Assessing the Spectrum of International Undergraduate Engineering Educational Experiences: A Cross Institutional Survey

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Abstract

International experiences are viewed as important components of undergraduate engineering education. Yet little has been done to define global preparedness, specify alternatives for achieving it, or determine to what degree being globally prepared is the result of personal attributes, prior experiences (including pre-college), or specific educational experiences. A collaboration of investigators from four universities are investigating how the broad spectrum of international experiences both in and outside of formal curricula impact engineering students' global preparedness. Now in its fifth year of research, we have conducted three primary studies to learn more about global preparedness. The first was an extensive Delphi survey with subject matter experts. The second consisted of a quantitative and qualitative analysis of students at our four partner institutions. The third is a much larger survey of engineering students at 13 representative engineering programs across the U.S.

This paper focuses on the results of the third study. At each campus we have obtained stratified random samples of freshmen and seniors; in the case of seniors we have subdivided the sample into two cohorts – those who had an international experience while an undergraduate student and those who had not participated in an international activity. All students completed a carefully tested instrument that captured their demographics, experiences and a measure of their global preparedness. To determine the latter, we utilized the nationally normed Global Perspective Inventory developed by Braskamp and colleagues. This has enabled us to identify changes in global awareness, knowledge and thinking over the course of the students' transition from incoming freshman to graduating senior. We report what we have learned from this extensive sample of over 2,500 students. The results of this third study and the two earlier linked studies have resulted in guidelines for engineering administrators and faculty interested in preparing students for the global economy. Similar to our earlier papers, we provide an overview of the updated results of this NSF funded research initiative that has investigated how the various internationally focused learning experiences within engineering (both curricular and co-curricular) impact students' global preparedness.

Introduction

[Sections Labelled "Introduction" and "Overview of the Work" are reprinted from the 2015 and 2016 ASEE Poster Session Papers which provide preliminary material for the reader.][1,2]

Faculty from four universities have been collaborating on a National Science Foundation sponsored research initiative to examine how the various international education opportunities, both curricular and co-curricular contribute to the global preparedness of engineering graduates. Although five years ago, a national study found that 43% of responding engineering deans, department heads and senior faculty believed that "international programs" were not important and not promoted at their institutions[3], today that is changing. We are observing that universities in general and engineering programs in particular are paying much more attention to their students becoming globally competent or having a global perspective, as indicative of the most recent *Open Doors* report of the Institute of International Education, which found that 5% of

U.S. students who studied abroad in 2014-15 were engineers, compared to less than 3% ten years ago.[4] In comparison, 54% of Iranians, 36% of Indians, and 18.6% of Chinese students studying in the U.S. are engineers. Among the highly developed countries, France (12.6%), Canada (8.1%), and Germany 7.3%) exceed the U.S., while Japan (4.4%) and the U.K. (4.2%) are now trailing behind.

To us, it is clear that the global preparedness of engineering students is an important educational outcome, especially among the more forward thinking engineering programs. This can be viewed as the natural result of a number of national commissions and scholars, who more than a decade ago noted the impact of globalization and the implication for continued U.S. economic leadership if there were no change.[5-7] Further, as others have pointed out, 21st century engineers are being called upon to solve complex problems in collaborative, interdisciplinary, and cross-cultural contexts. This requires ". . . a new type of engineer, an entrepreneurial engineer, who needs a broad range of skills and knowledge, above and beyond a strong science and engineering background . . ."[8] Yet, most evidence about how international experiences and education impact engineering students lacks empirical research to guide educational practices. It is only recently that such studies are beginning to appear.[9, 10]

Hence, our purpose has been to understand the various ways that engineering programs can produce better globally prepared graduates, recognizing that the curriculum is crowded, and such areas as innovation, entrepreneurship and service learning are also seeking slots. To us, it has been quite clear that a better understanding of how the various curricular and co-curricular international experiences impact students' global preparedness is a needed first step.

