



Global Engineering Perspectives Scholars Program (Work in Progress)

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Margot Vigeant is a professor of chemical engineering at Bucknell University. She earned her B.S. in chemical engineering from Cornell University, and her M.S. and Ph.D., also in chemical engineering, from the University of Virginia. Her primary research focus is on engineering pedagogy at the undergraduate level. She is particularly interested in the teaching and learning of concepts related to thermodynamics. She is also interested in active, collaborative, and problem-based learning, and in the ways hands-on activities such as making, technology, and games can be used to improve student engagement.

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Deborah is an Assistant Professor in the Civil & Environmental Engineering Department at Bucknell University. Her teaching and research focus on sustainable production of biofuels and bioproducts. She and her students use laboratory studies and modeling techniques—such as life cycle assessment—to develop and improve the environmental performance of resource recovery from wastewater and multi-product biorefineries.

Dr. Craig Beal, Bucknell University

Craig E. Beal earned a B.S. in Mechanical Engineering from Bucknell University in 2005 and M.S. and Ph.D. degrees in Mechanical Engineering at Stanford University in 2007 and 2011. Dr. Beal is an Assistant Professor of Mechanical Engineering at Bucknell University and was the Jane W. Griffith Faculty Fellow from 2012-2015.

Dr. Beal's teaching interests include system dynamics and control, mechanical design, mechatronics and robotics, and first year introductory engineering. His research is focused on the application of control systems to vehicle dynamics to improve safety, stability, and performance of vehicles on roads with uncertain friction conditions. Current research projects include identification of road surface conditions from onboard measurements and approaches to maintaining stability during sudden changes in road condition.

Dr. Amal Kabalan, Bucknell University

Dr. Kabalan studied properties of semiconducting materials for photovoltaics applications at Harvard University. She completed her dissertation at Villanova University where she worked on the application of superlattice structures in solar cells. Her research focuses on integrating nanotechnology structures in electronic devices. Currently she is working on improving the efficiency of ZnTe/ZnO solar cells.

She is also interested in humanitarian technology. She is working on developing solar backpacks for students who lack access to electric power around the world.

Outside the lab and the classroom, Dr. Kabalan loves to travel and to immerse herself in different cultural experiences.

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Abstract

Research has shown that study abroad yields the greatest educational outcomes for intercultural competency when it is couched in a curriculum that encourages preparation before and reflection after the abroad experience. To enhance the educational outcomes of engineering students' study abroad experiences, we developed a certificate program that couples an abroad experience with additional coursework in global topics and a reflection assignment. The certificate program is based on a similar program at Northern Arizona University, and is otherwise rare in our peer schools. The goal of the program is to encourage students to engage in coursework and experiences that cultivate cultural competency, and to recognize students' efforts when they do so. In addition, this program is designed to be manageable within our existing engineering degree programs while requiring global learning and international experiences beyond simply studying abroad. Students who satisfy the requirements will have "Global Engineering Perspectives Scholar" added to their transcript.

The program requirements are: (a) demonstrate proficiency in a foreign language, (b) participate in an abroad experience, (c) complete a minimum of three courses designated by the university as global connections or foreign language, (d) complete a minimum of three engineering courses, and (e) submit a reflection assignment. The reflection assignment was based on the following prompt: "How did the completion of the requirements for this program enhance your engineering education and help prepare you for your future?" The reflection can be in the form of a presentation, video, or 2-page impact statement for public dissemination. The first cohort of nine Global Engineering Perspectives Scholars graduated in 2019, including students from five degree programs with competencies spanning five different languages.

Motivation for the program

Globalization is driving the need for engineers to work effectively in international environments, and navigate differences across cultures [1]. Studies on intercultural competencies for engineering students typically describe the benefit of such competencies as allowing them to work with people from different cultures in an increasingly globalized world. There is also some evidence that global competencies can improve engineering students' abilities to approach problems in different ways [2]. For example, engineering education in France has focused on derivations, whereas engineering education in the U.S. has focused on following a series of defined problems solving steps. When students learn in more than one country, therefore, they can expand their approach to problem solving.

An often-noted goal of study abroad is to increase students' intercultural sensitivity and competency through gaining hands-on knowledge of other cultures. Intercultural sensitivity can be achieved when students recognize differences across cultures [3]. But to recognize cultural

differences, students need to develop self-awareness of their own cultural identities. After developing awareness students need to transform cultural sensitivity into behavior that allows them to be effective in a different cultural context, in other words be culturally competent, [3]. Educational outcomes for intercultural competency can be increased when study abroad is couched in a curriculum that includes preparation before and reflection after the abroad experience [4].

