



International Experiences to Promote the Globalization of U.S Engineering Students: Challenges, benefits and new perspectives

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Abstract

In the engineering and construction industries, many firms are working in a more global marketplace. Because of this, these firms are looking to hire college graduates that have more of a global view. In order to prepare college engineering and construction students to operate in this environment, it is imperative for universities to provide international experiences to their students. Traditionally universities have provided study abroad programs, many of which are generic in nature and often only provide coursework in general education. There are many roadblocks to providing such experiences, with cost and interruption to the expected time to graduation being the primary issues. This paper aims to explore multiple alternative opportunities for U.S. students to gain international exposure and experiences and the benefits and challenges of the different international programs, emphasizing alternatives to the traditional year or semester study abroad model. This initial case study found that opportunities such as International Virtual Design courses as well as participation on International Competition Teams such as the Associated Schools of Construction competitions as cost effective solutions that provide the international experiences employers are seeking while not extending the time a student needs to obtain their degree.

Key words: Globalization, international experiences, international competitions, undergraduate engineering education

Introduction

In the age of globalization, the boundaries in technical industries such as engineering and construction have blurred over the years. Academic institutions, engineering professionals, and corporate organizations continue to benefit from the commercial advantages, creative ideas and competitive advantages that can be obtained from a well-organized multicultural educated team [1], [2] Additionally, companies within the U.S. and abroad are concerned with the shortage of engineers that possess the global mindset needed to support today's workforce [3]. The need for globally aware and competent engineers is relevant, and they are needed now.

Engineering undergraduate students from the United States need international experiences if the country is to maintain its excellence in STEM fields [4]. With the globalization and technical advancement of society there are multiple ways to infuse international experiences in higher education with the most traditional being study abroad programs. These study abroad programs were originally designed for students pursuing humanities and social science degrees in the U.S. [5]. Currently, the need for international experiences extend beyond those degrees and have become a need in STEM fields. Two contributing factors have been identified as limiting factors for engineering students participating in study abroad experiences.

Cost is cited as the major limiting factor restricting many U.S. students with multiple majors from pursuing study abroad programs [4], [6]. Adding to the cost challenge, STEM students also face challenges with the time commitments involved with study abroad experiences. Many engineering programs have specific course sequencing requirements and create complications for students seeking time away for semester long study abroad experiences [4], [6]. Jones and Oburst refer to the “intensity of the undergraduate” engineering programs along with the “lockstep progression through the four or more years of study” weighing against engineering students taking part in traditional study abroad. The challenges with both time and costs lead to less than 2% of engineering students participating in semesters abroad.

Costs and time challenges present obstacles to international collaborations; however, as Shaurette (2014) states, “because the benefits of international collaboration are significant, creative solutions to implementation challenges for individual situations are justified” [7]. Beyond traditional semester (or longer) abroad programs, other international opportunities exist with differing costs and time commitments. Short-term study abroad programs, co-ops, service learning projects, international competitions, and international class collaborations can provide opportunities that challenge students out of their comfort zones, allow for problem solving in a diverse group and subsequently provide a taste of globalization [8]. Students still experience cultural diversity, challenges with linguistic barriers, and differing norms and ethics similar to an experience of longer duration.

Global Competence

Presently the engineering industry is changing rapidly in terms of technology more than ever before. Engineers are expected to keep up with the change of pace by constantly upgrading themselves with technical engineering competence and to develop additional skillsets, including global competence to survive in a global engineering environment. A key element to develop global competence and perspective is through a gratitude of, and admiration for other cultures. Several studies unanimously agree to the fact that the best way to develop such skills is through international exposure through significant academic prospectus that exposes students to cultures other than their own [9]. Timely studies show a need for an American workforce that is more globally conscious, more competent in cross cultural communication, and more conversant in international business customs. A society that is completely global demands engineering students with international perspective. Recruiting companies consider global competence as one of the key skills while hiring process [9].

