Image courtesy of Engineers Without Borders

Sustainable Education

Readying Today's Higher Ed Students to Tackle the World's Grand Challenges

An ABET Issue Brief
Fall 2018

SUMMARY: Advancing sustainable solutions to the world's most pressing environmental challenges will take more than technical skills. Students of higher education, especially those in STEM fields, need diverse and global perspectives to understand—and address—long standing problems in new ways.

A MESSAGE FROM ABET'S CEO

Earlier this year at our annual Symposium, leaders from the STEM community convened to discuss the role of higher education programs in an increasingly global world. We examined our role in ensuring that today's college students are prepared to develop solutions that make life on our planet safer and more sustainable. We explored issues of population growth, climate change and the depletion of natural resources, and we agreed on the value of sustainable design solutions. As we discussed, the environmental challenges of today's world are not isolated to one continent or community. They affect all people and all countries, from the poorest to the richest.

Through our discussions, a common theme emerged: Global experiences for STEM students, and the resulting diversity and cultural perspectives they gain, are critical to future solutions in sustainability.

For instance, most engineers can develop sound designs that meet necessary technical requirements, and that can be marketed to those who fit its target audience. But technically-sound and well-marketed does not ensure sustainability. What good are mass market electric cars, for example, if the increased demand for lithium and other rare metals also depletes already limited water supplies, contaminates crops and destroys fragile ecosystems?

The STEM leaders of tomorrow can't solve one problem while creating another. They must think through the process holistically while also considering global impacts and cultural sensitivities.

Kevin Huggins speaks at an ABET workshop.

This ABET Issue Brief takes a deeper dive into programs that infuse humanities studies and first-hand experiences into their STEM programs with the goal of creating global citizens, poised to address the world's greatest sustainability challenges.

"For our students to be ready and equipped to identify, address, and help solve the issues of today's world, they need a global perspective to streamline and coordinate solutions."
Kevin Huggins

The role of global perspectives in STEM education

In 2000, the United Nations launched the Millennium Development Goals to improve the quality of life in emerging countries. Although the goals were promising, there lacked a comprehensive structure that worked across country lines, political ideologies and industry sectors. And so, in 2015, the Sustainable Development Goals were instated to call for collective impact and buy-in to solve the world's most complex issues.

Today, the focus is on sustainable development, defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] But, sustainable development doesn't simply happen. Sustainable development must be learned through real life experiences, as Kevin Huggins, ABET IDEAL Scholar and Professor of Computer Science and Analytics, learned first-hand while teaching at the United States Military Academy:

According to Huggins, "Language is a doorway into other cultures. Once a person can embed inside another culture, it's easier to understand why certain design decisions were made, what we can learn from them, and how we can pull from them in designing our own engineering solutions."

One way to build more globally-aware students is to "learn a foreign language," said Huggins. "Having a greater sense of how other people connect can help to sensitize our students to the challenges facing our world."

Although the need for sustainable development is well known, limited access to global perspectives can equally limit the impact that one person, one corporation, or one country can have.

Yvette E. Pearson, Associate Dean for Accreditation, Assessment, and Strategic Initiatives in the George R. Brown School of Engineering at Rice University agrees. "As engineers, we must challenge ourselves to bring greater attention to our role in helping to fulfill some of the not so obvious engineering-related

Image courtesy of Engineers Without Borders

sustainability goals, like zero poverty, zero hunger, quality education, and gender equality. STEM graduates must be ready to address the Sustainable Development Goals that don't as naturally have a connection back to engineering, in their own language through their unique experiences."

Teaching diverse solutions

In higher education, we expose students to a healthy exchange of ideas with their classmates and professors. This promotes the formation of a global perspective: the awareness that there is a wealth of knowledge and backgrounds that are valuable and integral to the design and implementation of solutions.

As environmental and sustainable challenges continue to grow, there has never been a more critical time to broaden student perspectives beyond university campuses. All students can benefit from increased cultural sensitivities and awareness, which can then make them more empathetic designers. Equally as important is helping students understand that the best, or most sustainable, solution isn't always the most technical.

This concept is well represented through the work of Engineers Without Borders (EWB), whose mission is to "[build] a better world through engineering projects that empower communities to meet their basic human needs and equip leaders to solve the world's most pressing challenges." At EWB, all requests come from the communities themselves. Chapters compete for projects in a bid-like process, and once a project is won, it's often the start of a long-term relationship in that community.

Central to their success, said Cathy Leslie, EWB Executive Director, "is an emphasis on mentors with practical experience who challenge students to consider cultural and social factors in the local areas.