With Bucknell University's liberal arts environment and strong set of faculty-led study abroad programs, we have a unique opportunity to offer meaningful global education experiences to our engineering students. This motivated us to create a certificate program that would enhance study abroad experiences of our students. Students are required to take courses on global and cultural issues and reflect on the abroad experience after their return to campus. We recognize that a global engineering perspective would be equally beneficial for Bucknell University students who are not engineers. Encouraging students from the college of arts and science and the college of management to complete coursework at Bucknell that is complementary to their abroad experience and also to explore a few engineering courses would help broaden their perspectives.

This scholars program is designed to be manageable within our existing engineering degree programs while requiring global learning and international experiences beyond simply studying abroad. It is also designed to be achievable by non-engineering majors. We estimate about 5-10 graduating engineers per year out of approximately 100 students currently qualify (or nearly qualify) for this designation. It is our plan that by creating and promoting this Scholars Program, we will encourage more students to engage in these activities, potentially up to 25-50 students per class year. To date we've had one cohort of nine scholars graduate with the next cohort expected to complete their requirements this spring.

In the rest of this paper we will discuss the history of the program, as well as our experiences to date in administering the program. We are interested in learning how or if this program deepens cultural competency among participants and if the credentialing aspect of the program motivates students to enroll in more courses with global themes.

Description of Program

The Global Engineering Perspectives Scholars Program at Bucknell University, which was inspired by Northern Arizona University's Certificate in International Engineering and Natural Science [5], includes both curricular and non-curricular components. To earn designation "Global Engineering Perspectives Scholar" on their transcript, a Bucknell University student must complete the following: (a) demonstrate proficiency in a foreign language, (b) participate in an abroad experience, (c) complete a minimum of three courses with significant global or cultural content, (d) complete a minimum of three engineering courses, and (e) submit a reflection assignment in response to a prompt. Each of these requirements will be discussed in more detail below.

Students can demonstrate proficiency in a foreign language in several ways. A student can take a 200+ level foreign language course at Bucknell University, take a language department placement test that shows that they have a proficiency equivalent to a 200+ level foreign language course at

Bucknell, or take a disciplinary course in a foreign language. International students who are fluent in their native language and have English as their second language satisfy this requirement and are not required to demonstrate proficiency in a third language.

To satisfy the requirement of participating in an abroad experience, students must participate in an educational abroad experience that lasts at least 3 weeks. Hence, the study abroad experience can be either short term (e.g., 3-week summer program), full semester, or year-long. The type of experience can also vary, as course, an internship or a research experience abroad can satisfy this requirement.

In addition to their foreign language requirement and abroad experience, students must complete a minimum of three courses with significant global or cultural contents. At Bucknell University, we accept courses that are designated by the university as a “global connections” or “foreign language” courses. Foreign language courses at our institution must include a cultural component, and hence we allow them to satisfy this requirement. Foreign language courses taken to satisfy this requirement can also count towards fulfilling the foreign language proficiency requirement described above.

While the Global **Engineering** Perspectives Scholars Program was designed to be accessible to students in any major, the emphasis is on developing cultural competency within the practice of engineering. Thus, there is also a requirement that students seeking this certification complete a minimum of three engineering courses. Any engineering major automatically satisfies this requirement, but students with non-engineering majors are required to complete at least 3 engineering or computer science credits to qualify for this program.

The final requirement, which ties the other requirements together, is a required reflective assignment in response to the following prompt:

A “global engineer” is defined as one who has the personal qualities, international knowledge, and technical skills required to work effectively in a range of international settings and work environments. How did the completion of the requirements for this program enhance your global engineering perspective and help prepare you to live and work in a globally connected world? Be sure to support your reflection with specific examples from each component of the program (abroad experience, foreign language proficiency, and global/engineering coursework) and the impact of your experiences on your development of cultural competency and as a global engineer.

The reflection can be in the form of a presentation, video, or 2-page impact statement. The purpose of the reflection is to encourage students to reflect on, process, and integrate their abroad and other global experiences. In addition, with student permission, in the future we hope to use student reflections to advertise the program and encourage more junior students to pursue the certification.

