Curriculum Intervention: Assessing Need for and Implementation of Sustainability Development in a Global Context within the First-Year Engineering Curriculum at Purdue University

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Statement of Need

Globalization is a world-wide phenomenon that is reshaping international relations in tremendous ways and at impossible rates. Due to rapid advancements in communication, transportation, and information technologies, there has been an increasing connectedness of humanity around the globe. With this trans-global integration comes many benefits, but also countless challenges. It is critical that engineering education facilities constantly update and restructure their curriculum to produce engineers who are capable of tackling the world’s greatest global challenges of this globalization era.

Purdue University has already responded to the challenges and needs posed by globalization in proactive and innovative ways. In 2008 former president of Purdue Dr. France A. Cordova developed a “new strategic plan…designed to place Purdue among the few, great, global research universities” (Cordova, 2003, pg 3). The plan was called New Synergies, and had three focus areas, one of which being to “meet global challenges” (Cordova, 2008, pg 3). In this announcement, Purdue claimed that it “prepares its students to assume roles as both citizens and leaders of an evolving world,” and gives them “the tools they need to succeed in a global society” (Cordova, 2008, pg 4). Purdue has implemented several changes and promoted significant growth in the realm of global competence by increasing student interest in STEM careers, increasing opportunities for global experiences, promoting diversity within the campus culture, and promoting sustainability consciousness (Cordova, 2008, pg 4). However, more change is needed to ensure that Purdue engineering graduates remain relevant and capable. In a report on recommendations for improving education curriculums, the author writes that “changing demographics, global competitiveness, scientific and technological advances (and more) calls for risk taking initiatives to break systems apart and to put them together in ways that better serve students, science, and society over the next decade” (Narum, 2006, pg 3). Therefore, to better serve the students of Purdue, it is crucial for the engineering curriculum to be refined once more.

In response to the growing demands of globalization, our team proposes a curriculum intervention of the First-Year Engineering Program. We wish to analyze the depth of global competency concepts taught in the course, with a specific focus on sustainability. As the world continues to grow more interconnected and more resources are put to use at faster rates, researchers predict that “the management of sustainability and environmental risk – including reduction of greenhouse gas (GHG) emissions – will soon be the most important decision facing corporate boards and managers” (Aggarwal, 2011, pg 54). Furthermore, providing sustainable
food and water security still remains one of the most crucial global challenges facing the world today. Thus, sustainability effects every aspect of life, from economic development and corporate profit, to the fight for the provision of basic human rights. To ensure that the processes of globalization do not consume the vital resources necessary for survival, it is crucial that young engineers develop an understanding of sustainability and perform their specialized tasks with a sustainable vision in mind.

**Background Literature and Theoretical Framework**

There are countless research articles that point to the need for students to receive higher quality educations in response to the changes and challenges of globalization. The engineering curriculum should be tailored to increase global competency, which will help Purdue compete more effectively in the international education competition. Furthermore, the engineering curriculum should specifically focus on the sustainability aspect of globalization.

**Global Competency**

Due to globalization, many successful companies are now transnational, with teams that are working all throughout the globe. However, according to research reports, “a scarce resource in this environment is the ability to...manage complex business relationships and teamwork across cultural and linguistic barriers” (Saxenian, 2005, pg 39). Thus, engineers need better training to more effectively prepare them for trans-national projects and the cultural challenges that are often associated with such diverse teams. To address this scarcity, in 2008 a “group of 23 distinguished engineering educators convened… to discuss the globalization of US engineering education… [and] what proactive steps need to be taken by engineering educators to ensure that their graduates are prepared to be productive citizens and professionals in today’s and tomorrow’s complex world” (Grandin, & Hirleman, 2009, pg. 3). At the conclusion of the meeting, they reported a “review of the rationale for incorporating global perspectives and skills into the engineering curriculum, as well as the urgency for doing so” (Grandin, & Hirleman, 2009, pg. 3).

Furthermore, not only is global competency crucial to ensure the success of multi-national teams, but it is also crucial for engineers to be able to tackle the world’s biggest challenges. In The Globalization Reader, authors Lechner and Boli state that “Globalization has helped to increase the number of problems,” and that “the tighter web of global connections entails new risks as well as new opportunities” (Lechner, & Boli, 2015, pg 266). Thus, as sovereignties become more interconnected and problems become more apt to “spill across borders” (Lechner, & Boli, 2015, pg 266), engineers should be the ones to address the resulting “urgent global problems...ideally engineers with global training” (Grandin, & Hirleman, 2009, pg. 11). However, the curriculum must evolve accordingly to best equip the newest generation of engineers.
International Competition

Research also points to the fact that the engineering curriculum must evolve simply to keep up with the other engineering institutions and maintain its relevance. As “the world is becoming dramatically more interconnected and competitive” (Narum, 2006, pg 4), “competition for brains has emerged as a major development issue” (Skeldon, n.d., pg 371). With the highly-advanced transportation technologies, movement across borders has become incredibly easy and much more common. Students are now able to travel across the world to receive their educations, and just as “firm and industry leaders are rushing to capitalize on the advantages globalization can bring” (Gereffi, & Wadhwa, 2008, pg 13), students also are rushing to capitalize on the advantages globalization can bring them, specifically in respect to acquiring the best education in order to secure the best opportunities later in life. Therefore, American universities, including Purdue, must continue to produce engineers with higher and higher levels of global competency to remain a competitive and relevant university.

