Symposium on Imagining the Future of Undergraduate STEM Education
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Submitted stories from symposium participants on the topic of
Transforming the Student Learning Experience

Michelle Anderson
The University of Montana Western

In 2020, my niece Penny is 3 years old. She has been a digital native using multiple technology platforms since she began to walk and talk, but she also loves the beautiful multi-dimensionality of the natural world. She is, and I hope will continue to be, resilient and filled with joy. In 2040, I imagine she will be graduating from college and figuring out her place in a world with more people and more complex environmental and social challenges. I hope that her K-12 experience supported and was linked to her undergraduate one. I hope her first (but maybe not last) encounter with undergraduate education, whether it was a 1-year certification or a multi-year experience was one that empowered her and her peers in light of, not despite of her gender, ethnicity and cultural background. If she pursued a STEAM education, it was because her learning environment seeming structured in relevant and flexible ways to her as a holistic, compassionate person and provided a way forward to several careers, including ones she imagines but don't not yet exist. Her teachers were experiential facilitators rather than lecturer alone. She was not trapped in a single disciplinary silo or a set schedule in her education or existing in a community that lacked diversity, because the world doesn't work that way. She graduated with a portfolio of her work instead of exams she threw away. She isn't afraid of complex and multistage problems, because her entire life has been shaped by them and her education has provided tools and a pathway to learn and engage with these problems. She sees STEAM education as a way to make sense of her local and global community and her place in it, regardless of the rapid pace her life and world is and will continue to change.

Anonymous submission

Carlos, a Hispanic senior in high school was in the robotics team and is now eager to start his first semester of engineering school. One of the first courses is a robotics design course. As a freshman, Carlos does not have enough knowledge to build a robot on his own, but his instructor will know that. The class will build on Carlos' knowledge of robotics, his eagerness for the subject, his basic algebra, physics and calculus skills, and his programming. The instructor wants for him to realize he needs to understand better the dynamics of controls, and that he needs a little bit more math to program the robot controls to do what he wants it to do. Carlos will also not be evaluated in any knowledge that he could either find on the internet, or program into a computer. He will be evaluated by his eagerness to learn, the results obtained and Carlos will also be helped by a team. Teamwork is also fundamental in assessment of competencies.

Eric Brechner
Future learning experiences with AI, AR, and search
University of Washington Bothell

The engaging experience of self-discovery using AI, augmented reality (AR), and search guided by experts using handheld phones and tablets is already coming together today. Imagine a chemistry professor invites students to examine ordinary objects using AR to zoom down to the molecular level with simulations of bonds and interactions. A biology professor has students see through their own skin to watch internal processes in action. A civil engineering professor takes students on a field trip to a nearby overpass where students simulate load conditions and traffic. An astrophysics professor dims the lights as students peer into the night sky, zooming into star formations and colliding galaxies. In every case, students of all ages and backgrounds are encouraged to explore, ask questions, reveal the underlying mathematics, and code experiments to learn and discover.

We can enable and accelerate these future inclusive learning experiences by embracing AI and AR for education, integrating simulations of all kinds into these environments, and providing professors controls to guide students through their explorations. We have the foundation today to create the lifelong learners of tomorrow.

Melissa K. Demetrikopoulos
Chair, Division of Program Development and Assessment
Institute for Biomedical Philosophy

