Achieving Global Competence: Are Our Freshmen Already There?

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Abstract

Engineering programs are being challenged to produce graduates who are globally prepared or have a global perspective. While an admirable goal, how best to not only accomplish but also measure this? As part of a much larger study of the effectiveness of various forms of international experiences, we have used a comprehensive instrument to survey our incoming freshman engineering students relative to demographics, international experiences, and global perspectives. To do this we have incorporated the Global Perspective Inventory (GPI), a nationally normed instrument that measures students' global learning and development into a survey of their international experiences and demographics prior to entering the University of Pittsburgh. Specifically, the GPI's three components measure how a student thinks (i.e., Cognitive domain); how a student views him/herself as an individual with a cultural heritage (i.e., Intrapersonal domain); and how a student relates to people from other cultures, backgrounds, and values (i.e., Interpersonal domain). We have used this instrument to better understand the level of global preparedness of our incoming freshmen, and particularly, how it is influenced by demographic factors and experiences prior to entering college. In this paper we present our findings, comparing freshmen with graduating seniors relative to global preparedness and experience. We provide recommendation for engineering faculty, including how to better identify those students who may enter with relatively low levels of global "preparedness," as well as those who are at the higher end. Findings to date suggest that a large number of students enter the university with a relatively high level of global preparedness. While students from suburban areas tended to have the highest GPI levels, this was also true for students from rural areas and small towns if one or more parents had an advanced degree. We also found a somewhat more disproportionately high number of female students were among those with the highest social interaction dimension of the GPI. Most important, when we compared the GPI scores of freshmen to those of graduating seniors, we found that the students' international experiences prior to entering college appears to be a major factor in their achieving a global perspective by graduation.

Introduction

The need for engineering graduates to achieve a reasonably high level of "global preparedness" has been recognized and promoted by both the professional and educational engineering communities in conferences, national reports, and publications.[1] The National Academy of Engineering (NAE), the National Science Foundation (NSF), and the National Research Council (NRC) have each challenged universities to graduate students who are globally prepared or have a global perspective.[2–4] But how can this be measured? Which types of international experiences are most effective in fostering global preparedness among engineering students? What contextual

factors are catalysts for students achieving various degrees of global preparedness? In what ways can engineering programs best provide students from diverse backgrounds with a variety of international experiences to maximize their global preparedness? These are questions we have set about to answer as part of a large, multi-university study[5].

Specifically, in this NSF funded study of the effectiveness of various forms of international experiences, we have used a nationally recognized and normed instrument to survey both first year and senior engineering students initially at four partner institutions, and more recently at an additional dozen engineering programs throughout the U. S. In doing this, questions arose that we needed to address if we were going to better understand the impact of the various forms of international educational experiences available to engineering students: How many of our freshmen enter with international experiences? What are these experiences? How does the demographic background and experiences of these entering students impact their global preparedness? What is their global perspective level when they enter the university? How does this compare to national data?

To address these questions, we administered the Global Perspective Inventory (GPI), a nationally normed instrument that measures student's global learning and holistic development[6] to all entering freshmen at medium sized, public school of engineering in Fall 2015. The GPI was chosen because it most closely captures the global competency constructs which we intended to measure (based on a prior Delphi study[7-9] that we conducted), has been extensively tested for validity and reliability, and is easily accessible and understood by international education researchers and the students they are assessing. As discussed below, the GPI consists of three scales, each of which is divided into two subscales. However, these subscales are based on two different holistic human development perspectives that frame the GPI: *the theory of cultural development* and *intercultural communication theory*. Because of the large amount of data, we decided for our initial analysis to aggregate the scales based on their underlying theories; i.e., cultural development and communication. Once significant differences have been identified, then we will be able to drill deeper into the subscales in follow-up studies.

Here we present our findings from this first, descriptive study, in which we have analyzed the incoming first year engineering class and have compared it with a sample of graduating seniors to begin to answer the questions concerning the level of global preparedness of both entering freshmen and graduating seniors and how these levels are influenced by both demographics and experiences. In addition, we are interested in learning how many of our entering students "are already there?" relative to their global perspective. This exploratory analysis will enable us to form hypotheses about the nature of "global preparedness," and its overall development prior to and during the college years as we begin to analyze a much larger sample of data from students across the country. Here we provide preliminary recommendations for engineering educators,

including the need to better identify students who may enter with relatively low levels of global preparedness (as well as those at the higher end), and, consequently, to more effectively foster global preparedness throughout the undergraduate years.