Fortunately, the “key issue in engineering education should be the quality of the graduates, not just the quantity” (Gereffi, & Wadhwa, 2008, pg 13), and “while the United states cannot compete with China and India in terms of numbers of engineers, the United states can retain its edge by continuing to be a global hub for world-class engineering education and research, and by focusing on the quality of the education that it provides its citizens” (Gereffi, & Wadhwa, 2008, pg 22). Thus, universities in the United States (including Purdue) are currently in a good place with regard to international competition because the quality of an American engineering education is highly regarded. However, in order to maintain this dominant lead in education, American universities must continue to improve their curriculums.

Focus on Sustainability

Finally, it is not enough for Purdue to simply focus on implementing globalization concepts into its curriculum. Rather, the concept of sustainability, and sustainable development, should be the forefront of the topic. On countless occasions, researchers write about the “need for a transformation of the system that will be sustainable over the long-term” (Narum, 2006, pg 2). As more resources are put to use and more products are produced, global-scale resource utilization becomes incredbly significant. As stated in The Globalization Reader, “sustainable economic development and prosperity address many of the other economic problems discussed” (Vreeland, 2015, pg 273). Therefore, proper implementation of sustainable development carries the potential to solve countless global problems and to ignite development. However, failure to consider sustainability can and will have detrimental effects. For example, “there is considerable evidence that the rising numbers of humans, including the remarkable doubling in the last half century (2.5 billion in 1950; 6 billion in 2000), are now putting significant pressures on some mispriced resources, including the availability of clean air and water” (Aggarwal, 2011, pg 54). Furthermore, research continues to point to the fact that unsustainable practices have led to deforestation, intense pollution, lack of resources, and overall, lack of access to basic human needs for countless communities of people around the world. As the global population continues
to grow, consuming resources and abusing the environment (causing “environmental issues such as ozone depletion or global warming”,) globalization may actually threaten humanity (Lechner, & Boli, 2015, pg 266).

In response to this “ever deepening crisis of global environmental change” (Park, & Conca, 2008, pg 13), the world has “taken action to protect the environment and ensure basic human rights” (Lechner, & Boli, 2015, pg 267), and our team believes that engineers should emerge as global leaders in navigating the sustainability movement. Sustainability is difficult to implement because it is a collective action problem in which a single group suffers the costs while everyone reaps the benefits. Therefore, many companies and current engineers are not particularly interested in sustainable development. However, if engineers are taught the importance and significance of sustainability, and understand that their efforts can make a difference on a global scale, they are more likely to take ownership of the issue. If you give someone ownership, they are more likely to care, and therefore they are more inclined to take action. This concept is seen in a case study which looks at implementing a bucket brigade system into an interior seating manufacturing plant in Mexico. In the case study, the consultant “let the workers feel as if they were creating the process themselves, and that made the workers feel important and responsible for its success” (Acosta, & Leon, 2010, pg 227). Similarly, if engineers are given ownership over playing a part in tackling environmental change through sustainability, there is greater potential for positive advancements to be made. This ownership can be provided through education and awareness within the college curriculum, and in response engineers will be better equipped to “make globalization work for sustainable development and to jump start implementation efforts” (Park, & Conca, 2008, pg 13)

Research Objectives and Questions

As demonstrated in the above sections, is it crucial for young engineers to receive training in global competency, specifically within the realm of sustainable development. Thus, to ensure high quality development of Purdue engineers is this area, our research team proposes a curriculum intervention involving two parts:

1. An analysis of the global competency and understanding of sustainability of current engineering sophomores who recently completed the First-Year Engineering (FYE) program at Purdue University.

2. An implementation of concepts from a current Purdue course, CE/EEE 355 Engineering Environmental Sustainability, into the FYE curriculum, as well as an implementation of globalization concepts as needed.

Furthermore, our team seeks to answer the following research questions:

1. How consistent is the material that is taught across different sections within the FYE program?

2. How much control and influence does each engineering professor have in covering the topics of globalization and sustainability?
(3) What hands-on, practical experience and exposure to globalization concepts are the students getting?

These research questions are in part inspired by the work of Raj Aggarwal in his journal publication on sustainability and globalization. In his article, he writes, “while most schools claim to cover the global aspects of each subject matter in functional specific classes, actual coverage depends greatly on the commitment and ability of such faculty to teach global aspects and the global topic is more often neglected than not” (Aggarwal, 2011, pg 67). Based on personal experience and on discussions with other students, it appears that the issue spoken about by Aggarwal may be present in the FYE education system. Some students expressed that they learned a decent amount about globalization from their FYE teacher, while others state that the subject was never mentioned. Thus, our research team wishes to study more closely not only the depth of global competency of FYE students, but also the consistency (or lack thereof) among the differing sections. Furthermore, Aggarwal seems to suggest that classwork is not enough; rather hands-on experiences are necessary for deep understanding of globalization concepts. Aggarwal writes suggest that one way of doing this is to encourage students to “participate in nationally oriented events celebrating important foreign holidays from across the world that also enhance cross-cultural awareness and knowledge” (Aggarwal, 2011, pg 68). In response to this aspect of education, our research team wishes to also analyze the practical, “real-life globalization and sustainability experiences students are getting.