Whatever we do we should not lose sight of the idea that there are universal truths. While it is important, and even critical to consider perspective, it is also important to consider that there are shared and even universal truths. For example, most scientists would likely agree that there are forces between large objects such as planets that are separated by vast distances and forces between small objects such as electrons and protons that are separated by minuscule distances. The types and magnitudes of these forces are also largely agreed upon as universal truths. While we should remember that while the existence of these forces is nearly universally accepted as truth, perspective would be important for the understanding of these forces, to the experience with these forces, to the importance of these forces, and to values related to the forces. When we remove the idea that there are universal truths, we eliminate the structure and language necessary to communicate between disciplines, communities, and individuals because we have eliminated anything that can be understood using commonalities. Shared language provides a mechanism for communication and sharing of learning and facilitates breaking of silos between disciplines. There should be a balance between shared and individual meaning. Providing clear operational definitions and shared vocabulary that can be translated across languages allows for more inclusion and broadening participation. Within an expanded shared structure, there is room for perspective and individual meaning which will bring a richness of experiences to any endeavor. For example, recall the old analogy of the six blind people and the elephant. There is something that is actually an elephant. The first person feels its side and describes it as broad and flat like a wall, the second feels its tail and describes it as rope like, the third its ear and so on. They each bring their experience with the elephant (that shapes their perception of what an elephant is) to their explanation/report of the elephant. Nothing about this process changes what an elephant is. The underlying reality of the elephant is the same. They could choose to argue about what an elephant is due to their different individual experiences or they could understand that there is an underlying truth of the elephant and choose to work together and bring their individual experiences to bear in discovering this underlying truth. I hope that as we come to understand and value perspective and differential experiences that we do not eliminate the idea that we as a scientific community are searching for universal truths. By bringing more ideas/perspectives (more blind people in this case) to the table we have the possibility of getting incrementally closer to the underlying universal truth. This is the strength that we find in interdisciplinary and multidisciplinary research; each field brings its expertise and perspective to the collective in a way that expands the knowledge base of each discipline in a synergistic manner. The whole becomes greater than the parts because the whole is able to reveal more of the underlying truth. Therefore, it is critical to bring together various perspectives and diversity of thought when trying to discern the truth. In addition to the more commonly considered areas of diversity of thought that focus more on demographic factors, it is also important to consider diversity of thought that address alternative avenues of gaining knowledge outside of formal learning pathways. Self-taught learners, informal learning environments, community-based learning, citizen science, authentic learning in place, and authentic learning at work are some of the avenues for gaining knowledge that should be acknowledged in order to enrich our understanding.

Mateus Silva Figueiredo
Teacher
State of Minas Gerais, Brazil

Teachers and professors of STEM courses in 2040 are in constant process of learning how to engage with their students and value their ideas. They are paid to go on courses and events that discuss the problems with STEM education and STEM literacy in society in general, alongside with elementary and high school teachers, policy makers and people from other positions in society and their communities.

Students are also able to choose their paths inside university. Degrees still exist, mandatory courses for those degrees still exist, but there is more focus on what students individually want.

There are also a lot of project-based-learning projects, in which students from different majors identify problems from their communities, identify members of the community that can help define and solve that problem, and try to make a positive impact on the world around.

Students will also have appropriate time to focus on assignments, because actually learning takes more time than simply memorizing facts and them writing them down in assignments.

Carlos Gutierrez
Professor of Chemistry
California State University, Los Angeles

In 2040, education will be “on demand; need to know basis”, with enough experiences throughout the undergraduate period that both depth and breadth of learning will be accomplished. Learning will be heavily mediated by technology that will facilitate communication. Learning will require extreme student participation – those who know how to learn will be advantaged, those that don’t will be left behind. Equity is a metastable state that will require constant readjustment.

Bradley Hamman
Lecturer
Texas State University

To transform the student learning experience for the future of education. The system will need to be filled with diverse opinions and ideas from several different segments in the population. Departments, colleges and even universities will be dismantled. Students will interact with ideas and problems that will have local, national and international consequences, and will be thrust into roles to implement change in their communities and nations. They will interact with students abroad for multi-cultural aspects to problems and their solutions. Language will no longer be a barrier to development of multi-faceted work as technology will have developed far enough for everyone to understand the context of each individual in the group. Students will use collaborative technologies and learning techniques and becoming self-developing and promoting agencies. Students will teach each other through projects and interactions bringing together ideas from all walks of life. No matter their position in society they will discover they are agents of change and provide society with valuable and essential talents necessary to move society forward to a better future. They will realize that education is a life-long experience and does not stop once they move into the workforce. They will no longer earn degrees, but they will earn experience and gain self-actualization that will lead to prosperity for their communities.

