

The Future of Undergraduate STEM Education: Inclusive, Flexible, Collaborative, Innovative

Several critically important factors evident today will contribute to what undergraduate STEM education will look like in 2040 and beyond. First, undergraduate learners today are more diverse than ever, in personal characteristics, background, preparation, and interests. Second, commitments to equity and social justice, as well as recognition of the need to draw on the full array of talent in society, require inclusive learning environments that recognize and support the diversity of ways that learning occurs and excellence is achieved. Third, research has advanced knowledge about the science of learning, the particularities of learning challenges in specific disciplinary areas, and the educational strategies that foster greater learning success for more students. Fourth, changes, opportunities, and challenges in the workplace are leading employers to call for graduates with transferrable skills, such as creativity and adaptability, and competency in teamwork, communication, conflict resolution, and problem solving. Fifth, technological advances—including “big data,” automation, and communication and learning processes unconfined by time and space-- provide affordances as well as new challenges for learners, teachers, learning contexts, and workplaces.

The convergence of these factors today contributes to a vision of undergraduate STEM education in 2040 and beyond that:

- Recognizes, embraces, and respects the diversity of learners;
- Draws on research on effective practices and policies to enhance learners’ experiences in undergraduate education;
- Uses cutting-edge technological advances to transform learning and measurement in higher education;
- Nurtures partnerships between educators, workforce leaders, and communities so that learners can move seamlessly among these contexts;
- Is responsive, adaptable, flexible, and innovative.

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 will result in increased educational success for more learners.

We will see broadening access to STEM courses and careers, improved learning outcomes, and more learners (including women and those in underrepresented groups) successfully achieving in early “gateway” courses and in reaching graduation. Those facilitating learning will implement educational models that are informed by cutting-edge knowledge from the learning sciences and discipline-based educational research. These learning models will recognize the importance of individual differences and deploy technology in creative ways to optimize learning gains and dispel the restrictions of lock-step education constrained by time and space. These models will also encourage the development of creativity, flexibility, learner-centeredness, disciplinary depth, and interdisciplinary connections.

Undergraduate STEM education will occur in a variety of contexts, within traditional higher education institutions and also within the community and in workplaces. The education and industry sectors will work together in mutually productive and seamless arrangements, building on best practices and knowledge concerning collaboration, engagement, internships, and undergraduate research. Hybrid models of lifelong learning will blend formal and informal, and structured and unstructured, approaches, and link learning and practice across the lifespan.

Effective educational models will be informed by research and data-based measurement approaches that provide ongoing feedback to support improvement and greater success. Researchers and reflective practitioners will contribute ongoing knowledge about organizational change and STEM educational transformation, connect DBER and learning sciences research, and engage in intersectional work across disciplines in service to continuous improvement in undergraduate STEM education.

How can this vision be achieved?

Achieving this vision requires more research and experimentation on how STEM learning is best achieved. Further research is needed in several areas: how to implement what the learning sciences and discipline-based education research are revealing about effective learning processes; how to design instruction and learning experiences that consider learners' individual circumstances, needs, identities, and motivations; new approaches to providing flexible pathways for learners; and how to use technological options to deepen and expand STEM learning. Related questions to explore in research and practice include: How can higher education more fully meet the needs of STEM learners from diverse backgrounds with diverse educational goals? How can faculty be encouraged to use what is known about evidence-based teaching practices? What curricula and delivery modes are most effective for strengthening STEM learning, and how can technology be used more effectively?

The vision also requires the development of innovative, potentially transformative, approaches to the relationships between higher education and the workplace, and between higher education leaders and other key stakeholders. Currently, employers lament the limitations in undergraduates' preparation. Advancing the vision will require creating mutually beneficial relationships between leaders in higher education and employers through which they collaborate to identify important learning outcomes, re-think existing course structures, create out-of-class experiences that link with other formal learning opportunities, and forge new pathways for preparing the STEM workforce. Additionally, achieving the vision requires focusing on the full system in which undergraduate STEM learning occurs, and explicitly involving multiple stakeholders such as higher education institutions, employers, government agencies, funding agencies, disciplinary societies, families, students, and faculty. Related questions to examine in research and practice include: How can better bridges be created between workplaces, communities, and higher education institutions? What are the interventions and tasks most needed at the national, institutional, and learning environment levels, and how can various stakeholders contribute?

We need to expand knowledge of how transformative, systemic change occurs and can be fostered.

Moving toward this vision would mean identifying and using multiple levers for change strategically across the multiple levels of the educational system and the broader society (e.g., classrooms, higher education institutions, professional societies, funding agencies). Specifically, we need to learn more about strategies for creating networks that involve and connect multiple stakeholders who can work collaboratively to achieve change goals; approaches to scaling innovation and change in higher education; metrics and measures for gathering feedback, assessing progress, and determining success within evolving contexts; and interventions that strengthen the perspectives and skills of change leaders across multiple stakeholders committed to the goal. Related questions to examine in research and practice include: What do leaders need to know and do? How can they learn to be more effective and strategic change agents?