Education 2013, 3(2): 126-129
DOI: 10.5923/j.edu.20130302.03

Infusing Global Education into Engineering Programs

Alina M. Zapalska*, Hudson Jackson, Kassim Tarhini, Sharon Zelmanovitz

Departments of Management and Engineering, United States Coast Guard Academy, New London, CT 06320, U.S.A

Abstract As the world becomes globally integrated and increasingly exposed to new challenges, academic institutions are becoming more accountable to prepare engineers who are ready to address the challenges of cultural, environmental, and ethical forces within the modern and global world. Technical competence accompanied by a good understanding of economic and political systems, and cultural diversity are required to appropriately address these global challenges. Using the United States Coast Guard Academy as a case study, this paper describes strategies that academic institutions can use to infuse "global education" into their undergraduate engineering programs.

Keywords Engineering Education, Global Education, Technical Competence, Global Integration

1. Introduction

One of the greatest challenges faced by academic undergraduate engineering programs is the need to introduce students to professional practice in the context of a global economy[7]. For engineers to work in an increasingly global market place, they have to possess an awareness of engineering needs and practices across racial, cultural, religious, economic, and various political systems of the global economy[3]. The authors argue that only with a sound understanding of cultural, environmental and ethical forces within the global world and appreciation of practices across cultures, will engineering graduates be prepared to serve in a global market place. With the incorporation of appropriate pedagogy and curricular development within engineering programs, the necessary global perspectives can be achieved to foster the respect and tolerance for differences in culture, race, and religion.

This paper presents the efforts and strategies that have been used or considered to infuse global perspective and strengthen global education within the Civil Engineering Program at the United States Coast Guard Academy (USCGA). The authors recommend that the efforts supporting "global education" should include: development of appropriate curriculum, promotion of the exchange of knowledge between universities and industry or governments throughout the world, student and faculty exchange programs, recruitment of international students, recruitment of international scholars, involvement in overseas development programs, and professional training for students, staff, and faculty.

* Corresponding author:
Alina.M.Zapalska@uscga.edu (Alina M. Zapalska)
Published online at http://journal.sapub.org/edu

2. Diverse Perspectives on Global Education

Global education has been acknowledged in recent years as a necessity in preparing students for an increasingly challenging global economy[6]. The educational literature offers models and substantial resources of continued growth and support for "global education"[9]. Although there are many facets or dimensions to "global education", there is no clear and concise compilation of exactly what the make-up of "global education" is [2]. Some authors argue that "global education" should be derived from the present experience to historical realities and should include a study of human and universal values, global issues, and problems within historical, cultural and political dimensions[4]. "Global education" must be proactive and include learning experiences that advocate the understanding of human values across different cultural groups and economic systems[3]. Cornwell and Stockard[2] note that globalization is tied to technological advancements and should be understood as the rapid and unprecedented global circulation of cultural forms. Rosenberg[8] argues that engineers must have a good understanding of both engineering concepts and global economic and financial conditions before they hope to embark on international projects and the success of engineers in the global market place depends on how successfully cultural differences are addressed and understood.

The ABET (Accreditation Board for Engineering and Technology) Engineering Criteria 2000 emphasized that engineering programs must show evidence that engineering graduates demonstrate *"an ability to understand the impact of engineering in a global/societal context" and "an ability to function on multi-disciplinary teams."* This emphasis on global perspective encourages engineering programs to

provide opportunities that expose students to multicultural, interdisciplinary and international experiences. The National Academy of Engineering (NAE) has also emphasized that engineers of the 21st century need to have the ability to communicate and function in globally diverse teams[5]. To improve the preparedness of engineers entering the civil engineering practice and address global education, the American Society of Civil Engineers (ASCE) has adopted the attainment of a Body of Knowledge (BOK) for entry into the professional practice of civil engineering which includes: (1) foundational competency; (2) technical competency; and (3) professional competency[1]. Technical and professional competencies include knowledge in basic science, mathematics, technical specialty, communications skills, leadership skills, professional and ethical responsibilities. These competencies vary depending on the engineering discipline and are mostly addressed in the required classroom and/or laboratory work. Although this model was developed for civil engineering, various components can be adopted by other engineering disciplines. Figure 1 presents a model proposed by the authors that incorporates the key components of ASCE-BOK that will promote global awareness in engineering education. Also included in Figure 1 are strategies proposed by the authors that may be helpful to academic institutions in their effort to enhance global and industrial perspectives of their engineering students.