Program Administration

Students who complete the requirements of the program must submit application materials that document how they have met each goal. Applications are due no later than early March of

students' senior year, though underclass students may apply as soon as their requirements have been completed. The Engineering International Committee, which includes members from each engineering department and dean's office, and office of global education, reviews the submissions and supporting documentation, and may request supplementary information, clarifications or revisions if needed to fully evaluate the candidate. In early April, a list of students who have satisfactorily completed the program requirements is submitted to the Registrar's Office. The designation "Global Engineering Perspectives Scholar" will then be added to each student's transcript.

First Cohort

The first cohort of nine Global Engineering Perspectives Scholars graduated in 2019, including students from six degree programs: chemical engineering (2), computer science (1), computer science and engineering (3), civil engineering (1), electrical engineering (1), and mechanical engineering with a second major in Spanish (1). The gender distribution—3 males and 6 females—is consistent with greater female participation in study abroad at Bucknell. The abroad experiences of the participants include 3-4 week summer educational programs (4), an 8-week internship (1), and full-semester educational experiences (4), while language proficiencies were demonstrated in Spanish (4), French (2), German (1), Chinese (1) and Russian (1). Seven out of nine students demonstrated language proficiency by taking foreign language courses, while two tested out of the requirement.

Five out of nine students had their abroad experience in a location that complemented their language proficiency, including two students who studied abroad in France, one who studied abroad in Spain, one who studied abroad in Russia, and one who completed a summer internship in Chile. Of the remaining students, one studied abroad in Jordan, two in Ghana, one in Costa Rica, and one in England. Note that only one student studied abroad in an English-speaking country. This spread in locations supported a secondary goal of this scholars program, which was to encourage students to study in locations that get them out of their comfort zone, such as in non-English speaking countries or outside of Europe. Five out of nine students satisfied their requirement of three courses with significant global or cultural content with exclusively foreign language courses, but other students took courses from a variety of departments including East Asian studies, economics, international relations, and political science. While only three global/cultural courses were required, several applicants completed four or more courses that satisfy this requirement.

Eight impact statements were submitted as 2-page written reflections, and one was submitted as an annotated power point presentation. Below are quotes from student reflections that illustrate some of the ways that completing this program enhanced their abroad experiences:

The time I spent fulfilling the requirements for the programs expanded my two-dimensional view of engineering problems into complex, interconnected webs. Implementing solutions to real life problems require technical skills, but also a sensitivity to the social, political, and other influences on the situation.

The discussion of my time in Jordan demonstrates the beginning of my cultivation of a holistic view of problem solving, which I further developed with a number of interdisciplinary classes at Bucknell. A continued dedication of learning about disciplines outside my major equipped me with a sensitivity to different cultural, societal, political [issues, etc.].

The [opportunity] to live in a unique society and see how [Russians] interact with technology had a dramatic effect. It made me realize that different countries interact with different types of engineering innovation in different ways.

Lessons Learned

The review committee, while satisfied that the students had met the goals of the program by completing the distribution requirements and engaging more deeply with their abroad experience, would have liked to see more thoughtful and better edited impact statements. As a result, the reflection prompt was changed to the one listed above. The previous prompt had been more simply stated as: “How did the completion of the requirements for this program enhance your engineering education and help prepare you for your future?”

In addition, after reviewing the applications from the first cohort of students, the application portal was modified to place the responsibility of correlating program requirements with courses/experiences with the students and to more clearly request the specific information the committee needs to evaluate whether each student has met the requirements for the scholars program. We are also continuing to promote the program via departmental advisors with the intent of expanding the number of underclass students that engage more intentionally with the program requirements. Engaging in the program earlier may deepen their gains in cultural competency.

Future Work

Looking forward, we are interested in providing the Global Engineering Perspectives Scholars with opportunities to share their experiences with more junior students to help encourage other students to engage in abroad experiences. We are also interested in learning how or if this certificate deepens cultural competency among participants and if the credentialing aspect of the program motivates students to enroll in more courses with global themes. To assess if this certificate enhances cultural competency among engineering students, we could modify and use quantitative and qualitative assessments, such as the tools developed by Mazzuerco et al. [1] and Knight et al. [6]. These assessment tools would be administered to students that study abroad and do or don't participate in the certificate program before and after their experiences, i.e., pre-study abroad and pre-graduation. This will allow us to see if there are gains in cultural competency associated with the program. In addition, we will conduct qualitative analysis based on student reflections administered by the certificate program and the university. We may also develop an assessment tool to survey alumni and non-alumni of the program post-graduation. These tools can be used to see if the program affected career paths, international activities, and leadership roles.

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