A means of addressing the needs for engineers with global skill sets is providing international opportunities. However, few universities have international programs integrated within their STEM curriculum [3]. There has been research that the need for global experiences within the engineering curriculum are necessary to achieve students with global competence. Warnick (2010) identified the following eight categories of engineering global competence [9]:

1. Exhibit a global mindset
2. Appreciate and understand different cultures
3. Demonstrate world and local knowledge
4. Communicate cross-culturally
5. Speak more than one language including English

6. Understand international business, law, and technical elements
7. Live and work in a transnational engineering environment
8. Work in international teams

Global competence is a needed trait of engineering professionals. It is hard to have a global mindset without having some sort of international experience. International experiences have typically been trips out of the U.S., immersing the students in another culture. But when one reflects upon the aforementioned eight categories of engineering global competence, none require students to leave for a study abroad experience; albeit, a study abroad experience would provide an opportunity to improve global competence in students.

Study Abroad

Over 100 years ago, the U.S. government along with institutions of higher education and non-profits created the conduit for scholars and students from other countries to enter the U.S., as it was seen as a way for America to benefit and progress [4]. The number of students entering the U.S. from other countries has increased by more than 80 percent over the past two decades [4]. There was a decline in new international students after September 11, and more recently due to what has been coined the “Trump Effect” as the policies that affect immigration and visas have changed [10]. Even with the drops in the new students, the total number of international students in the U.S. rose slightly due to international students who were already in the U.S. participating in the optional practical training program that allows them to stay in the U.S. for an additional 3 years while working on their student visas. In 2019 there were almost 1.1 million international students in the U.S. [11], [10]. The U.S. State Department keeps yearly statistics on the international exchange activity both inbound and outbound higher education students. The data is published by The Institute of International Education in the *Open Doors Report*. The statistical data on numbers of international students in the U.S. and U.S. students studying abroad in this paper come from the 2019 *Open Doors Report* [11].

The U.S. hosts about 21% of all international students worldwide, contributing \$17.7 billion to the economy over their multi-year stay [5]. Most countries view international experiences as critical elements to remain competitive in the world job market [5]. While the United States is one of the leading countries when it comes to hosting international students, fewer U.S. students leave the country for international experiences according to United Nations educational, Scientific and Cultural Organization (UNESCO). In fact, the U.S. is consistently ranked as the country with the lowest outbound ratio.

While a majority of international students enter the U.S. for multiple year experiences, earning degrees from higher education institutions, the outbound U.S. students do not typically study abroad more than a calendar year. In fact, only 1% of the U.S. students studying abroad stayed for a calendar year, with only about 2.2% of the 341,751 U.S. students studying abroad in 2017/2018 stayed aboard for the academic year. The 341,751 students participating in study abroad programs were an all-time high number when compared to the last decade, however this number is a very small fraction of the total number of students in the U.S. Most U.S. students opted for shorter study abroad durations [11].

The shorter terms like one semester and summer term study abroad experiences are more popular among U.S. students. In 2017/2018 the summer study abroad term attracted 38.5% of the students seeking study abroad experiences, with a majority of around 30% of the 38.5% of students opting for a two to eight-week summer international experience. About 5.5 % chose summer experiences that lasted 2 weeks or fewer and 3% stayed abroad more than 8 weeks during the summer [11]. In the same year, 30% of students chose the semester abroad option. Other durations of study included the following: 8 weeks or less during the academic year, January term, one quarter, and two quarters. The duration of U.S. studies abroad experiences from 2013-2014 through 2017-2018 are represented in Figure 1.

Figure 1 provides a snapshot of the data on study abroad durations for U.S. student for the last 5 years. Results shows a very clear pattern of decreasing number of students for long term studies abroad experiences. However, there is a steady rise in the number of students taking part in study abroad programs consisting of 8 weeks or less during the academic year and programs which are fewer than two weeks. In comparison, the number of students participating in academic year, one quarter, two quarter and a calendar is almost insignificant. From the graph, one can conclude that currently students are more interested in study abroad programs that require shorter time commitments, while still providing international exposure [11].