"It's important to have local professionals, outside of the academic world, who can recognize the local capacity of the community. One well-meaning engineering firm trying to help, for example, could inadvertently end up taking away local jobs."

Sustainable design isn't about being novel or innovative. It's about being human, first.

"Novel makes me think of innovation, but we don't always fully appreciate indigenous solutions," Leslie said. "A lot of people go into a community thinking innovative solutions are the answer. More often, however, a community needs help building capacity to solve their own problems. That's what makes for a truly sustainable and respectful solution, and it's that kind of sustainability that we need to further develop."

As an example, Leslie cited a project in Dominica focused on post-recovery work following a Category 5 hurricane. "When we first arrived, we realized that nobody was talking to local engineers and contractors. Instead, they determined where the local people needed their assistance without their input—plus they were requesting 100 engineers from our organization to help build capacity," she said. "So, we spoke to the locals and, after our conversation, brought in trainers and a few engineers to help them build their capacity so they could build their own solution instead of importing engineers."

Leslie also talked about the importance of finding opportunities with similar needs and impacts in the U.S. In 2014, EWB launched a program called Community Engineering Corp which works with U.S.-based community associations, nonprofits, and municipalities in both rural and urban areas. Under this program, students learn the importance of understanding local capacity and need without leaving the country.

"Engineers Without Borders aims to develop engineering professionals who are technicians, just as much as they are advocates," added Leslie.

What's working

In equipping students to be successful, higher education programs must create resources that foster empathy, build advocates and challenge structures. These resources shouldn't stop at the classroom, but rather extend into extracurricular activities so they become a normal way of operating, as shown in the three examples below.

Image courtesy of USD

PROGRAM IN ACTION #1:
The Student-Led Perspective
University of San Diego, California (USD)

Students at the University of San Diego (USD) in California have used a human-centered approach in applying the lessons they've learned in STEM lectures to global problem-solving, particularly at the Shiley-Marcos School of Engineering.

One such initiative is "Mobility, Opportunity, Versatility, Empowerment" (M.O.V.E.) and its precursor, "Simple Seat, Better Lives." Both are student-led and focus on building and delivering portable latrine assistive devices for landmine survivors and persons with disabilities in Uganda. The inspiration for the initiatives was the story and work of Margaret Orech. Orech became an advocate for persons with disabilities after being exposed to their challenges when she was injured in a landmine explosion. Orech founded the Uganda Landmine Survivors Association to help alleviate the financial and physical hardships that those with disabilities face. One of those challenges is using the bathroom, which requires the assistance of another person purchasing an expensive latrine aid device, or open defecation. All these options have major social, economic, or health related disadvantages and are not efficient solutions.

After speaking at USD in 2014 and requesting solutions, Orech was contacted by a team of engineers at the university. Project lead Mei-Li Hey and a team of students began to design and prototype affordable assistive devices that could provide a resolution and "Simple Seat, Better Lives" was born. Three years later, with much progress and an expanded project focus, the initiative has become M.O.V.E. Central to the project's mission is cultural sensitivity. The design process is informed by Ugandans to ensure that the devices take both social considerations and sustainability into account. Students learn about materials that can be locally-sourced and they work with a vocational school to teach local Ugandans how to make the devices.

Transitioning away from a singular focus on design posed a learning curve for students. However, M.O.V.E team leader Kathryn Forsythe believes that a combination of faculty support and receptive students ensured success. Based on her experience, she said that, "students have to be ready to ask people what they need instead of assuming. It's easy to get into the mindset of 'we know what's best for you,' and that is so dangerous."

Forsythe's sentiment—that STEM professionals tend to create designs that don't always include the context of where they will be implemented and by whom—was echoed across different programs and universities. By leaving out aspects of the user experience, such as the environment and social or cultural norms, engineers limit the populations they can reach and the problems they can solve.

Image courtesy of USD

PROGRAM IN ACTION #2:
The Faculty-Led Perspective
University of Illinois at Urbana-Champaign (UIUC)

Jenny Amos is a teaching associate professor for bioengineering at the University of Illinois at Urbana-Champaign (UIUC). With a research background that spans across both STEM disciplines and humanities, Amos advocates that incorporating experiential learning into classrooms is central to facilitating an impactful learning experience. Through a department-wide grant from the National Science Foundation, external funding from VentureWell, and a university partnership with Njala University in Sierra Leone, Amos has been able to position experiential learning as fundamental to her ENG 298 class.

Jenny Amos (center, kneeling) with students in Sierra Leone.