Kai Jun (KJ)
PhD Candidate
Virginia Tech

Assessments, some argue, are instrumental in facilitating learning among students. While thinking about transforming learning experiences in STEM by the year 2040, I argue assessments should be part of the conversations. Although we have made strides in assessment research in STEM, more can be done to focus on improvement and innovating how we assess student learning toward improving student learning experiences. Diversifying assessment approaches in classrooms, I think, is key to this effort. For instance, many engineering instructors still tend to prefer exams or tests as the only form of assessments in concept heavy courses, even if research has shown that they are not helpful in promoting student conceptual understanding of materials and knowledge. I think tests are important, but diversifying and complementing tests with other assessments, such as portfolios, reflective-based activities, and collaborative assignments, can further enhance students' learning experiences.

Richard Kopec
Profesor & Program Director
St. Edward's University

Key themes for the future of STEM education are interdisciplinary, equitable, culturally sensitive.

The future the story we will tell about education is that it will focus on development of professional competence, personal integrity, and social development. Higher education is a rite of passage known as a college education is transitioning students from vague ideas of future careers and big picture ambitions to concrete pathways tailored specifically to each student's interest and abilities. But I also see education as a group endeavor, where students work cohesively and collaboratively in multidisciplinary groups solving problems that are meaningful to them.

This story highlights personal social development, personal professional development , and development of moral and ethical values as they manifest in their professional and personal lives.

Whatever we do, we should not lose sight of the fact that beyond technical competence and discipline-based knowledge, they are also forming a self-identity and identifying personal values. We need to foster that.

Arthur Lee
Chevron Fellow
Chevron Corporation

Future STEM education should be flexible and open, encouraging design and creativity. We should not forget that the fundamental knowledge of specific disciplines need to be well defined, and that interdisciplinary work does not obviate the need for fundamental domain knowledge. That is also the context in which future STEM students need to learn how to work in teams, in a collaborative manner to achieve specific goals.

Diego Navarro
Emeritus Professor & Founder / PI
Cabrillo College & Academy for College Excellence

Though this vision of a STEM education in 2040 fits within a spiral of ever deepening use and application of STEM and 21st century professional competencies while a STEM student is in college, I will focus on the first semester, a critical semester if we are to succeed in creating a robust pipeline of racially minoritized STEM students and professionals in 2040.

At the core of this vision is:

I. nurturing of college students from disadvantaged neighborhoods and substandard high school educational experiences to become the diverse STEM workforce the U.S. needs to maintain technological competitiveness,

II. transforming the trajectory of many families for generations to come by having their first family member succeed in becoming a successful STEM professional; as a STEM professional they will become an example to family and friends that shows a way out of poverty that is a guiding light to their children, nieces, nephews, grandchildren, aunts and uncles, and friends

III. addressing difficult societal problems with perspectives that are informed from their lived experience not just from reading.

To make sure that these students can make the transition effectively to college-level performance we must address the first semester of college, sometimes the first three weeks of college the most critical three weeks of a racially minoritized student's college life [(1.a) – see bibliography for references below].

In this vision of the first semester each student has the experience of:

1. Participating in an academic culture of dignity where they feel emotionally and psychologically safe.

1.1. We need to move beyond culling students the very first semester to supporting them to become the STEM professionals that they strive to become. We need to develop an educational pedagogy that helps these students transition their strengths in persistence and survival to the academic environment [(1.b) – see bibliography for references below].

1.2. There are several longitudinal academic and salary outcome studies (funded by the NSF, Gates Foundation, Hewlett Foundation, James Irvine Foundation and Joyce Foundation) that point the way, indicating that a high percentage of racially minoritized students from poverty can make this transition effectively if they are supported in a culture of dignity and where they feel psychological and emotional safety. These studies show that underprepared minority students from poverty can step up to the challenge of accelerated learning [(1.c) – see bibliography for references below].