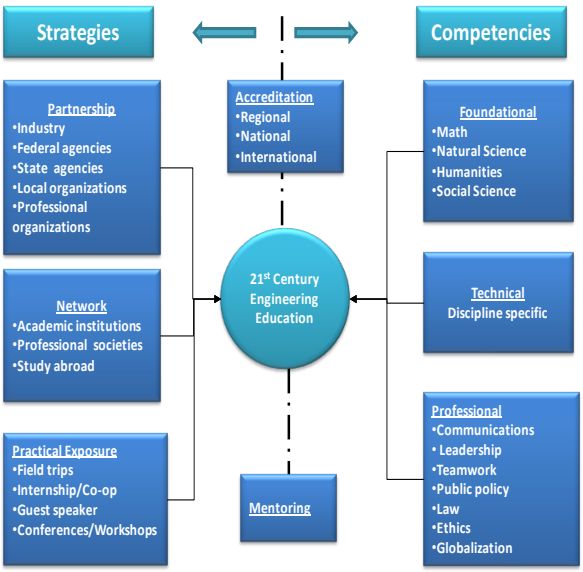

Figure 1. Components of Global Engineering Education Model

3. Global Education Strategies at the U.S. Coast Guard Academy

The United States Coast Guard Academy (USCGA), located in New London, Connecticut, is the smallest of the United States federal military academies. It offers bachelor degrees in eight majors-Civil Engineering, Electrical Engineering, Mechanical Engineering, Naval Architecture and Marine Engineering, Government, Management, Operations Research and Computer Analysis, and Marine and Environmental Science. The USCGA's mission is to educate, train and develop leaders of character who are ethically, intellectually, and professionally prepared to serve their country and humanity. Graduates pursue a number of different career paths and many of them serve in the Coast Guard as practicing engineers, pursue professional licensure, and attend graduate school. Examples of implementation strategies of the model shown in Figure 1 are presented in Table 1. This table highlights examples in each category of the model.

Table 1. Examples of Implementation Strategies used in Civil Engineering

Model Component	Examples of Implementation
Technical & Foundational competencies	Achieved through technical engineering & core courses in math, science, humanities, business, law, maritime studies & physical education.
Professional competency	Addressed through particular emphasis in technical/core courses & extracurricular activities such as: -information literacy -leadership & ethics -global water & sanitation -community service -involvement in professional organizations
Partnership & Networking	Collaboration with several organizations & institutions: -United States Coast Guard -Department of Homeland Security -Department of Defence -American Society of Civil Engineering -Society for American Military Engineers -Engineers Without Borders -Habitat for Humanities -Local non-profit/community programs
Practical exposure	Emphasis is placed on infusing industrial and community relevance, and Coast Guard mission readiness into the curriculum through practical class projects, field trips, guest speakers, capstone projects, community service, summer internships, and membership in professional organizations.
Mentoring	Each student is assigned three mentors in academic, athletic & military areas. Students are also required to mentor their juniors. There is also a sponsor family program that provides additional opportunities for individual growth.
Accreditation	Engineering programs are ABET accredited, the institution is also accredited by the regional higher education accreditation agency.

Within the technical competency emphasis is placed on balancing theory and practice of engineering so graduates are intellectually and professionally prepared to provide engineering services to the Coast Guard. In addition to technical courses, engineering majors take a wide variety of coursework outside of engineering discipline to encourage self-evaluation and discovery, and develop other professional skills. With over 27 credit hours of non-technical core courses plus six additional credits of

Health and Physical Education, students are able to develop and hone the professional skills that are critical to their success as the CG officers and professional engineers. Students have opportunities to study economic, political, cultural, ecological and technical aspects of globalization to understand the differences and similarities in characteristics among those systems. They are expected to be capable of participating in discussions and think about the causes, effects, and solutions to global issues and problems. For example, the Economics, International Law, Morals and Ethics, and Maritime Law courses provide students with an understanding of their roles as engineers in developing solutions to the issues and problems of the global economy.