Engineering faculty have anecdotally recognized that students who participated in study abroad and other international programs tended to develop such skills as problem solving, cross-cultural communication, and the ability to work effectively with culturally diverse teams. Living internationally, especially in a non-English speaking country, seemed to prepare students to not only take risks, but to adapt to new environments, develop a greater understanding of contemporary issues, and to put engineering solutions in a global and social context.[11] All of which are skills or outcomes that ABET has required for the past 17 years. However, it is also clear that much more research is required to fully support, quantify, and generalize these findings beyond anecdotal accounts. Stated another way, while researchers and administrators generally agree that international engineering educational experiences are beneficial, we lack empirical evidence of how the various experiences contribute to global preparedness, nor do we even agree on what global preparedness is. Since these experiences present additional expenses to both students and institutions, we need to ensure that the educational benefit is worth the cost. How can these experiences be tailored to achieve educational value? How should we advise students based on the individual's background, prior global preparedness, and financial resources so that the experiences are most effective?

Our research has been addressing three perceived gaps in engineering education: First, the need for a systematic study of curricular and co-curricular offerings in international engineering education to determine the extent to which the various international academic and non-academic experiences impact the global preparedness of engineering students. Second, the identification of key constructs that characterize a globally prepared engineering graduate. Third, measurement of

the impact that these experiences, both collectively, and individually have on engineering students.

By addressing these gaps, we contribute to the understanding of how engineering students become globally prepared, while providing educators with important, actionable items about curricular and extracurricular practices that can enhance engineering global preparedness. This paper provides an overview to date of a research endeavor that addresses these two concerns.

Conceptualizing Global Competency

Three concepts "global preparedness," "global competency," and "global perspective" have all being proposed as desirable educational outcomes. We have pointed out that there is limited consensus on the terminology around global preparedness, which also varies by academic discipline; e.g., intercultural competence (international education researchers) versus multicultural competence or intercultural maturity (diversity scholars). Engineering education researchers have focused on global competence. Defining and measuring global preparedness has proven to be even more difficult.[12]

Hunter[13] working with an international panel of experts, developed a working definition of global competence: "having an open mind while actively seeking to understand cultural norms and expectations of others, leveraging this gained knowledge to interact, communicate and work effectively outside one's environment." Deardorff[14] summarized intercultural competency as "the skills to listen, observe and evaluate, analyze, interpret, and relate." Fantini found a variety of terms being used, both within the literature and in regard to assessment tools. Among them are multiculturalism, cross-cultural adaptation, intercultural sensitivity, cultural intelligence, international communication, transcultural communication, global competence, cross-cultural awareness, and global citizenship.[15] More recently, the National Education Association[16] defined global competency as referring "to the acquisition of in-depth knowledge and understanding of international issues, an appreciation of and ability to learn and work with people from diverse linguistic and cultural backgrounds, proficiency in a foreign language, and skills to function productively in an interdependent world community. This definition contains four basic elements: International awareness, appreciation of cultural diversity, proficiency in foreign languages, and competitive skills."

Several conceptual frameworks to describe global competence have been developed. Fantini[15] has pointed out that most frameworks can be divided five groups: 1) motivation, 2) knowledge, 3) skills, 4) context, and 5) outcomes. These include an often cited one by Deardorff, who used grounded theory to model intercultural competence, defined as the ability to interact with those from different backgrounds, regardless of location[17]. Here intercultural competence moves from attitudes to outcomes. Parkinson has suggested the attributes of a globally competent engineer.[19] Jesiek et al have identify three specific contextual dimensions of global engineering competency: technical coordination, understanding and negotiating engineering cultures, and navigating ethics, standards, and regulations[19]. They emphasized the situations and behaviors encountered rather than an explicit listing of skills, knowledge, and attributes.