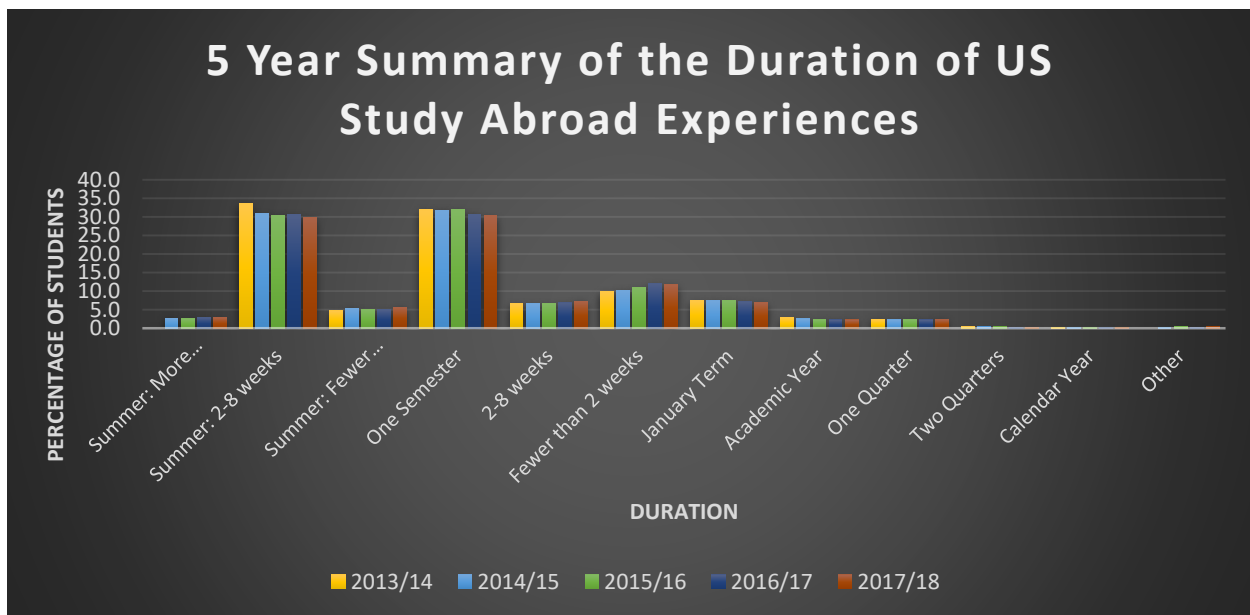


Figure 1: U.S. students’ duration of study abroad programs
 Source: IIE, *Open Doors: Report on Duration of Study Abroad 2007/08-2017/18*

Alternate International Experiences

Short term international experiences are becoming increasingly popular among students. As students shy away from longer terms abroad, there are opportunities for alternate international experiences that still provide global interaction. Several studies and on-going research show that international class collaborations, international competitions, service-learning projects, and co-

ops help future engineering students to gain an international exposure without committing to long term programs and financial impacts associated with longer durations abroad.

There are several significant determining factors affecting international study which include: country size, cost of living, distance from the host country, educational background, university quality, host country language and climate [5]. The cost of study abroad programs can vary depending on the location of the institution, the discipline of study and the length of the program. At Indiana University Purdue University Indianapolis (IUPUI), the average cost of semester long study abroad program is \$6,439, average cost of summer program is \$4,026, average cost of a spring break program is \$3,188 [12]. These are average costs that do not include tuition and other fees. All graduating engineering students might not have the time and money required for a study abroad program. All these factors along with current socio-economic condition of the host country play vital role as deciding factors when it comes to study abroad program. However, a few of the alternative international experiences do not require the physical presence of a student to other international country.

International Virtual Design Courses is one such example of an alternate international experience. These courses were designed to provide students with an international experience similar to study abroad, but would not require significant financial or time commitment from the students [13][8]. The International Virtual Design Experience courses are designed for engineering students whose institutions are widely separated by geography, time and culture, where students use electronic communication technologies to engage with other students and instructors. The first International Virtual Design Experience course was a collaboration in the year 1996 between the Middle East Technical Institute (METU) in Ankara, Turkey and Union College, New York. Students from both the institutions were paired to form design teams. Within a span of 16 weeks, the students were challenged to complete design and submit the results into a competition held at Turkey [14].