The core courses enable students to understand differences between opinion and perspective on globalization issues and they are able to: (1) Comprehend long-term global trends such as population growth, economic development, the patterns of resource use, the dispersion of nuclear weapons and the possible consequences of these trends; (2) Consider the current and possible consequences of terrorism, nuclear and biological war for self and others of different world views; (3) Identify human problems in different societies and historical settings; (4) Recognize in other cultures the needs, behavior, life experiences, and existential concerns common to all people; (5) Identify technologies, institutions, languages, and beliefs that link people in many regions of the world; and (6) Perceive that different life styles and cultures have different impacts on human lives. By weaving experiential modes of teaching throughout the required courses for graduation, students with a variety of learning styles will grasp concepts and see the application of what they are learning.

There has been a strong effort to infuse international content into the Academy's curriculum. This has been accomplished through specially designed courses, revision of syllabi, or the incorporation of lectures or assignments on global themes into existing courses. Professional development and curricular innovation have been made possible by the creativity of the faculty, ongoing support from the administration, and assistance from outside grants. As proposed in Figure 1, the engineering programs at USCGA have also developed unique partnerships with the Coast Guard Engineering Units located throughout the United States. These engineering units are committed to the goals and mission of the academy in providing leaders of character that are professionally prepared to serve as officers and engineers. They continue to support the USCGA in providing professional input to restructuring courses, mentoring students, provide opportunities to solve real life projects as well as funds needed to complete them. Some of the responsibilities of the engineering units in this partnership with USCGA include: (1) providing input as courses are refined or added, real life capstone projects and opportunities to finding solutions to Coast Guard engineering problems, case studies, summer internship opportunities, field visits during the academic year, exposure to public policy applications, opportunities for interactions with federal, state, and local agencies; (2) serving as guest speakers, mentors to students on professional licensure and professional societies; and (3) serving on an engineering advisory board to gather input from the Coast Guard and industry. USCGA has also implemented international and intercultural education through the acceptance of exchange students from other countries, provide mini-study tours abroad, student-exchange programs, foreign language programs, participation in regional, state, and national consortia, seminars, and conferences focused on international education. By having international students at the Academy, the students are exposed to different cultures and perspectives without leaving their campus. This works well when there is a high degree of cooperation and compatibility between the foreign and domestic student bodies. The use of cadet exchange programs helps meet the demands for realistic international experiences and learning and are perceived as a means of broadening the base of international exposure and understanding. Due to resource and logistical constraints, few students have an opportunity to take advantage of true overseas academic exchange experiences through the prestigious scholarship programs such as the Gate's and Fulbright scholarships. Students have the opportunity to sail throughout the world onboard the Eagle Flag ship as part of their summer training. Additional opportunities to serve on cutters with international Coast Guard missions are also available during summer training.

Cross-cultural workshops, conferences and foreign officers' visit to the Academy also provide means for introducing students, faculty and staff to the international elements. Foreign travel study programs offer faculty as well as students insights into the culture, economy, and politics of other countries. USCGA seeks opportunities to promote faculty training; help maintain relations with international agencies, sponsor exchange programs for students and faculty, and conduct symposia and seminars related to international issues. A substantial number of faculty members have some international background and experience that has been utilized constructively by the Academy in its efforts to infuse an awareness of global perspectives and industrial relevance on campus.

There are also numerous collaborations between the USCGA academic institutions with some of these collaborations being established by individual professors to facilitate their research efforts and to establish broad reaching partnerships that provide students with the best instruction with global experience. Having the USCGA faculty establish formal networks and collaborations with other universities nationally and abroad will enhance knowledge, technology transfer, global perspectives and industrial relevance through joint research projects and exchange programs for both students and faculty. Students also benefit from courses and other activities that are designed to provide them with opportunities to solve national and/or international engineering problems that are diverse and interdisciplinary in nature.