1.3. The culture of dignity and belonging can be created rather quickly in 5 to 8 days with an immersion approach [(1.d) – see bibliography for references below]. This approach was first developed in 2003 and implemented with NSF ATE funding - NSF Award #0302913. We have a study of 769 students from six colleges which indicates that students improved in seven of eight psychological factors (e.g., academic self-efficacy, college identity, mindfulness, etc.) associated with academic success at a $p<.001$ level of significance after a 8-day immersion course. With the exception of two factors, the change remains consistent or improved four months later at the end of the semester [(1.c) – see bibliography for references below].

2. Students become fully engaged in a STEM learning environment when their life experiences are utilized, their STEM learning is contextualized, and their need for relevance are met by working in teams to address social justice issues that have affected their families, neighborhoods and communities.

2.1. Racially minoritized students from poverty have PhDs in social injustice. Their life experiences equip them with inherent knowledge to effectively formulate research questions and apply research methods when given proper guidance by STEM faculty. The following description was instantiated in an NSF-funded project, i.e., NSF Award #0802581.

2.2. Using a scientific method-oriented pedagogical process model in the first semester, students experienced intensive preparation in science and math, centered around a Project-Based Course which contextualizes and allows the student's to apply what they are learning in a just-in-time curriculum model. In the central Project-Based Course, students worked in self-managed teams to study and report on a significant current community issue (a theme) that requires substantial scientific and math literacy. One proposed theme, for example, is diabetes, which is present at high levels in Watsonville, CA; another possibility is saline intrusions of the local aquifer that supports the valley's agriculture. The Math and Science feeder courses, using a "just in time" method, provide the students with the math and science background needed to advance their progress toward understanding the content and methods of the project theme. (To understand the methodology used to develop this integrated just-in-time model see the American Association of Community College Pathways Webinar – A FRAMEWORK FOR PATHWAY COHERENCE: Meta-Major Design & Levels of Integration at https://www.pathwaysresources.org/webinars-events/)

2.3. The lecture and laboratory portions of these courses are thoroughly integrated into a system called "studio teaching". In order to maximize student attention and engagement, breaking each day's work into alternating segments of lecture and demonstration, followed by active hands-on lab exercises or computer simulations. These lab exercises may last from 15 to 50 minutes and are then followed by discussion of the results measured or observed by the class. Their results are then related to a scientific theory or law which explains how their data correspond to the model's prediction and puts these results in a larger context.

3. Students learn 21st century professional competencies in teams where they experience belonging and which supports their application of these competencies.

3.1. In an immersion course at the beginning of the first semester plus another class over the rest of that semester students learn 21st century professional competencies. They apply these competencies as they work in their Project-Based social justice research team. Students develop skills, build a sense of belonging and confidence to trust one another, and learn to communicate and become dependable because their team mate's need them for their success. The competencies described below in #3.2 are provided just-in-time to support the success of the social justice student research teams. This approach has been applied in the development of computer support specialists instantiated in NSF Award #0302913.

3.2. As background, in my 7 years of social science research in Hewlett Packard Labs where I studied professionals in a number of industries for which Hewlett Packard built products, I've found that on average 20% of professional competencies where highly technical, the other 80% encompass collaboration and other professional competencies. We've found in this NSF funded project the following 21st century professional competencies to be critical to project-based team success:

3.2.1. self-managing team methods;

3.2.2. communicating findings and solutions to relevant stakeholders;

3.2.3. collaborative leadership (listening, interacting, dealing with conflict);

3.2.4. self-discipline and professional hygiene (meeting deadlines, aligning action with commitments, prioritizing work, etc.)

3.2.5. marshalling action (project management, strategic planning, budgeting, product needs assessment, etc.)