Another recent study shows that a series of international collaborative virtual course was conducted by universities in Japan, Germany and Sri Lanka. Results from the study accomplished the fact that smart virtual e-learning courses is an alternative effective method to teach students global software engineering [8]. International Virtual Design Experience courses are becoming more common as electronic communication technologies are readily available and students are well versed in digital communication tools. The combined effect of advanced communication technologies and e-learning methods challenge students to learn, evolve, problem solve, and work as team in a mixed cultural group.

A recent study shows that International Student Competitions are another means to gain international exposure along with other benefits of its own [15]. As an example, the Associated Schools of Construction host international student competitions where two to three undergraduate students from one country pair with the same number of students from another country to form a competition team. The students use smart communication applications to plan and strategize ahead of the competition, and then meet up to finalize the preliminary work and compete. The students learn and adapt to new technologies required to deliver their part in the competition. Many universities or corporate donors subsidize the competition and travel taking away the burden of financial costs completely or partially from the students. The timeframe of the competition preparation is typically a couple of months, while the actual travel and

competition experience is about a week. The international competitions provide students global exposure, increase students' cultural awareness, challenges students' problem-solving abilities, and deliver projects in an unfamiliar environment. Studies conducted show that such competitions have profound positive impact on students [16],[17],[18].

International service learning projects are also a means for students to gain cultural experiences while practicing project based learning and teamwork. Service learning groups like Engineers Without Borders, Bridges to Prosperity, and Global Brigades incorporate international experiences service learning projects that often place students in locations of need to help solve problems surrounding basic human necessities like access to clean water, proper sanitation, and access to healthcare and education facilities [19]. Similar to the other aforementioned international experiences, students gain international exposure, problem solving experience on real world projects, and are challenged in ways that affect their future lives and careers as engineers [19]. Service learning projects can range in duration from a couple of weeks to entire semesters abroad.

Figure 2 shows the percentage of students taking part in study abroad programs for a full academic year versus summer programs less than weeks versus a two-week program during a semester. As displayed by the graph, there is a significant decrease in participation of students for a full academic year and significant rise in participation for short-term international experiences. The percentage decrease in case of academic year program from 2010/11 through 2017/18 is -40.54%. The percentage increase in case of summer short term programs is 72.27% and programs fewer than a week during a semester is 40.96% [11].