Ragusa was the first to place specific emphasis on measuring *engineering global preparedness* in developing the Engineering Global Preparedness Index (EGPI) with four interrelated constructs: engineering global efficacy, engineering global-centrism, engineering global ethics and humanity, and engineering community connectedness.[20-22] We have expanded upon these aspects of engineering global preparedness to define the concept as the readiness to engage and effectively operate under uncertainty in different cultural aspects to address engineering problems[23]. To us, engineering global preparedness brings together the set of congruent behaviors, attitudes, and characteristics in a system, agency, or among professionals, enabling that system, agency, or professionals to work effectively in cross-cultural situations. As such, we have proposed the following working definition: The readiness to engage and effectively operate under uncertainty in different cultural contexts to address engineering problems.

Overview: Three Studies

This project has been conducted by a multidisciplinary team from four universities. The project has been divided into three separate, but interconnected studies: These are

- Delphi study that resulted in both a framework and an emerging conceptual model;
- Mixed-methods study involving both qualitative and quantitative analyses of student samples from our four original member schools;
- Cross-institutional study that added samples of students from a dozen additional engineering programs.

Study One: Expert Developed Framework

Study One's purpose was to establish a framework for and a conceptual model of the global engineer's professional attributes. This could then be used to ultimately develop instruments focused on outcome measurement. The comprehensive Delphi study involved four rounds involving a broad range of subject matter experts (SMEs). The first round focused on identifying the characteristics of a globally prepared engineer and the learning experiences necessary to produce such an individual. Those responses were used to construct a questionnaire to identify both where there was consensus and divergence relative to these attributes and learning experiences. Those results were then used for the third round in which the SMEs revised their judgments and provided their rationale as input for a face-to-face "summit." The summit's purpose was to reach consensus about the learning outcomes and programmatic elements. Semantic maps were created to schematically relate attributes and experiences to global engineering preparedness outcomes. Individual maps were then synthesized into a single map that then provided an organizing framework for international engineering education and illustrated the interrelationships among engineering global preparedness attributes and three other broad categories: intercultural contextual knowledge, personal and professional qualities, and cross-cultural communication skills and strategies, See Figure 1 for an overview.[1, 12].

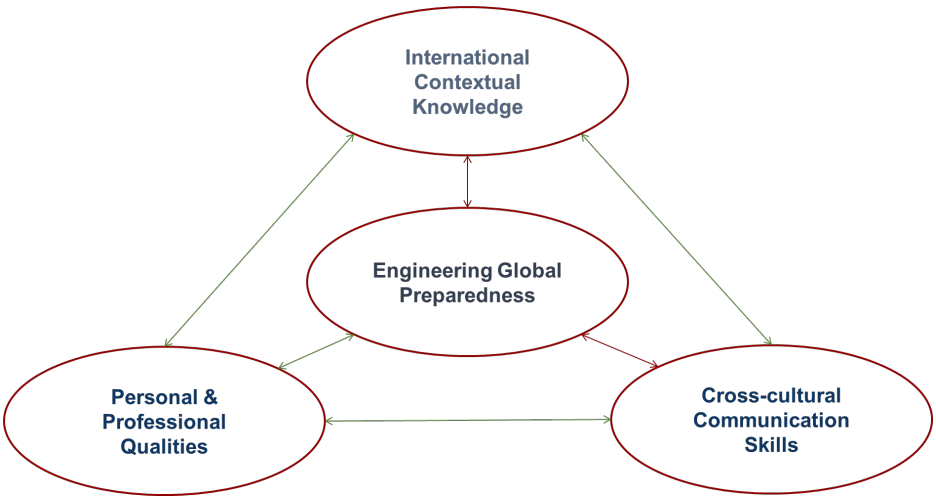

Figure 1. Overview of Engineering Global Preparedness

Study two: Mixed Methods Analysis
Study One resulted in a model of global engineering preparedness and how it is influenced by various attributes and experiences. That model also provided the basis for a "background" instrument that was employed in Study Two to learn more about how global preparedness might be achieved. A mixed-methods design (i.e., quantitative and qualitative components) was used to measure the learning outcomes identified in Study One by sampling students at each of the four partner institutions. To do this, two instruments – the EGPI (described above) and the Global Perspectives Inventory (GPI) that is described below were selected, since the constructs identified in Study One mapped reasonably well into both. Hence, these two global perspective instruments were used to provide proxy measures of global preparedness.[2, 12]