3.2.6. product development approaches (requirements definition, user needs analysis, etc.), and
3.2.7. developing flexibility and dealing with increasing degrees of freedom and ambiguity.
3.3. In our sixteen years of teaching in this manner with 80% of the students from racially minoritized populations from colleges situated in urban, rural and suburban locations we've established evidence that these 21st century competencies can be taught effectively. We have longitudinal academic and salary outcome studies that indicate that these competencies can be effectively taught to underprepared racially minoritized students from poverty. We also have evidence which indicates that faculty can be taught to teach other faculty to effectively teach these competencies to students and get the same outcome effect as the original cohort of students [(1.e) – see bibliography for references below].
3.4. At the end of the semester research teams present their research and solutions in a public forum. Government officials attend these presentations because our students are gathering data from communities that UC Santa Cruz cannot obtain. For example, one team studied why youth join gangs; the team members were either former gang members or had family members in a gang; 75% of the survey respondents were gang members since these students went to gang parties to collect the data; since they were a part of the gang community they were accepted there. UC Santa Cruz does not have access to these communities. The public presentation becomes a rites of passage into the community of scholars and they receive recognition from their home community as college students too. Examples of presentations can be accessed at https://drive.google.com/drive/folders/1iuATL9hhYxXubtaWD7sj5NoOD1s0rdrM?usp=sharing.

Of course there are other things needed in the first semester as well as throughout the student's college experience. Student's will need proper guidance, curriculum modules that are engaging, assessment methods that take into consideration their life learning, an electronic portfolio to document their abilities and what they've learned, exposure to future career possibilities, work-based learning opportunities, etc.

1. BIBLIOGRAPHY (For ease, these referenced materials can be found at https://drive.google.com/drive/folders/187fI05rUMXWe41yz85Io2sZTeWDZviF-?usp=sharing):
a. Rethinking Entry to College – Rose Asera paper
b. Students of the Future, Change article
c. Summary of Evidence for Academy for College Excellence
d. Case Study of Academy for College Excellence.Research and Planning Group for the California Community Colleges
e. Faculty Training Evaluations, University of California Center for Justice, Tolerance & Equity

CJ McClelland
Teaching Associate Professor and Director of Grand Challenges Scholars
Colorado School of Mines

Imagine coming to school and declaring your mission instead of a major. Students will join supportive communities in which mentors help them choose a path of courses, experiences, and projects that will help them to build the skills, abilities, and mindsets they need to achieve their mission, including interdisciplinary competence, the ability to gather context and think in systems, an understanding of people and cultures on a global scale, experience solving problems and implementing solutions in the community, and using inquiry to follow personal curiosities. Faculty will run projects and create modules to help students learn fundamentals and integrate their learning. Various pathways through education will be grouped by theme, rather than discipline. Themes such as sustainability, joyful living, health, infrastructure. When students leave school they will have a collection of credentials, portfolios, and artifacts of their work in addition to a possible degree.

Jason Meyers
Assoc. Prof. of Biology and Neuroscience
Colgate University

The story I hope we can tell is how we orient students into the sciences at the beginning of their undergraduate career. Right now we funnel students into disciplinary-based courses with large textbooks, content-focus, and an emphasis on examinations. When we think about high value practice, many speakers and participants have talked about summer research experiences, and these are often highly integrative experiences, without textbooks, focused on curiosity and exploration, and with no grade at the end. It is time to tell the story about how the structures in place at the beginning of students' careers are limiting progress, limiting curiosity, and limiting who is allowed through into the sandbox. In the future, students become introduced to college-level science from broad curiosity-based approaches. They learn to use key elements from across disciplines in order to ask questions. They don't see organic chemistry as a chore, or statistics just as a keychain to try each one until something fits, but understand the connections in situ. They are not graded by exams and what they remember, but receive formative feedback that help them position their growth past, present and future.