Literature Review

Global preparedness of incoming freshman

As noted, a series of national reports and studies, motivated by globalization, and even the ABET criteria have caused engineering educators to recognize a need to prepare graduates with the knowledge, skills, and attitudes to compete globally. Yet, despite an apparent growing consensus on the educational importance of international experiences, there is little consensus as to how this can best be achieved.[6] Research has shown the positive effects of study abroad on global learning, but these findings are constrained by how this is measured, and how it might change over time; nor have other mitigating factors been controlled[10-12]. While this is a descriptive study, motivated by our earlier work, we posit that the perspectives, backgrounds, and prior experiences of entering freshman engineering students contribute significantly to their global preparedness trajectory throughout college. Mckeown[13] echoes similar beliefs in his book *The First Time Effect: The Impact of Study Abroad on College Student Intellectual Development*, citing research that indicates that previous international influences such as travel and parent backgrounds can lead to greater perceived levels of global competency compared to students who have not had an internationally oriented upbringing[14,15]. However, to date, studies that have attempted to measure global preparedness have found only modest gains over the four college years[6,10,16]. Of particular interest is work done by Salisbury, An and Pascarella who explored the impact of study abroad on intercultural competence while accounting for precollege characteristics, institutional differences, college experiences, and study abroad intent[10]. Their findings suggest that although international experiences such as study abroad can contribute to gains on measures of intercultural competence, the nature of these gains across particular underlying constructs only marginally supports that study abroad in and of itself prepares students.

In addition, research conducted by Bennett and associates[17,18] document the developmental nature of global preparedness, and finding that time is required to acquire intercultural competence. They have identified six orientations that people move through in achieving intercultural competence, with the first three conceptualized as more *ethnocentric* (avoiding cultural difference), and the second three conceptualized as more *ethnorelative* (seeking cultural difference). Students progress through these orientations as their experience with cultural difference becomes more complex and sophisticated[17]. We presuppose that the college international experiences and strategies that are designed to prepare students most effectively not only depend on their background and prior experiences, but also on their initial global perspective orientation.

The Global Perspective Inventory (GPI)

The GPI, developed by Braskamp, Braskamp, and Engberg[6] measures how students think, how they view themselves as people with a cultural heritage, and how they relate to those from other cultures, backgrounds, and values. It was designed and constructed so that persons of any age or specific cultural group can use the 5-point Likert-type scale instrument. The GPI identifies three major domains of human development (cognitive, intrapersonal, and interpersonal), with two subscales within each domain. The **Cognitive** domain centers on one's knowledge and understanding of what is true, what is important to know, and how one determines each of these things. The **Intrapersonal** domain seeks to understand how one integrates one's personal values and self-identity into one's personhood and how one becomes aware of this process. The **Interpersonal** domain considers one's willingness to interact with persons with different social norms and cultural backgrounds, acceptance of others, and comfort with relating to others. Of particular importance are the two theoretical perspectives that encompass these developmental domains: *cultural development* and *intercultural communication*. Cronbach's alpha (α), a unique estimate of the reliability of a test's scores and score interpretations, is reported for each subscale[19] (see below). There are different reports about the acceptable values of alpha, ranging from 0.70 to 0.95[20].

Theory of Cultural Development is based on the work of Robert Kegan[21] who argued that as people grow they are engaged in meaning making. People rely on their thinking, feeling, and relating with others in forming their life journey. King and Magolda have refined these domains in describing students in their social-cultural development during their college years, and call this developmental view "intercultural maturity[6,22]. The subscales in the GPI that reflect the theory of cultural development are:

- Cognitive – Knowing (α = .66);
- Intrapersonal – Identity (α = .74); and
- Interpersonal – Social Responsibility (α = .73).

Table 1 shows GPI cultural development sample items by subscale. The Knowing subscale reflects the degree of complexity of one's view of the importance of cultural context in judging what to know and to value and is "content free." Identity is a combination of the level of awareness of one's unique identity and degree of acceptance of one's ethnic, racial, and gender dimensions of that identity. This is a central goal in the development of college students in their formative years. Social Responsibility measures the level of interdependence and social concern for others and is often a common goal among educators in engineering programs[6].

Table 1. Cultural Development Sample Items by Selected Subscales

Subscale/Construct	Sample Index Item
Cognitive Knowing	"I take into account different perspectives before drawing conclusions about the world around me."
Intrapersonal Identity	"I put my beliefs into action by standing up for my principles."
Interpersonal Social Responsibility	"I consciously behave in terms of making a difference."

Intercultural Communication Theory: Scholars who prescribe to this theory have also recognized the importance of cognitive (thinking), affirmative (feeling), and behavioral domains (relating to others) to success with communicating in multi-cultural contexts. It is argued that to be an effective communicator in a global society, one must be competent and sensitive within these domains. The subscales that reflect the Intercultural Communication Theory are:

- Cognitive – Knowledge (α = .77);
- Intrapersonal – Affect (α = .73); and
- Interpersonal – Social Interaction (α = .70)

Table 2 gives the GPI's intercultural communication theory subscales. The Knowledge subscale reflects the degree of understanding and awareness of various cultures and their impact on our global society. This subscale also portrays a level of acquisition of knowledge about multicultural issues. The Affect subscale measures the level of respect and acceptance of cultural perspectives different from one's own and degree of emotional confidence when living in complex situations. The Social Interaction subscale measures the degree of engagement with others who are different from oneself and degree of cultural sensitivity when living in pluralistic settings[6].