The two global preparedness instruments were used with a background survey to capture each student's demographic characteristics and international experiences. The resultant questionnaire consisted of four components: profile characteristics (e.g., gender, age, class standing,), educational background (e.g., university, major, QPA), travel abroad/ international experiences (e.g., level of interest in international issues, foreign language proficiency), and characteristics of the international experiences (e.g., programmatic elements of experiences such as duration, amount of reflection, and comfort zone). The combined set of instruments (EGPI, GPI, and background survey were administered to two samples of seniors at each of the four partner institutions – those who had at least one international experience and those with no international experiences. In addition, a third sample of incoming freshmen served as both a comparison group and an institutional baseline. This dataset was then used for the quantitative study

The 25% of seniors with the highest scores on both the EGPI and GPI, and the 25% with the lowest scores on the two were then invited to participate in the follow-up qualitative study. A total of 58 semi-structured interviews were conducted (approximately 20 to 30 minutes each). All interviews were recorded, transcribed and then analyzed. The primary purpose was to better understand how those seniors' might have achieved relatively high levels of global preparedness in comparison to the low scoring students. Three overarching questions framed the interviews: "Why did you choose to study abroad and/or pursue an international experience?" "Did these

experience change the way you think about engineering?" "Did these experiences affect your thinking about the cultural relevance of engineering?" A set of probes based on the constructs of the two instruments and background survey facilitated the interviewers in presenting the overarching questions. The interviews enabled us to extend our theoretical framework as shown in Figure 2.

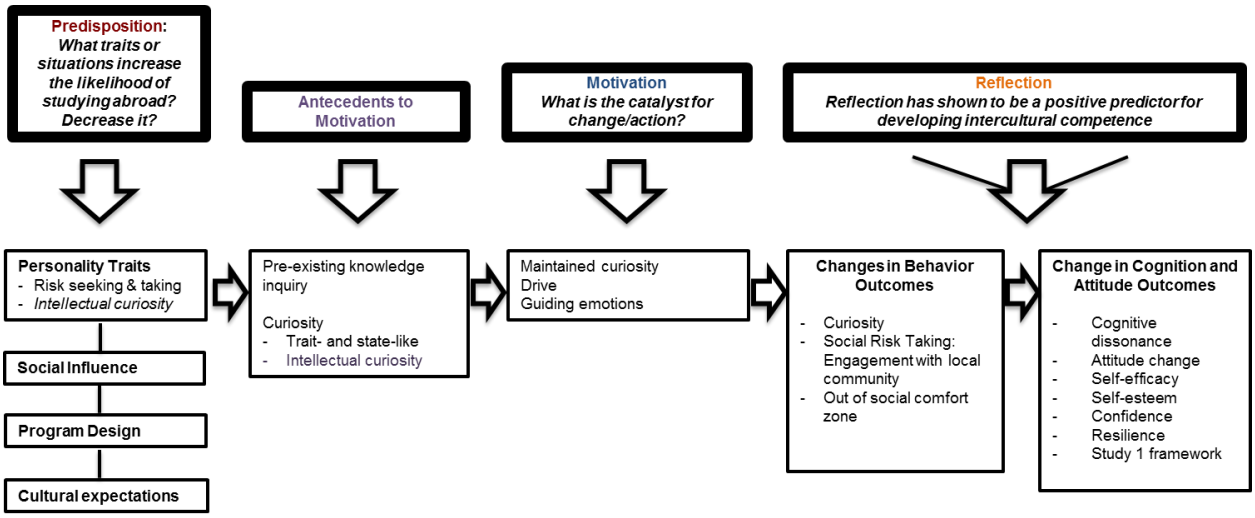

Figure 2. Refined Theoretical Framework[2]

In addition to the refined framework, the qualitative analysis revealed that the high scorers tended to be:

- Motivated to select programs based upon reputation
- Experienced situations of social risk taking, but were able to navigate through those situations constructively
- Developed an increased sense of independence as a result of their experiences.