Cordelia Ontiveros
Professor Emerita
California State Polytechnic University, Pomona

A key theme for the future of undergraduate STEM education: STEM Education that is socially and culturally aware, equitable, and inclusive.

In the future we will tell about education systems that offer multiple valid pathways for students to pursue STEM undergraduate education, that accept students where they are, and that accept and acknowledge that their experience is valid, relevant, and important.

This story highlights that students feel a sense of belonging and community, that they matter, and that they count as competent STEM students.

Whatever we do, we shouldn't lose sight of the idea that all of us will need to be flexible and adaptable to a changing world.

Jessica Parr
Associate Professor (Teaching) of Chemistry
University of Southern California

Key themes for the future of undergraduate STEM education are more providing a more active learning environment that motivates students to learn through their varied interests. In the future a story we tell about education is the revolutionary change that took place in attitudes toward learning, inclusion, and how students were allowed more ownership of their own learning experience. In order to achieve an excellent, equitable experience for all of our students we need to bridge the divide between the educational researchers and the practitioners who are teaching our students. We need to have greater collaboration between researchers who are pushing the boundaries and developing best practices and the faculty who are teaching the students. We need to make sure that conversations are facilitated that do not include huge amounts of jargon, but provide real solutions and strategies to implement the best practices in the classroom. Students need to be involved in these conversations, not simply as those we try these new strategies on, but as developers.

Xyanthine Parillon
Faculty; Founder
University of Houston-Downtown; Biomed Careers

Key themes for the future of undergraduate STEM education are creating a STEM workforce that has engaged in equality of access to experiential learning opportunities. In the future a story we will tell about education is that digital learning labs did not exist and they have transformed higher education where scientific approaches, problem based learning, has occurred that has boosted outcomes in higher education campuses.

This story highlights how the digital transformation increased credentials for community impact.

Whatever we do we shouldn't lose sight of systematic changes in organizational structure to support an interdisciplinary STEM workforce for the future of 2040.

Eliza Jane Reilly
Executive Director
National Center for Science and Civic Engagement

My vision for the future is to make some of the great innovative curricular reforms that are student centered and have been around for decades become a reality---PULSE, BioQuest, Summer Institutes for Scientific Teaching, POGIL etc have contributed some part of this vision. As have CUR, Campus Compact etc. For over twenty years our STEM reform project (SENCER) has supported faculty in both transforming their own teaching strategies and their student's experience of learning in STEM by linking civic engagement to science. The idea is to change the "story" of a course from say "GEN Bio" or "Chem 100" or "Intro to Environmental Science" to "Biomedical Issues of HIV-AIDS (now COVID-19)" or "Toxicity" (in water, household chemicals etc"), "Brownfield Action (cleaning up an urban brownfield)" or "Chemistry and Ethnicity" (exploration of uranium dumping on Navaho Land) These courses provide context for the STEM learning (which helps with retention) but also shows both the power and limit of science in solving these sticky problems, which address ethics, culture, race, history, policy—demonstrating that science never happens in a vacuum. These real world problem-based learning experiences are not only student centered, they are student driven, usually directly related to issues of strong relevance to students and their communities, and they are inevitably interdisciplinary. These topics INVITE students into the process of both science and civic agency, and very typically involve a hands on, community-based component. Our journal just published an issue with over 35 submissions on "teaching through COVID" showcasing how faculty pivoted to use COVID as a real world problem for teaching.

Erika Steele
Research Associate
The Institute for Social Science Research @The University of Alabama

The other day, my son told me that he hated science as he's watching videos about speculative biology. We argued a bit about how $E=mc^2$ is not science. It is a fact, in the same way that the chemical formula for water is H_2O is a fact. Science is all of the speculation and theorizing that you are hearing on your YouTube videos. In the future that I envision, People will not only view science as a set of logical and rational facts, but they will also recognize artistry and creativity it takes to make new discoveries in science. They will understand that scientific discoveries are about advancing society , improving people's lives, and coming up with new ways to be entertained. Currently, most people view the products of scientific knowledge as "science." They do not understand that science is a way of thinking and using knowledge. It starts with the way science is taught.