Table 2. Intercultural Communication Items by Selected Subscales

Subscale/Construct	Sample Index Item
Cognitive Knowledge	"I am informed of current issues that impact international relations."
Intrapersonal Affect	"I am sensitive to those who are discriminated against."
Interpersonal Social Interaction	"I frequently interact with people from a race/ethnic group different from my own."

Braskamp and colleagues have collected a large sample of college student GPI scores[6], which can be taken as "national norms." See Table 3 below. An examination of each of the subscales in the table reveals an upward trend in only three of the six – knowing, social responsibility and affect. The other three reveal no pattern in student progress through the four years of college. Consequently, for our analysis, we chose to use the average of the cultural development and the intercultural communication items. These averages are also shown in Table 3; they indicate an increasing growth trend for the former and no trend for the latter. That is, based on a very large sample of college students, there is a small, but consistent positive growth pattern for those items based on cultural development theory, but no similar pattern for the three subscales based on intercultural communication. Figure 1 illustrates how we have combined the six constructs to give us two measures of the students' global perspectives level. Note that these "norms" are based on data primarily from liberal arts students; it only includes an estimated 15% from STEM students (and obviously less for engineering students). Further it is biased by a large majority of respondents being female who tend to have higher GPI scores[23].

Table 3: Means of GPI Scales by College Year[6]

| Scale	First-year	Sophomore	Junior	Senior	Average
Cultural Development	3.75	3.79	3.81	3.84	3.80
Cognitive Knowing	3.51	3.65	3.68	3.70	3.63
Intrapersonal Identity	4.05	4.01	4.03	4.07	4.04
Interpersonal Social Responsibility	3.69	3.71	3.73	3.74	3.72
Intercultural Communication	3.71	3.69	3.68	3.72	3.70
Cognitive Knowledge	3.62	3.56	3.57	3.63	3.60
Intrapersonal Affect	4.10	4.15	4.16	4.17	4.14
Interpersonal Social Interaction	3.42	3.35	3.30	3.36	3.36
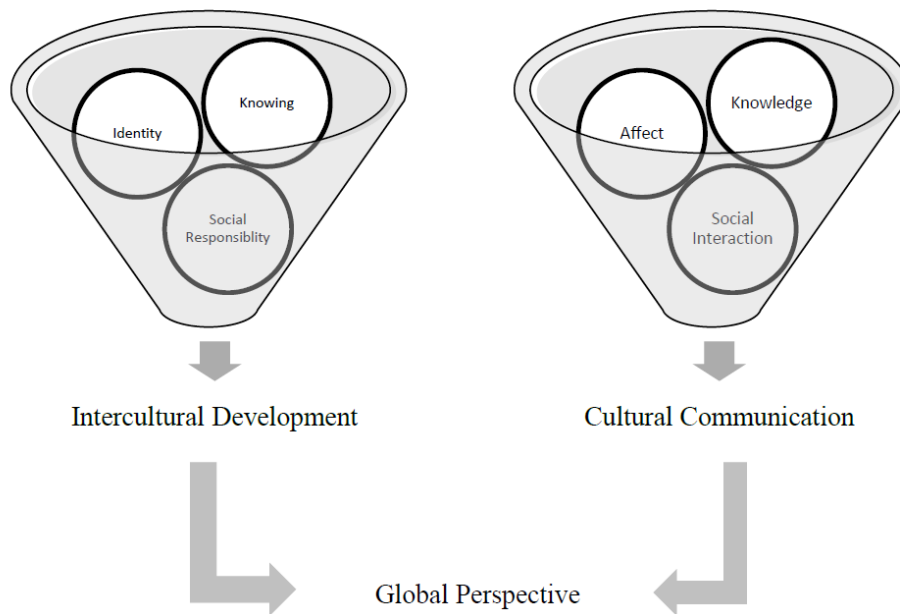
Figure 1: The GPI Constructs – Combining into Two Measures

Methodology

Survey Design, Administration and Participants

To collect data for our descriptive study of students' global preparedness, we administered an instrument that included the GPI and a set of questions soliciting demographics and prior international or globally-related experiences. Demographic items included gender; type of location where the student was raised (i.e., urban, suburban, rural or small town); parents' educational background; possession of a passport; birth place of student; and parents' birthplace. Types of international or global experiences included personal tourism, study abroad (by length of time), second language acquisition (ability to speak; ability to take a course in that language); international service learning; and internship or co-op abroad (for college seniors). The complete set of international or global experiences contained in the survey is shown in Table 4 (although clearly not all are applicable to incoming first-year students). Respondents were asked to indicate all experiences they had, and to provide detailed information on their most recent experience. Alternatively, a student could select "no international experiences." For each international experience, the student was asked to indicate the duration of time spent abroad (if applicable) and if the experience was before or while in college. Obviously, all freshmen experiences were prior to entering college.

