gig economy, and other future employment realities affect STEM careers and the skills employers seek?*
- *Which jobs and sectors are likely to grow, contract, emerge, or disappear entirely?*