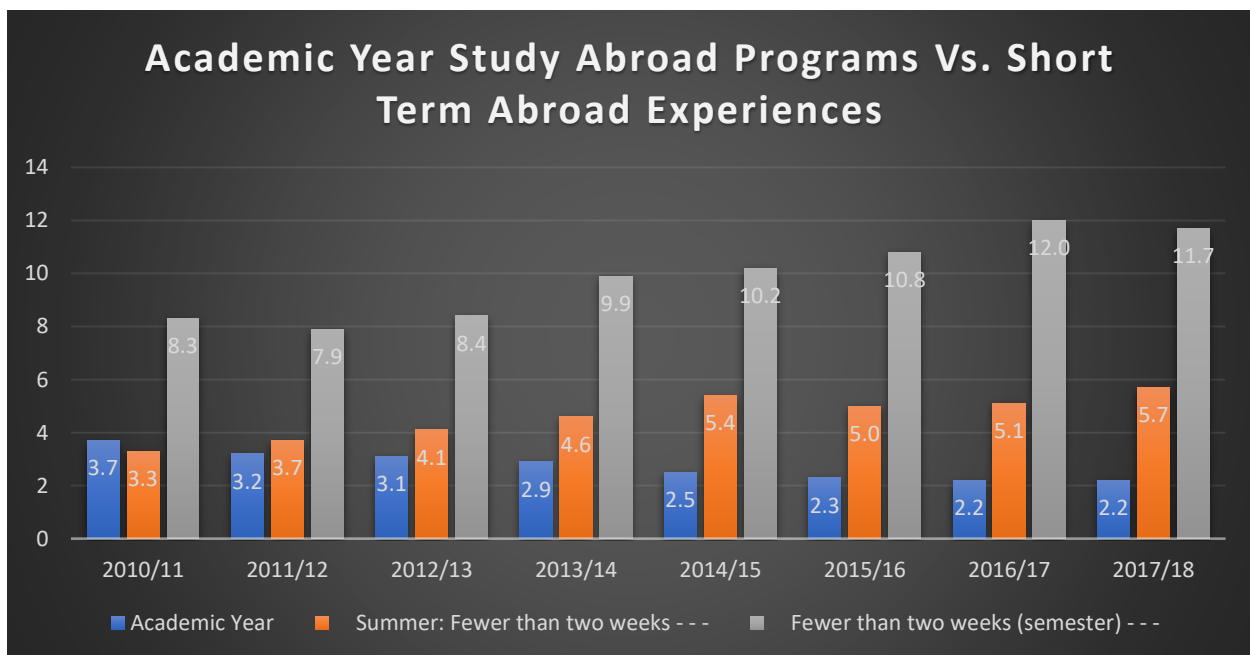


Figure 2: Academic Year Study Abroad Program Vs. Short Term Abroad Experiences

Source: IIE, *Open Doors: Report on Duration of Study Abroad 2007/08-2017/18*

Benefits of International Collaboration for Students

International collaborations and experiences, whether short or long durations, provide opportunities for graduating engineering students making them internationally competent, improving their world-mindedness, and increasing their self-confidence. Research shows higher graduation rates and employability with students who pursue study abroad programs [20]. International collaboration experiences positively impact the students' technical skillset, improves career opportunities, and has a long term effect on their personal career promotion and progression [21].

There is a significant gap between what the employers need and what the institutions think they are producing. A survey conducted by Gallup-Lumina Foundation found out that, about a third disagree with the fact that higher education institutions in this country helping graduating students with the skills and competences that business needs. -- including 17% who strongly disagree -- while another third is neutral [22]. The contemporary idea in engineering is to complete a program with rigorous coursework, completing numerous courses, assignments and projects. Most engineering undergraduate programs focus on technical coursework.

Employers are looking for more than just technical skills in the engineers that they hire. They look for new employees equipped with soft skills which are currently considered equally important as technical skills. A study by Hansen and Hansen included the following as the most critical employability skills by the employers: communication (listening, written and verbal); analytical/research abilities; computer/technical literacy; flexibility/adaptability/managing multiple priorities; interpersonal abilities; leadership/management aptitudes; multicultural sensitivity/awareness; planning/organizing; problem-solving/reasoning/creativity; and team work [23]. International collaboration for students encourage students to gain insight towards professionalism; reliability; ability to cope with uncertainty; work under pressure; capability to communicate and interact with others, either in teams or through networking; good written and verbal communication; information and communication technology skills; creativity and self-confidence; good self-management and time-management; and willingness to learn and accept responsibility. These skill sets are uncommonly developed by students inside their domestic environment [24] [25] [26] .

A study conducted by the Corporate Member Council (CMC) of the American Society for Engineering Education (ASEE) summarized communication; teamwork; leadership; flexibility; curiosity and desire to learn - for life; ethical standards and professionalism as the key criteria's that an employer look into [27]. There are multiple soft skill attributes that are form an integral part of global engineers, all of which can be gained through international exposure. Encouraging students to take part in the different programs that open up opportunities for international collaboration is the ideal way to learn multicultural awareness, teamwork, responsibility, leadership, communication to name a few.

Conclusion

To meet the demands of the global workforce, employers are looking for engineering graduates with global competence. Employees with a global mindset are able to communicate across cultures and see value in diverse experiences as it leads to more effective problem solving. International experiences with the most notable being study abroad can provide opportunities for students to encounter other cultures and communicate cross-culturally. However, to date less than 2% of the almost 20 million college students are participating in international experiences [11], [28]. While costs and time away from studies are the two most cited challenges, the benefits gained through international and cross-cultural interaction are crucial to the advancement of the students in their future careers.

Studies on alternate international experiences to study abroad have shown similar benefits to study abroad on improving the global competence of participants, but often cost less and/or require shorter or no time abroad. Options like student international competition teams offer a hybrid approach with virtual collaboration occurring before the competition to prepare, and an international experience that follows as part of the competition. Virtual Design Courses also provide opportunities for global exposure as student learn and work on cross cultural teams using electronic communication technology. While experiencing other cultures firsthand provides the most comprehensive international experiences, other alternate options should be explored to increase the global competence of the 98% of college students that are not currently getting the benefits of international exposure.

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