ENG 298, the course code for Introduction to Sustainable Engineering, is an online course that teaches international design standards as well as the role that ethical, social, and political relationships play in STEM professions. Students in the class gain exposure to different design settings, imparting on them the value of processes like utilizing locally-sourced materials and seeking community and stakeholder engagement—but most importantly, "they learn how to understand need," said Amos.

"I take my students on a walking tour of a state-of-the-art hospital in the United States, a walking tour of a free clinic in the United States, and then a virtual tour of a clinic in Sierra Leone," Amos continued.

> **"When I first ask them to identify the needs of the clinic in Sierra Leone, they typically try to apply the systems and technology of the hospital to the clinic—the clinic needs an ultrasound, for example. Then, I encourage them to try again with a human-centered approach. Students begin to think about the context of the clinic and its environment. It is transformative for them, they are focusing on the need with context and are better able to understand how they can help. It makes them be culturally responsive instead of imposing their own beliefs."**

While very few students travel with Amos to Sierra Leone, all students learn the same lessons via the virtual tour and other footage she gathers during her research trips. Amos acknowledges that funding for student and faculty international travel can be difficult, citing groups like VentureWell as vital to the success of her program.

This dynamic component to the course was created with input from Kenny Long, now a joint M.D./Ph.D. student at the University of Illinois College of Medicine. Long helped coordinate the overlap between the Sierra Leone project and the wider global health certificate program. Together, Long, Amos, and other colleagues developed the program's objectives after students voiced interest in global health topics that were unavailable at UIUC. Long said his involvement was partly attributed to the fact that he was developing courses that he wishes he had exposure to as an undergraduate.

Today, more than 100 students have taken ENG 298 and five have been to Sierra Leone.

According to Amos, experiential learning opportunities—whether an immersive, on-the-ground experience or a virtual one—provide students with the invaluable lesson of being culturally responsive and understanding need-based design. As she proves with ENG 298, lessons about human-centered approaches to design do not necessarily require international travel. Many can be found in both urban and rural settings stateside, or through virtual opportunities. "Sometimes, a field trip to a local clinic can be just as powerful as a trip abroad."

Image courtesy of Tecnológico de Monterrey

PROGRAM IN ACTION #3:
Cultivating Global Citizens through Social Service

Tecnológico de Monterrey (Tec)

The National School of Engineering and Sciences at Tecnológico de Monterrey (Tec), a university with 26 campuses across Mexico, is using the country's mandatory service requirement for undergraduate students to cultivate an interest in social innovation at home and abroad.

"It is important for students to understand how what they do here and now will affect the rest of the world," said Jaime Bonilla-Ríos, associate dean for International Affairs of the National School of Engineering and Sciences at Tec. "If we don't properly manage water or garbage locally, for example, the challenges will eventually affect everyone everywhere."

Tec's vision is to form leaders with an entrepreneurial spirit, human sense, and global perspective. Therefore, there is a need to fulfill each of these adjectives with specific actions. One of the ways Tec does this is by taking advantage of Mexico's mandatory 480 hours of social community service (SCS). Higher education students must comply with the SCS requirement before graduation.

Tec saw an opportunity to embed the SCS into an academic experience to develop competencies in the students. In doing so, Tec is helping students serve their communities in meaningful ways, not just "painting walls" but to really apply their knowledge and creativity in helping people and communities take care of their own destiny in a sustainable way.

The SCS activities range from advising on line high schoolers to create computer literacy programs in elementary schools; to fund raising campaigns to build houses for people owning a piece of land but lacking money for the construction; to creating water cleaning artifacts to teach the communities on how to take care of turtles to create an appropriate ecotourism offer; among others.

The interaction with communities helps students be more sensitive and have greater awareness of the needs of less fortunate people. This awareness, together with the compulsory course Climate Change and Energy Use for all engineering majors, creates new social competencies. By putting their newfound skills to work students can become successful STEM professionals.

Furthermore, this program benefits teachers just as much as students. Tec also challenges its educators to strengthen core competencies in the areas of citizenship, ethics, and sustainability by requiring them to complete 40 hours of training and professional development each semester. What educators learn from this training is used to create new courses, devise new course materials, and implement new learning experiences that help students become effective agents of sustainable change.

As with other universities, Tec also offers an exchange program that allows 60 percent of its student body to gain international experience. "Each year, 4,500 international students come to Tec and 7,000 Tec students leave to study abroad," said Bonilla-Rios. "This exchange helps transform the way students see the world and allows them to develop the emotional intelligence and global perspective needed to work collaboratively on big problems with diverse STEM professionals."