Further, we found that working on a cross-cultural team was an important part of the international experience for the high scorers. We also observed that a relatively large number of high scores came from families where at least one parent had a masters or PhD degree. Both the quantitative and qualitative analyses prepared us for Study Three.

Measuring Global Preparedness – the Global Perspective Inventory

Braskamp[24], citing King and Magolda, has proposed three dimensions of learning and development (i.e., dimensions of a global perspective): cognitive, intrapersonal, and interpersonal, which he refers to as knowing, feeling, and behaving. To Braskamp, this view of student development is holistic and integrative, because students need to develop in all three dimensions if they are to become mature persons[25]. These are embodied in the Global Perspectives Inventory (GPI), which he and colleagues have developed, nurtured, and validated.[26] To Braskamp, global perspective taking involves three critical questions related to each of these developmental domains: "How do I know?" "Who am I?" and "How do I relate?"

Braskamp notes that "as one develops an enlarged global perspective, she incorporates more complex ways of making meaning that are grounded in intercultural knowledge, cultivates greater acceptance of cultural differences and solidifies her sense of self, and develops more mature interpersonal relationships and a stronger commitment to social responsibility."[27]

The GPI has been widely adopted as one way of measuring the impact of various experiences including more recently international experiences. Specifically, the instrument measures how students think, view themselves as people with a cultural heritage, and relate to those from other cultures, backgrounds, and values. As noted, the GPI identifies three major domains of human development (cognitive, intrapersonal, and interpersonal), capturing each with two subscales. 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*.[26]

We have selected the GPI as our primary proxy measure of global preparedness because the constructs that we developed in Study One and Study Two map into its three domains. In addition, the GPI has been rigorous validated, is widely used, and provides national "norms." In particular, a number of studies, primarily by Braskamp and Engberg have used the GPI to examine the impact of study abroad experiences with consistent results.

For example, the GPI was administered in a pre- and post-test manner to a sample of students from ten different programs who participated in a semester long study abroad experiences. Significant differences between the pre and posttest means were found on five of the six GPI scales, although the magnitude of differences varied.[28] Engberg used the GPI to examine the effect of study abroad experiences on a range of college students. In one investigation, he found that study abroad participants had significantly higher scores on four of the GPI dimensions compared to nonparticipants. The largest effects were found in the cognitive knowing and cognitive knowledge domains followed by social interaction. In contrast, negative, non-significant effects were found in the identity and social responsibility constructs. In a second study, Engberg used a pre-test – post-test design on a sample of 659 college students who studied abroad for a full semester (in a wide range of host countries). He found that the returning study abroad students had significantly higher posttest scores for all six GPI dimensions compared to the pre-test ($p<.001$). The largest differences were found on the cognitive knowledge scale, while the smallest were found on the social responsibility scale. The intrapersonal dimensions, cognitive knowing and social interaction scales had more moderate differences (see Table 1). Engberg concluded that "based on this study, it appears that study abroad participants demonstrate significant growth across each of the GPI dimensions, with intercultural knowledge and social responsibility showing the largest and smallest gains, respectively." However, in neither study did he adjust for qualitative differences in the programs, or differences of duration, location, language, and other host country aspects.[29]

As noted, Engberg found the strongest effect was in intercultural knowledge. To him, this illustrated how study abroad can provide students with a more informed understanding of different cultures and current global issues. He felt that the students that he tested had developed "a stronger understanding of their sense of self, increased tolerance for difference, and a greater inclination toward interacting across difference." To Engberg, "the results provide an empirically based understanding of the potential for study abroad to influence cognitive, intrapersonal, and interpersonal development."[29] To us, they provide further justification for using the GPI as a dependent variable and outcome measure.