Table 4: International Experiences

Personal tourism
Second language course
US-based research project with a global issue
US-based engineering course with international project
Service learning program – engineering focused (e.g., Engineers without Borders)
Service learning program – non-engineering focused
University housing with an international focus
Study Abroad
Course with a global focus – engineering based
Course with a global focus – non-engineering based
Internship, co-op, or technical research project conducted internationally
Dual-degree program with an international university
Other – provide details

We administered the instrument to all incoming freshmen engineering students in for the Fall 2015 term and graduating seniors for both Fall 2015 and Spring 2016 terms. (Because of a large co-op program, seniors graduate in December, May and August.) First-time freshmen took the survey during registration prior to the start of the school year. Out of a freshman class of 616 students, we received completed responses from 530 freshmen, representing 86% of the class. Of this number, 515 individuals were non-international students. The graduating seniors completed the survey between the midpoint and end of the semester; we analyzed completed responses from 382 seniors, representing 69% of the graduating students (and anticipate additional surveys being received). These seniors received nine different B.S. engineering degrees (bioengineering, chemical, civil, computer, electrical, industrial, mechanical, materials science and engineering science).

The average SAT score for the freshmen engineering students was 1397; 29% were women; only 18 were international students. For this current study, we eliminated from our analysis those students who indicated they were citizens of another country and in the U.S. on a student visa.

Demographics

We were surprised to find that 70% of our responding freshmen possessed a U.S. passport; 32% were female compared to 29% for the entire class. The large majority (73%) had both parents and at least one grandparent born in the U.S. (and they also). Further, the large majority (70%) were raised in a suburban environment, compared to 12% in an urban environment, 13% in a small town, and 5% in a rural setting. Only a few were first-generation students; i.e., 6% had parents with just a high school education; another 5% of parents obtained an associate degree in contrast to 35% at the BS/BA level, 37% with an MS/MA degree, and 17% with a doctorate

degree. Over a fourth of the students (27%) indicated they could converse in a second language and 21% indicated that they would be comfortable taking a course in a second language. With respect to ethnicity, 82% identified themselves as Caucasian, 15% Asian-American and 6% African-American. In general, these students had more international experience than anticipated.

Analysis Methods

Having learned that 70% of our incoming students possessed a U.S. passport, we were motivated to investigate the relationship between their international experiences prior to college and the students' respective global preparedness levels. We decided to do this, by using the tree structure shown in Figure 2. This enabled us to draw comparisons not only between those who had no international experience with those who had one or more.
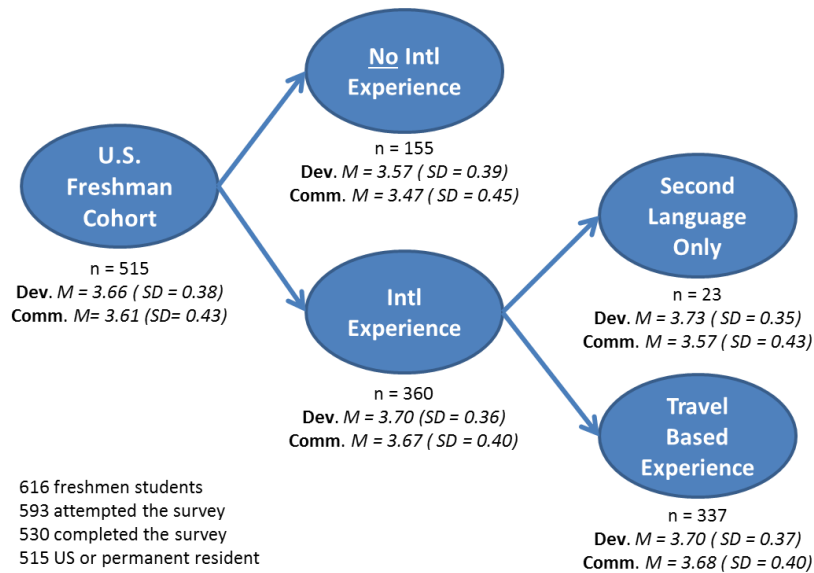

Figure 2: International Experiences and GPI scores for Entering Freshmen Engineering Students

As shown in Figure 2, the average Cultural Development (CD) and Intercultural Communication (IC) levels for all entering students were 3.66 and 3.61, respectively, compared to the freshmen "norms" given by Braskamp et al[5] of 3.75 and 3.71, respectively (which were obtained during the first year rather than prior to beginning college, and were heavily weighted by liberal arts and female students). However, for those students who entered with no international experience, the respective CD and IC levels dropped to 3.57 and 3.47 respectively. In contrast, the GPI for those freshmen that had some form of international experience rose to 3.70 and 3.67, clearly demonstrating a substantial difference between the two cohorts.