Recommendations to scale best practices

In conducting research for this brief, the following considerations emerged for leaders of higher education STEM programs:

1. **Be intentional in the integration of global issues and differing cultural factors**
   Finding sustainable solutions to complex issues require STEM professionals who are well-versed in, and sensitive to, global issues and differing cultural factors. Students must understand how their solutions affect the community but also how they can involve that community in the design process. STEM program leaders should examine how they can provide opportunities for students to see solutions from vastly different perspectives.
2. **Create opportunities for students to connect the traditional, the unexpected and the exceptional**
   Some of the most powerful moments in teaching sustainability occur outside of the classroom or through virtual encounters. As found in our research, it was in these moments that students began to understand how good design, applied in new and unexpected ways, can lead to greater impact.
3. **Keep students at the center when shaping educational experiences**
   Rather than seeing students as the ones primarily doing the listening, consider engaging them earlier in the development of curriculum. Determine what they need, and then solve for it, as the best user-centered design solutions do.
4. **Allow the educational experience to bleed into professional experiences, and vice versa**
   Aligning curriculum with diverse opportunities to help solve for real-world problems can accelerate a student's ability to think through a globally-aware and sustainable lens. Consider opportunities to align with unexpected partners in businesses and the social sector who may have opportunities for students to apply their user-centered design skills.
5. **Prioritize immersive experiences that reinforce diverse thinking, but don't underestimate the need to have a diverse classroom from the start**
   Diversity—of thought, pedagogy, cultures, background, and experiences—is essential to giving students the global perspective they'll need to lead the world toward a more sustainable future. Those global perspectives and cultural sensitivities, while they can be learned through immersive or virtual experiences, can also be learned right in the classroom if diverse perspectives are present from the start.

Closing

At ABET, we appreciate and understand the importance of better design; it is imperative to building a better world. Therefore, ABET accreditation focuses on what students learn to ensure graduates are prepared to enter and succeed in the diverse and ever-changing global workforce. STEM programs viewed through a lens of global learning report direct improvements in their ability to increase enrollment, improve retention, and develop more thoughtful and prepared graduates.

Today, STEM education must be far more innovative than ever before. It must remove disciplinary borders, be grounded in collaboration, informed by business, and, at its core, be customizable and flexible to the changing world around us. For our part, we listen intently and work hard to meet those challenges—continuously supporting the evolution of STEM education. Our own commitment to innovation and continuous improvement requires nothing less.

About ABET

ABET is a forward-thinking, purpose-driven federation comprised of 36 professional and technical member societies. We accredit college and university programs in the areas of applied and natural science, computing, engineering, and engineering technology at the associate's, bachelor's, and master's degree levels. Based in Baltimore, our reach is global, and we have over 4,000 programs in 32 countries. We accredit programs, not institutions. As a specialized accreditor, we provide accreditation for post-secondary programs within degree-granting institutions already recognized by national or regional institutional accreditation agencies or national education authorities worldwide. Our accreditation is voluntary. With ABET accreditation, students, employers and the society we serve can be confident that a program meets the quality standards that produce graduates prepared to enter a global workforce.

Acknowledgments

ABET wishes to thank all of those who contributed to the development of this issue brief, including:

Yvette E. Pearson, Associate Dean for Accreditation, Assessment, and Strategic Initiatives in the George R. Brown School of Engineering, Rice University

Renetta Tull, Associate Vice Provost for Graduate Student Development and Postdoctoral Affairs, University of Maryland, Baltimore Campus

Kevin Huggins, Professor of Computer Science and Analytics, Harrisburg University

Jenny Amos, Teaching Associate Professor, University of Illinois at Urbana-Champaign

Elizabeth Voss Woodburn, Student, University of Illinois at Urbana-Champaign

Mei-Li Hey, Student, University of San Diego, Simple Seats, Better Lives

Kathryn Forsythe, Student, University of San Diego, M.O.V.E.

Cathy Leslie, Executive Director, Engineers Without Borders USA

Jaime Bonilla Ríos, Dean, School of Engineering and Information Technologies, Tecnológico de Monterrey

Kenneth Long, M.D./Ph.D. Fellow, University of Illinois at Urbana-Champaign

Notes

[1]World Commission on Environment and Development, Our Common Future (*"Brundtland Report"*), (Oxford: Oxford University Press, 1987), 44, http://www.un-documents.net/our-common-future.pdf.

415 North Charles St
Baltimore, MD 21201
www.abet.org