I envision a future where STEM professors are prepared to teach science in a way that students are prepared to use the content to solve real world problems. I think we have come a long way from the way science was taught in college when I was an undergraduate. There are more people embracing innovative teaching practices in the sciences than there were when I finished my PhD in Science Education in 2013. There is research that says students learn science better when we move from away from traditional teaching practices to more student centered practices, yet there is still resistance.

Students are resistant to innovative teaching methods because they do not see them as teaching, and they do not feel that they are learning. From my dissertation research, this happens when 1) they use problem-, service-, or project-based learning experiences without providing the students with enough feedback, guidance, or mentoring on how the work that they are doing is related to the subject they are there to learn about, and/or 1) professors do not change how they are assessing student learn. Students have the tendency to learn material that will be on the test, if developing science literacy skills are not being assessed and students are not being guided through how it is helping them learn as young scientists, they will resist. As long as students resist and rate innovative teaching practices lower than traditional courses, stakeholders will also be resistant to change. In the future I envision, professors will understand how to assess skills development by knowing how to create scoring rubrics, observation protocols, checklists and other tools necessary to evaluate skills development. When we can provide evidence to support this kind of learning, we will start to see these teaching methods being embraced and we can begin to transform the way science is taught.

With that said, we also have to realize that not all students come to colleges and universities with the same skills. While there are state and national education standards that are supposed to give students equal opportunities to learn science this does not happen for multiple reasons. Not even factoring in race and gender, the fact is that your zip code determines how you are exposed to science in K-12. It determines the opportunities that you are provided with in school. Some children go to public schools that can't provide enough textbooks for students while others go to science camp. In the future I envision, this does not happen. Whether we continue to emphasize facts, or we transform college science teaching to embrace more innovative teaching practices, we may miss a lot of students because we do not all come to the university on the same standing.

Alice Tarun
Assistant Prof
St. Lawrence University

I envision that there would be a shift away from content based learning to a more experiential-based learning that is student-centered and focused on problem or project-based learning. The students are taught the foundational concepts important for the field (e.g. Biology). But then be encouraged to apply and practice what they learned by participating in authentic research experiences in their courses, or through mentored individual internship programs. The students will be encouraged to identify and study global or relevant problems particularly wicked problems that are hard to solve. Relating what they learn to relevant and social issues/problems would empower and engage the students.

Meena Thiyagarajah
PhD Candidate
University of Florida

Key themes for the future of undergraduate STEM education are portfolio-based experiential learning based on real world scenarios that is predominantly applied leveraging STEM alliances both locally and globally.

Community engagement cultivates a holistic STEM learning ecosystem and are the nutrients that provide the immersive experience to create a native digital STEM lifelong learner. The skills of the future workforce as echoed by the many participants need agile thinkers that can utilize complex reasoning, apply creativity while still embodying the soft employ-ability skills that are highly desirable.

In the future a story we will tell about education is that it is highly personalized to suit the individual lifelong learner, higher education transcends borders through affordable micro-credentialing programs. Content is more relevant with examples that reflect the fabric of diverse society and real-world requirements. Students select stackable courses to layer their foundational knowledge to meet workforce needs (Just in Time approach). These programs should be adaptive to the STEM native's personal pursuit/passion. Suggestions from the new internet of things would utilize intelligent predictive analytics (the "Netflix of courses"). Design cognition by Nigel Cross that nudges STEM natives to be solution focused, creatively conceptualize, embrace shifts in modality would have already been explored prior to embarking on undergraduate studies.

The role of the Mentor and Mentee will likely be AI based coupled with subject matter experts. Media such as advanced Augmented reality examples will be suggested to complement learning by the AI mentor and will solidify STEM Identities. The multi skilled lifelong learner can up-skill and re-skill easily due to this shift of learning associated with ease of switching between cognitive abilities. Equity focused education would be second nature since this is inculcated in foundational courses from Pre K onward.