Note that in creating the tree structure shown in Figure 2, and to maintain consistency when comparing the freshmen to other academic levels, particularly graduating seniors, a set of definitions was developed. Specifically, for a student to be classified as having "no international experiences," one of several scenarios applied: The student must have checked the "no international experiences" option, provided no response to the international experiences question, or selected only the second language course experience, but indicated no fluency in that second language; i.e., not able to carry on a conversation in the language nor take a course with instruction in that language. Conversely, students who indicated having had at least one international experience or indicated proficiency in a second language were classified as having had an international experience. This enabled us to further break down the students in terms of those whose international experience was travel based (95.5%) versus non-travel based (4.5%). Interestingly, the Cultural Development GPI level was slightly higher for the no travel group compared to the "travel" group – 3.73 to 3.70, while the Intercultural Communication level was substantially lower – 3.57 to 3.68, an expected result.

Table 5: GPI Levels for No Experience vs. Travel Experience by Demographic Factors

Category	Gender		Where Raised			Parents Education Level		
No Experience	Male (72%)	Female (28%)	Urban (6%)	Suburban (76%)	Small or Rural (18%)	HS/CC (20%)	BS/BA (39%)	MS/PhD (41%)
Development	3.55	3.63	3.59	3.57	3.58	3.59	3.57	3.56
Communication	3.47	3.48	3.55	3.47	3.45	3.41	3.48	3.49
Category	**Gender**		**Where Raised**			**Parents Education Level**		
Travel	Male (66%)	Female (34%)	Urban (12%)	Suburban (71%)	Small or Rural (17%)	HS/CC (8%)	BS/BA (30%)	MS/PhD (62%)
Development	3.67	3.76	3.64	3.69	3.8	3.63	3.69	3.72
Communication	3.66	3.70	3.69	3.62	3.71	3.60	3.65	3.70
Percent with Travel Experience	**67%**	**72%**	**82%**	**67%**	**67%**	**40%**	**63%**	**77%**

We next divided the two categories of no international experience and international travel experience by demographic factors. These results are shown in Table 5. As shown in the table, for all categories those who traveled had higher GPI levels for both Cultural Development and Intercultural Communication. Note that these differences are especially large for the Intercultural Communication level for the three demographic factors examined. The table also reveals several other factors that suggest further analysis. In particular, 82% of students who were raised in an urban environment had an international travel experience prior to entering college compared to only 67% for those from a small town or rural environment. Only 40% of those whose parents had only a high school education had an international experience, while nearly twice the proportion - 77% - of those with one parent with a PhD had an international

travel experience. A slightly higher percentage of females compared to males (72% to 67%) had international travel experiences.

These results suggest that a comparison with graduating seniors would be an appropriate next step. If graduating seniors had no additional international experience beyond those in high school, would their GPI levels be higher than the entering freshmen? If additional experiences were acquired during college, how much higher would the GPI levels be? Consequently, we decided to compare the results to graduating seniors (who were also given the instrument). As noted, because seniors graduate in December, May and August, we will not have a complete set of data until the end of summer 2016. Here we report on the first two sets of graduating seniors. For the seniors, we included an additional level of detail in our analysis in order to identify whether the international experiences (if any) had occurred prior to college *only*, during college *only*, or prior to as well as during college. These results are summarized in Figure 3. For each branch of the tree, we calculated the average GPI scores. Travel experiences were defined as limited to a student's time before college if only the "pre-college" check boxes were selected by the student. The "during college only" definition was analogous.
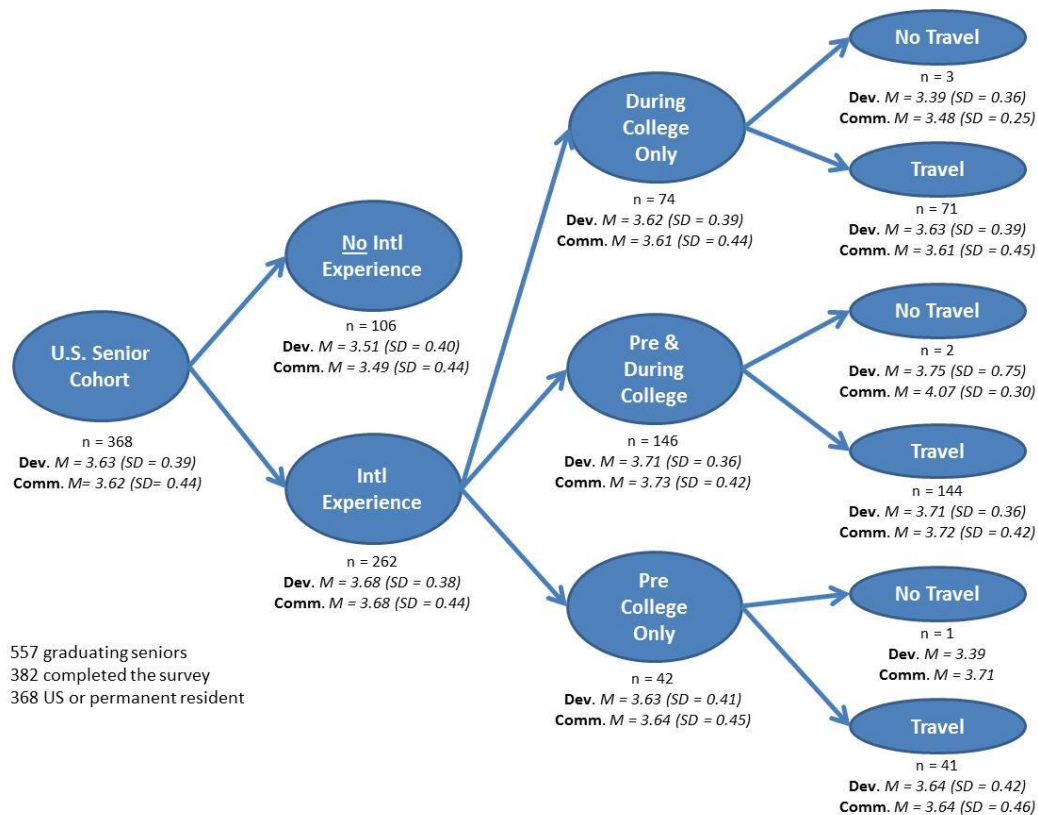

