The University of South Florida (USF) offers degree programs that aim to develop a workforce of globally competent engineers and scientists who possess a “global” suite of skills and competencies.
The 21st century has brought many stressors to the management of air, water, and land resources and associated critical infrastructures that support societal, economic, and environmental well-being. Some of these stressors include rapid local- and global-scale changes occurring in population growth, urbanization, pollutant releases, affluence, and climate. In many locations of the world, rapid urbanization is outpacing the provision of public services, and many low- and middle-income economies continue to grow at a rapid pace. These countries also have a disproportionately larger percent of their population impacted by a lack of access to clean air and safe water; urbanization is believed to contribute to this widening gap.

To address these and other complex challenges, support the 2030 Agenda for Sustainable Development, and meet the 17 Sustainable Development Goals, the question arises, are environmental educators developing a workforce of “globally competent” engineers who possess a suite of skills and competencies, such as the ability to integrate culture, perception, and behavior with advances in science and technology? In this article, we define global competency and then discuss two programs offered at the University of South Florida (USF) to develop such a workforce. One of our goals as educators and researchers is to develop a workforce of globally competent engineers and scientists who possess a “global” suite of skills and competencies, such as the ability to “integrate culture, perception, and behavior with advances in science and technology.”

What is Global Competency?

Global competency has been described as “the ability to understand and work effectively with engineers and other co-workers who are raised, educated, and living in countries other than their own and who solve and define problems differently than oneself.” This definition builds on recommendations made by the National Research Council and National Academy of Engineering that students be educated to develop their global competency. Specifically, the National Research Council states students should have the following four skills:

1. language and cultural skills;
2. teamwork and group dynamics skills;
3. knowledge of the business and engineering cultures of counterpart countries; and
4. knowledge of international variations in education and practice.

There is also literature describing the importance of international experiences in the development of global competency (e.g., Shen et al.). A significant number of international students now study engineering and science in the United States, however, only a small percentage of U.S. engineering students do any type of for-credit learning abroad. Further complicating the development of global competency is the fact that only 3 percent of U.S. students study abroad for an academic or calendar year; in fact, the Institute of International Education (https://www.iie.org/) reports that 63 percent of all U.S. students who study abroad only travel internationally for a short term (i.e., fewer than 8 weeks).

**International Development Engineering Program**

The International Development Engineering program emphasizes training in global competency, principles of humanitarian and development engineering, stakeholder informed problem solving, and sustainable development, and provides advanced education with a two-year international training and work experience prior to entering practice. This program provides skills identified by the Council of Graduate Schools to be lacking in many graduate degree recipients (e.g., working in a team environment, project management, delivering outcomes on budget, and the ability to discuss technical issues with nontechnical individuals).

To date, we have graduated more than 120 students (master’s and doctoral) in this program who majored in environmental, civil, and mechanical engineering. After graduation, students return to the United States to work for industry, consulting firms, local, state, and federal government, and some work overseas for small and large international development actors, such as U.S. Agency for International Development (USAID), Oxfam, CARE, Catholic Relief Services (CRS), United Nations Refugee Agency (UNHCR), and United Nations International Children’s Emergency Fund (UNICEF).

Before starting their international experience, students complete course requirements that include some that are specific to their major and three other courses on application of appropriate technology to environmental and health problems, assessment of global health, and application of anthropology to engage stakeholders and assess behavior change for technological innovation.

Our largest partner is the U.S. Peace Corps, though we have also placed students with international nongovernment organizations. Students have worked in every region of the world in over 24 low- and middle-income countries. In the case of the U.S. Peace Corps, students typically serve in an environmental or health sector and receive travel and in country financial, health, and safety support. A small stipend is provided after completion of service that assists in transition of returning to the United States to complete thesis requirements and seek employment.

The U.S. Peace Corps provides training in language and teamwork, cultural considerations, stakeholder engagement, and appropriate technology that is followed by at least six
semesters (two years) of overseas service. During this time, students typically learn one or more languages and develop a thesis topic and conduct research with guidance from a team of faculty and in-country partners. After completion of service, students return to campus to complete their thesis based on an aspect of their overseas experiences. Table 1 provides examples of how students integrate their service and required research.

### Utility-University Caribbean Partnership

The majority of the Small Islands Developing States (SIDS) of the Caribbean are characterized as upper middle or high income, and therefore do not qualify for supported research programs like the USAID Partnerships for Enhanced Engagement in Research. Their small size, isolation, climate vulnerability, and water scarcity, coupled with low investment in science technology, engineering, and mathematics, absence of engineering programs in many nations, and access to climate adaptation financing, present opportunities to build meaningful partnerships to address environmental needs. Connecting the needs of a utility with graduate training and research provides win-win situations for the utility that has limited budget and staff time and for the graduate students who wish to develop their global competency.