There has been a strong advocacy for effective partnership

or collaboration between industry and academic institutions. There are many approaches that link the USCGA educational programs and industry such as establishing technical advisory boards, promoting summer internships, and providing practical capstone projects. An important step in addressing the issue of global perspective and industrial relevance is to annually organize a regional symposium or a series of seminars related to "Industrialization and Globalization." The objective of the symposium or seminars is to formally invite principals from private engineering firms and from local and federal government agencies to form and continue partnerships. These partnerships should focus on the main goal of preparing engineering practitioners with support for faculty professional development and research as a secondary benefit. The USCGA has greatly benefited from the involvement of faculty who served as practicing engineers with international experience.

As the USCGA sets up partnerships with industry, curricular and courses are structured to balance the need for fundamental engineering instruction with an infusion of skills and practices used in the field at both national and international levels. The need for institutional support has been recognized at the highest administrative levels in order to properly infuse and sustain these activities into engineering programs. If left solely to individual professors or programs within the Academy, these efforts may be less effective and would be difficult to sustain over time. It is recommended that accreditation standards include a requirement for academic institution to foster industrial and global partnerships that best prepare future engineers for practice. With the proper balance of foundational technical and non-technical education coupled with exposure to real–life engineering in a global context, the next generation of engineers will be well-prepared to take on future global challenges.

4. Conclusions

Global education involves learning about problems and issues that cut across national boundaries and about the interconnectedness of systems - ecological, cultural, economic, political, and technological. In order to provide undergraduates with a well-rounded global education and prepare them for global engineering practice, their education must be structured to provide a balance between theory and practice in the context of "global education". Students should be introduced to the strategies, skills, and dimensional issues that define global affairs. To accomplish this, academic institutions must meet the needs of industry by producing engineers with the basic technical knowledge, analytical skills, critical and problem solving skills, teamwork, communication, leadership, and entrepreneurial skills and practical experience deemed adequate in a globalized engineering industry.

Today, world stability and economic prosperity depend upon our understanding and respect of other countries, their religion and cultural practices. This world trend has made the need for global awareness more relevant. Three main aspects must be addressed by engineering programs: (1) the engineering community must be knowledgeable about the opportunities and the benefits that international markets provide; (2) universities and industry must collaborate to improve the engineering curricular programs in order to fully take advantage of these opportunities; and (3) the government must provide policies and support the academic initiatives that would prepare future engineers to successfully function in a global environment.

REFERENCES

[1] American Society of Civil Engineers, "Civil engineering body of knowledge for the 21st Century," 2nd Edition, 2008

[2] Grant Cornwell, Edward Stockard, "Globalizing knowledge: connecting international and intercultural studies," Association of American Colleges and Universities, Washington, DC 1999.

[3] Patricia Galloway, "The mission of the civil engineer in the movement of globalization," Journal of Leadership and Management in Engineering, July 2003, p122-127.

[4] Eric Jestrab, Charles Jahren, "Integrating industry experts into engineering education: case study," Journal of Professional Issues in Engineering and Practice, vol. 135, no. 1, pp 4-10. 2009

[5] National Academy of Engineering, "The engineer of 2020: visions of engineering in the new century," National Academies Press, 2004.

[6] Lyman Porter, Lawrence McKibbin, Management Education and Development: Drift or thrust into the 21st Century, McGraw Hill, New York, 1988.

[7] Gisele Ragusa., "Preparing University Students for Global Workforces", in Proceedings of 40th ASEE/IEEE Frontiers in Education Conference, Washington, DC, Oct 2010.

[8] Robert Rosenberg, "WIP - Going global: an innovative course for sophomores", in Proceedings of 40th ASEE/IEEE Frontiers in Education Conference, Washington, DC, Oct 2010.

[9] Noel M Tichy, "The Global Challenge For Business Schools," Human Resource Management, vol 29, no 1,, pp. 1-4, 1990.