Figure 3: International Experiences and GPI scores for Graduating Senior Engineering Students

We received completed surveys from 69% of the graduating seniors; the respective CD and IC levels were 3.63 and 3.62, which surprisingly are approximately equal to the respective levels for entering freshmen of 3.66 and 3.61. These levels are also substantially less than the norms reported by Braskamp, et al. for seniors of 3.84 and 3.72. (Why they are substantially different is an issue that will be explored in a later study.) However, it is important to parse these results as through the tree structure. It should be noted that international activities are strongly promoted within the study's engineering school. As shown in Figure 3, a very high proportion - 71% - of those seniors completing the instrument was classified as having had an international experience, all though for 1/6th, that experience was prior to coming to college. How do those graduating seniors with an international experience compare to those without one? Here the differences are quite striking – those with some form of international experience had GPI levels of 3.68 and 3.68, or just above the undifferentiated entering freshmen. In comparison, those with no international experience had levels substantially lower at 3.51 and 3.49. Recall the levels for freshmen with no experience were 3.57 and 3.47 respectively. Moving across the figure, seniors whose only international experience occurred pre-college had respective scores of 3.63 and 3.64 compared to freshmen entering with international experience of 3.70 and 3.67 respectively. Does this suggest that in the absence of no international experience during the college years, graduating seniors actually exhibit a decline in their global perspectives? Suppose the only international travel experience is during the college years? Here we see that the levels are 3.62 and 3.61 or about the same as that achieved by those who had their international experiences pre-college only. However, for those students who have had travel experiences both pre-college and during college, the levels rise to 3.71 and 3.73 respectively. Table 6 summarizes the relevant findings.

Table 6: GPI Scores of Freshmen and Seniors by Category

Academic Level and International Experience	Development Mean (SD)	Communications Mean (SD)
Freshmen – no experience	3.57 (.39)	3.47 (.45)
Freshmen – international experience	3.70 (.36)	3.67 (.40)
Seniors – no experience	3.51 (.40)	3.49 (.44)
Seniors – Pre-college only experience	3.63 (.41)	3.64 (.45)
Seniors – College only experience	3.62 (.39)	3.61 (.44)
Seniors – Pre-college and college experience	3.71 (.36)	3.73 (.42)

Discussion

This descriptive study of the global preparedness/perspectives of entering freshmen engineering students suggests that further analyses is needed to form more definitive conclusions; however, it

does begin to provide guidance for engineering educators. To reiterate our finding, first there were substantially more students who already had a passport and international experience than anticipated. Second, these first-year engineering students who already had an international experience had GPI scores that averaged 3.70 and 3.67 (based on development and communication theories respectively) compared to those who had no experience (3.57 and 3.47). Rather than calculate statistical significance (due to the very large sample sizes), we calculated the effect size[24] instead. Basically, the effect size (ES) measures the magnitude of a treatment effect; in this case, the "effect" of an international experience. To state another way, effect size can be used as a measure of practical significance[25,26]. As shown in Table 7, the relative effect sizes are .35 and .47, which according to Cohen, can be considered to be small and moderate gains respectively; i.e., gains below .2 are considered to be insubstantial or "insignificant"; greater than .2 up to .5 are small; .5 and greater are moderate and .8 and greater are large[24].