**Project Structure: Approach, Implementation, and Methods**

As discussed in the previous section, the first step in our approach would be to analyze the global competency and understanding of sustainability of current engineering sophomores who recently completed the First-Year Engineering (FYE) program at Purdue University. In this section, I will further expound on the second step; the implementation of concepts from a current Purdue course, CE/EEE 355 Engineering Environmental Sustainability, into the FYE curriculum, as well as an implementation of globalization concepts as needed.

Our research team believes that the concepts and learning objectives taught in the current Purdue CE/EEE 355 elective class are crucial for every engineer to learn. The course, called Engineering Environmental Sustainability, is taught by Dr. Larry Nies, and does an excellent job exposing students to issues of globalization and sustainability while also developing students’ critical thinking skills. I had the privilege of taking this course last semester, and it has been by far the most impactful, influential, and applicable course I have taken at Purdue. On the course syllabus, the course is described as “an introduction to the examination of global-scale resource utilization” (Nies, 2016, pg 1). The course very effectively explains the relationship between globalization and sustainable development, and teaches that “globalization will potentially provide increasing access to wealth for more people. However, the consequences of creating wealth – as defined above – for everyone could result in unprecedented additional stress on already overburdened ecosystems” (Nies, 2016, pg 1). Other pertinent descriptions from the syllabus include:
(1) Explanation of the need for sustainable thinking: “Humans have the ability to degrade the global environment to the extent that the earth's biosphere could conceivably be unable to produce the resources needed to indefinitely sustain the people of industrialized nations at their current standard of living” (Nies, 2016, pg 1).

(2) Objective of the course: “In this course, focused on student-centered learning, students will address current industrialized nation's practices, as well as those of rapidly emerging and developing economies, within the context of creating an environmentally sustainable society by actively engaging in the curriculum and utilizing critical thinking skills.” (Nies, 2016, pg 1).

(3) Learning outcomes:
   a. Communication: “Students will be able to individually and in teams skillfully communicate in writing, orally, and with multimedia their ideas and conclusions about managing sustainability issues in a manner that increases knowledge and understanding of the audience” (Nies, 2016, pg 2).

   b. Cultural perspectives: “Students will become global citizens and socially aware by gaining knowledge of diverse international and cultural perspectives and display social responsibility and leadership in managing sustainability issues, ultimately increasing their global literacy” (Nies, 2016, pg 2).

Due to the fact that I took this class, I can attest to the fact that every course outcome and learning objective written on the syllabus is effectively taught, and that students graduate from the course with significantly different perspectives. Based on experience, my hypothesis is that the concepts taught in this course, as well as the way this course is taught, critically enhance the education and performance ability of the students who take the course. Therefore, our research team wishes to look further into the impacts of this class, and consider how these crucial concepts can be incorporated into the education curriculum of every engineering student at Purdue. Ideally, we desire to simply make this class a required course for graduation. However, this implementation raises several issues and considerations:

(1) The engineering curriculum is already extremely dense; it may be difficult to add more credits to the graduation requirement.

(2) Should this class be required freshman or sophomore year to ensure that the engineers are able to apply the concepts of globalization and sustainability to their more advanced studies?

Expected Outcomes

At the conclusion of this research project, our team expects two tangible outcomes:

(1) A plan of implementation of sustainability and globalization concepts into the Purdue engineering curriculum

(2) A set of data measurements and specific goals to determine whether the implemented concepts make a difference
Countless research papers stress how important it is to “evaluate the impact of new initiatives” (Narum, 2006, pg 3). Specifically, Aggarwal writes that “it is important that education, and changes to make it more effective, must be guided by empirical evidence” (Aggarwal, 2011, pg 68). Thus, our research team seeks statistical evidence that a) the concepts learned in CE/EEE 355 make a significant impact on the capability of the student, and b) the implementation of new concepts based off of CE/EEE 355 make a significant difference when implemented into the FYE engineering curriculum.

**Conclusion**

In conclusion, the forces of globalization are leading to rapid changes among global dynamics and international relations, and several effects of globalization, such as poor resource utilization, are beginning to pose a threat to humanity. Therefore, engineers must be able to evolve alongside society and must have the skills to tackle the world’s leading problems. Engineers must also understand the importance of sustainable development to ensure a bright future for younger generations to come. As a result, our team suggests a curriculum intervention of the FYE program to better educated Purdue’s young engineers on issues of globalization and sustainability. Purdue is among the top engineering institutions, but to maintain its relevance and influence, there must be a shift in the curriculum to better prepare its graduates to work in this highly-globalized era.
References


Skeldon, R. International Migration, 370-374.