One example of this type of collaboration is with the Barbados Water Authority (BWA), a statutory body mandated to provide safe, reliable, and sustainable water and wastewater services to its customers. We initiated our partnership with four environmental engineering doctoral students who participated in a 10-day field experience co-taught by an environmental engineering faculty member and a management studies faculty from the University of the West Indies (UWI), Cavehill campus. Students developed a business plan for a pilot resource recovery system at the BWA. That initial connection led to increased collaboration between the three entities and in 2015, they began to develop a larger proposal to the Green Climate Fund (GCF), a new international funding source that provides loans and grants to eligible countries to implement projects that mitigate or/and adapt to climate change.

In March 2018, the GCF approved a US$47.5 million project titled, “Water Sector Resilience Nexus for Sustainability in Barbados” to the Caribbean Community Climate Change Center with the BWA as the executing agency and USF and

### Table 1. Example of in-country student activities and associated research topics for required research that generates new knowledge and contributes to students’ global competency.

<table>
<thead>
<tr>
<th>In-Country Activities of Students</th>
<th>Student Research</th>
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<tbody>
<tr>
<td>design and construct fuel efficient cookstoves to decrease exposure to indoor air pollution</td>
<td>design a cookstove with local materials and assess it for its cultural appropriateness and environmental sustainability</td>
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<tr>
<td>improve waste management</td>
<td>analyze material flows to improve solid waste management, and assess waste reduction strategies to improve household waste management</td>
</tr>
<tr>
<td>design and construct composting and urine diverting latrines and urine recovery technology to support small-scale farming</td>
<td>assess pathogen fate during field operation of composting toilets, develop technologies for urine recovery during on-site sanitation, evaluate user perceptions of eco-sanitation technologies and the use of recovered resources</td>
</tr>
<tr>
<td>design and construct small scale tubular anaerobic digesters for collecting energy from waste</td>
<td>assess pathogen fate in small scale digesters and whether household fuel demand matches methane production</td>
</tr>
<tr>
<td>build resilience to climatic natural disasters into livelihoods and a utility water sector</td>
<td>perform stakeholder and gender analyses for water infrastructures, assess potential of using reclaimed wastewater to support nutrient management and economic activity</td>
</tr>
<tr>
<td>design and construct gravity flow water supply systems</td>
<td>develop a decision support tool to determine proper size and placement of flow reducers in the distribution system, assess new technologies for disinfecting community water systems, and assess sustainability of community managed water systems</td>
</tr>
<tr>
<td>drill wells, add and maintain pumping and rainwater harvesting, treat water at the household level</td>
<td>compare energy expended by different users and economics of adopting different types of pumps for their ability to meet household water demands</td>
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Environmental Education that Enhances the Global Competency by James R. Mihelcic and Maya A. Trotz
UWI as university partners. The project is intended to shift production and distribution of water away from energy provided by fossil fuel combustion to renewable and cleaner energy, and transform silo’d institutions to utility/university/community/private sector partnerships that exchange knowledge, promote stakeholder engagement, mainstream gender, build a future workforce, and foster entrepreneurship opportunities.

The GCF application process requires the completion of stakeholder analyses and gender analyses, both topics that are becoming increasingly important with international entities like the World Bank, InterAmerican Development Bank, and USAID. These types of studies also align with components of ENVISION, a sustainable infrastructure certification program endorsed by the American Society of Civil Engineers (which is now taught at USF and other universities).

Graduate students have traveled to Barbados to conduct research, including the stakeholder and gender analyses used in the proposal (e.g., Isaacs3). The approved project includes funds for capacity development for water sector resilience in Barbados and student internship programs at the BWA. Lastly, a new National Science Foundation (NSF)-funded National Research Traineeship grant that USF leads is building on this collaboration and will support U.S. graduate student training on community engagement and systems thinking approaches to solve problems at the water, energy, and food nexus, with the BWA and other Caribbean partners.

Conclusion
The multipronged approach to building global competency at USF covers student experiences in extremely economically challenged communities without access to clean air, improved sanitation, shelter, and safe drinking water to working with decision-makers on future country-wide projects for water security. Collectively, they have a wealth of knowledge that can be plugged back into courses, in-class discussions, and mentoring. We are currently considering ways to capture this through videos and blogs to share widely for others to use and learn about international engineering culture.

Creation of demonstration pilots as community spaces to address complex challenges are currently being discussed for convergence research and broadening participation. Doing this in international settings would be a paradigm shift for the environmental sector for which student programs like those presented here, would contribute to and benefit from.

Learn more about USF programs online at http://cee.eng.usf.edu/peacecorps/ and http://www.strongcoasts.org/

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