Whatever we do we should not lose sight of our humanity and social and ethical considerations should always be checked.

Huyen Thi Minh Van
Postdoctoral research associate
Texas A&M University and Foreign Trade University

Key themes for the future of undergraduate STEM education are Career trajectory of STEM students and the role of technology in students' learning experience.
In the future a story we will tell about education is student learning should be more experiential, active, and reflective of the society changes. We will proceed with a modular training on entrepreneurship competence based on a randomized controlled trial design. We hypothesize that after the training, STEM undergraduate students participating in the treatment group display significantly more accuracy in recognizing opportunity than before the training and better than the control group. This story highlights the interactive role of the students in the learning process. Whatever we do, we should not lose sight of the needs of the future STEM students.

Gabriela C Weaver
Professor of Chemistry
University of Massachusetts, Amherst

Next week I'll be getting my college degree! I'm an immigrant and my parents never attended college. But I've known since middle school that I could attend college because it is a matter of being interested – and there is no cost to me or my family. I did some of my college classes online while I was in high school. Then I attended my local community college for a year because my mom was sick and I needed to be home to take care of her. But I also took some more courses online. During that first summer I participated in a research experience program that allowed me to work in my community, and also counted for college credit.

The learning experiences that I've engaged in are all part of my online portfolio. When I decided to begin attending a university, I picked up my learning right where my portfolio left off at that point. I've had project-based courses, small-group courses, and service-learning projects in the community. Every summer I had the opportunity to do an internship in a different industry to find out what type of work I'd like to do. Through it all, I've been able to stay connected with a cohort of my fellow students with shared interests and experiences. I can't wait to get into the workforce and start contributing! And the best part is that I know I'll be able to keep building my portfolio as I gain new and different skills through the years.

Michelle Withers
Associate Professor
Binghamton University

Key themes for the future of undergraduate STEM education are:
Equitable instructional programs made up of a scaffolded series of authentic, diverse, interdisciplinary, project-based experiences focused on authentic problems that promote student interest and relevance, develop students as whole-people who value civic engagement and contribution, supported by asynchronous personalized/AI structures that aid in acquiring knowledge/understanding that is applied to their project-based experiences; evaluation that is exam-less, ungraded, and a portfolio-based accumulation of evidence of learning, skills and competencies that become the students "transcript" future progression.

In the future a story we will tell about education is how much: the Covid pandemic lit the fires of urgency that drove change at an unprecedented rate that allowed for the realization of visions that 20 years ago seemed impossible.

Whatever we do, we shouldn’t lose sight of: relevancy, equity, authenticity, joy, wonder, discovery and STEM for the greater good.

Yevgeniya Zastavker
Professor of Physics and Education
Olin College of Engineering

I would like to see the world in which our students are treated as whole beings, with all of their ways of knowing and being. The world, in which their wisdom traditions, cultures, first language, etc. are embraced and not negated. I would like to see the world in which both objective and subjective ways of knowing are celebrated and where there are no dualities between Eastern and Western ways of knowing, or masculine and feminine knowledge structures. It is the world in which curiosity is celebrated, wonderment is practiced, and moments of awe are thought after. What if we come together to wonder together? What if we learn from each other in all of our wholeness? What if we see (into) each other in all of our curiosities? What world could this be? Would we see beyond the color? Would we see beyond race? Would we see beyond gender? Would we learn beyond heteropatriarchal norms we have been conditioned to see the world in? Would we hear beyond biases that the dichotomy of abled vs. disabled bodies provides? Would we know the Other in a way that allows for otheredness to be the construct of the past and rather Other would be learned about to be embraced and integrated into Self? How would that world look? How would it be like to learn in that kind of world and in the learning environments that provide those kinds of embracing environments?