Table 7: Effect Sizes for Various Comparisons (Cohen's D)[24]

Comparison	Development	Communications
Freshmen no experience vs Freshmen with international experience	.35 (small)	.47 (moderate)
Freshmen no experience vs seniors no experience	-.15 (insignificant)	.04 (insignificant)
Seniors no experience vs seniors pre-college only	.30 (small)	.34 (small)
Seniors no experience vs. seniors college only	.28 (small)	.27 (small)
Seniors no experience vs. seniors with both pre-college and college experiences	.53 (moderate)	.56 (moderate)

We then compared entering freshmen with no experience to graduating seniors with no experience. Not surprising, effect sizes were insignificant (-.15 and .04). This suggests that our pools of students relative to international experiences or lack thereof are similar. Similarly, scores for freshmen who entered with international experience (3.70 and 3.67) compared to scores for seniors who had no additional experience in college (3.63 and 3.64) revealed an insignificant, but negative effect (-.18 and -.07). In contrast, when those same seniors who entered with experience but had no additional experiences in college were compared to seniors who had no experience, the effect sizes were both in the small range; i.e., .30 and .34. Taken together, this implies, no real positive progression occurs without some type of international experience, even if it is only pre-college.

Finally, we used those seniors with no experience as a baseline to compare to those who had only an international experience during college, and those who had both pre-college and in-college

experiences. For those with only an international experience while in college, the effect sizes are .28 and .27, or small. However, for those who had experiences both pre-college and in-college, the effect sizes are .53 and .56, or moderate. To us, this demonstrates that the international experience(s) engineering students have prior to beginning college is extremely important (and most likely has been an overlooked) factor in graduates achieving an acceptable global perspective.

Further, it suggests that a key to obtaining a relatively high level of global preparedness or perspective may be to both build upon that pre-college experience and at least encourage students to have multiple international experiences over the college years. In fact, one experience may not be sufficient. (A finding confirmed by the extensive studies of the Taglit-Birthright Israel Project done by Saxe and colleagues at Brandeis University[27].) As we acquire more data, we will be able to better parse the international experiences – looking at both number and type – to learn more about where the greatest impact occurs, and the effect of multiple experiences at both pre-college and college levels.

Finally, these preliminary results highlight the importance of encouraging engineering students who enter without prior international experience, to take advantage of an increasing number and variety of international education programs and research opportunities now available, if achieving global preparedness is important to the institution. In particular, engineering educators and administrators should focus on those students from rural areas and small towns as well as first generation college students, who may require additional encouragement (not to mention financial assistance) if they are to graduate as a more globally prepared engineer.

This paper provides a first look at these issues. Our much larger study will provide data from our three partner schools and an additional dozen engineering programs distributed across the U.S. that collectively offer a very diverse set of international opportunities, enabling us to begin to draw more definitive conclusions.

Acknowledgements

References

1.   American Society for Engineering Education. *The Green Report-Engineering Education for a Changing World*. (2010). Retrieved from http://www.asee.org/resources/beyond/greenreport.cfm

2.   National Academcy of Engineering. The Engineer of 2020: Visions of Engineering in the New Century. National Academy Press,(2004). Retrieved from http://www.nae.edu/Programs/Education/Activities10374/Engineers of2020.aspx

3.   National Science Foundation. *Investing in America's Future: Strategic Plan*, *FY 2006-2011* (Arlington, VA: National Science Foundation)

4.   Engineering Education and Practices in the United States: Foundations of our Techno-Economic Future *(Washington, DC: National Research Council)*

5.   National Science Foundation (EEC 116040) Collaborative Research: Assessing the Spectrum of International Undergraduate Engineering Educational Experiences.

6.   Braskamp, L. A., Braskamp, D. C. & Engberg, M. E. Global Perspective Inventory (GPI): Its Purpose , Construction , Potential Uses , and Psychometric Characteristics. *Glob. Perspect. Inst.* 1–35 (2014). at <http://gpi.central.edu>

7.   Besterfield-Sacre, M., C. Matherly, G. Ragusa, L. Howard, and L.J. Shuman. "Assessing the Spectrum of International Undergraduate Engineering Education Experiences," 2013 ASEE International Forum, Atlanta, GA, June 22, 2013.

8.   Streiner, S., S. Cunningham, S. Levonisova, S. Huang, C. Matherly, M. Besterfield-Sacre, G. Ragusa, L. Shuman, and D. Kotys-Schwartz, Moving Toward a Research Informed Conceptual Model of Engineering Global Preparedness, 2014 ASEE Annual Conference and Exposition, Indianapolis, IN June 2014

9.   Huang, S., S. Levonisova, S. Streiner, S. Cunningham, G. Ragusa, M. Besterfield-Sacre, L. Shuman, C. Matherly, and D. Kotys-Schwartz, "Exploring Engineering Education in Broader Context: A Framework of Engineering Global Preparedness," 2014 ASEE Annual Conference and Exposition, Indianapolis, IN June 2014.

10.   Salisbury, M. H., An, B. P. & Pascarella, E. T. The Effect of Study Abroad on Intercultural Competence Among Undergraduate College Students. *J. Stud. Aff. Res. Pract.* **50,** 1–20 (2013).

11.   Murphy, D., Sahakyan, N., Yong-Yi, D. & Magnan, S. S. The Impact of Study Abroad on the Global Engagement of University Graduates. *Front. Interdiscip. J. Study Abroad* **24,** (2014).

12.   Engberg, M. E., Jourian, T. J. & Davidson, L. M. The mediating role of intercultural wonderment: connecting programmatic components to global outcomes in study abroad. *High. Educ.* (2015). doi:10.1007/s10734-015-9886-6

13.   McKeown, J. S. in *The First Time Effect - Impact of Study Abroad on College Student Intellectual Development* 11–28 (2009).

14.   Gerner, M., Perry, F., Moselle, M. a. & Archbold, M. Characteristics of internationally mobile adolescents. *J. Sch. Psychol.* **30,** 197–214 (1992).

15.   Martin, J. The Relationship between Student Sojourner Percentions of Intercultural Competencies and Previous Sojourn Experience. *Int. J. Intercult. Relations* **11,** 337–355 (1987)

16.   Luo, J. & Jamieson-Drake, D. Predictors of Study Abroad Intent, Participation, and College Outcomes. *Res. High. Educ.* **56,** 29–56 (2014).

17.   Hammer, M. R., Bennett, M. J. & Wiseman, R. Measuring intercultural sensitivity: The intercultural development inventory. *Int. J. Intercult. Relations* **27,** 421–443 (2003).

18.   Bennett, M. J. Becoming interculturally competent. *Towar. Multicult. A Read. Multicult. Educ.* **2,** 62–77 (2004).

19.   Gliem, J. A. & Gliem, R. R. Calculating , Interpreting , and Reporting Cronbach ' s Alpha Reliability Coefficient for Likert-Type Scales. in *Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education* 82–88 (2003).

20. Tavakol, M. & Dennick, R. Making sense of Cronbach's alpha. *Int. J. Med. Educ.* **2,** 53–55 (2011).

21. Kegan, R. *In Over Our Heads: The Mental Demands of Modern Life*. (Harvard University Press., 1994).

22. King, P. M. & Baxter Magolda, M. B. A Developmental Model of Intercultural Maturity. *J. Coll. Stud. Dev.* **46,** 571–592 (2005).

23. Braskamp, L.A., personal converstation, January 28, 2016.

24. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

25. Sullivan, G., & Feinn, R. (2012). Using Effect Size-Or Why the P Value is Not Enough. *Journal of Graduate Medical Education, 4*(3), 279-282.

26. Kotrlik, J., Williams, H., & Jabor, M. (2011). Reporting and Interpreting Effect Size in Quantitative Agricultural Education Research. *Journal of Agricultural Education, 52*(1), 132-142.

27. Sace, L, et al, Taglit-Birthright Israel, Brandeis University, https://www.brandeis.edu/cmjs/researchprojects/taglit/publications.html; accessed January 31, 2016.

APPENDIX: Coding Process

To assess whether travel abroad had occurred for students with an international experience, we examined the "duration spent abroad" field associated with a set of international experiences. If the duration was *greater than* zero weeks for any of the experiences, the student was considered to have traveled abroad. Also, if the following international experiences were selected regardless of whether a "duration spent abroad" was specified, the student was likewise considered as having traveled abroad: personal tourism, study abroad, or internship/co-op/technical research project conducted internationally. If the student did not fit the "travel abroad" category, he/she was considered to have *not* traveled abroad. Experiences were defined as having occurred both before and during college if a mixture of pre-college and during-college check boxes were selected for the international experiences.

The following definitions apply to students who are <u>not</u> international students. International students have been removed from the analysis. International students are defined as a "Citizen of another country, student or visa."

None (no international experience) – the "no international experiences" check box is specifically checked or the student provided no response to the experiences question. Alternatively, the student had *only* a "second language course" experience and was <u>not</u> able to take an academic course in the language as well as converse in the language (i.e., second language course experience only and not fluent).

Any (international experiences) – any student who does not fall into the "None" definition above.

> **Pre-College Only** – only pre-college check boxes are checked for the international experiences (13 possible).
>
> **During-College Only** – only during-college check boxes are checked for the international experiences.
>
> **Both Pre-College and During-College** – a mixture of pre-college and during-college check boxes are checked for the international experiences.
>
> **Travel Abroad** – for students with *any* international experiences, the duration spent abroad is *greater than* zero months. Alternatively, the following international experiences were checked, regardless of whether degree of "duration spent abroad" was indicated or not: personal tourism, study abroad, or international internship/co-op.
>
> **No Travel Abroad** - for *all* of the international experiences chosen (i.e., checked) by the student - excluding personal tourism, study abroad, and internship/co-op conducted

internationally (10 check boxes) - the duration spent abroad is indicated as "Did not travel abroad."