In a second sample, Engberg and Jourian looked at both difference and effect size (which we will also be using) for one of the pre-test – post-test samples. They used Cohen's *d* to measure effect size. The significance can be interpreted as: below 0.20 no effect; between 0.20 and 0.50 a "small" effect; between 0.50 and 0.80 "medium" effect; 0.8 to infinity is a "large" effect.[33] Hence, as shown in Table 1, the largest effects were found on the Knowledge and Identity scales (Cohen's $D = .56$ and .40), all other effects could be considered small. Engberg and Jourian noted that GPI scores increased significantly across the cognitive, intrapersonal, and interpersonal dimensions, with the largest changes found in acquisition of cultural knowledge and students' emerging sense of self (identity).[30] As shown in Table 1, these results are basically consistent with Engberg's earlier study.[29] We report results relative to effect size and would consider the knowledge gain to have been moderate and the identity gain to be smaller, but significant.

Table 1. Paired Samples (Pre and Post) T-Tests across GPI Domains

Domain	Engberg[29] (N=659)			Engberg and Jourian[30] (N=510)		
	Post Mean	Difference	SD	Post Mean	Difference	Effect Size
Cognitive Knowing	3.58	0.11	0.42	3.88	0.10	0.22
Cognitive Knowledge	3.73	0.27	0.55	3.86	0.31	0.56
Intrapersonal Identity	4.19	0.15	0.42	4.14	0.17	0.40
Intrapersonal Affect	3.85	0.13	0.36	4.23	0.12	0.29
Social Interaction	3.65	0.13	0.41	2.94	0.14	0.23
Social Responsibility	3.79	0.06	0.38	3.83	0.10	0.23

Study Three: Cross Institutional

Based on the results from Study Two, a shorter, revised instrument was developed. Because of the relatively high correlation between the GPI and EGPI, a decision to use only the GPI was made. In addition, items that were no longer essential to the research or did not support the theoretical framework, were also removed from the instrument. The result was an instrument that took approximately 7-9 minutes to complete, primarily dependent upon the responder's number of international activities. International experiences included personal tourism, study abroad, second language acquisition (ability to speak or ability to take a course in that language); international service learning; and internship or co-op abroad. Table 2 provides the complete list of experiences. Respondents were asked to indicate all experiences they had, and to provide detailed information on the most recent experience. For each international experience selected, we asked about the duration of time spent abroad (if applicable), student's comfort zone, extent of reflection, and if the experience occurred before or during college.

To date, samples have been collected from 13 engineering programs that were selected based on their interest in international engineering education, geographic location, and affiliation in an effort to be representative of those U.S. programs that are supportive of such activities. An effort was made to obtain a sample of 200 subjects from each institution, with approximately 30 freshmen as a baseline, 110 seniors with an international experience, and 60 seniors without an international experience.

Table 2. Possible 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
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

Study Three Results

First Year Engineering Students Entering with International Experience

At our four partner schools, we were able to collect larger samples; e.g., all entering freshmen and all graduating seniors. We have compared the freshman and seniors at one of these institutions in an earlier paper.[32] Excluding international students, we learned that 70% of the U. freshmen entered with U.S. passports. For factors such as gender, where raised (urban, suburban, small town/rural), and parents' education level (high school or two-year degree, BS/BA or MS/PhD), first year students who had at least one international experience scored higher on all three major domain scales than those who did not as shown in Table 3. Female students exceeded male students in the interpersonal domain, regardless of international travel. When examining where students were raised, there were gains in all domains for those who had traveled internationally compared to those with no travel experience. The biggest gains between those students who had international experience versus those who did not were observed for entering students raised in small towns or rural environments. In contrast, the smallest gains occurred for those students who raised in urban areas. Also of note was that the portion of students from urbans areas, and that proportion of students whose parents' had MS/PhD degrees had substantially more international experiences than those from urban, rural and suburban areas and those whose parents had earned no more than an undergraduate degree respectively. That is, entering freshmen from urban areas or with at least one parent who had earned a master or PhD degree had more international experiences than those who did not.

Table 3. 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%)
Cognitive	3.49	3.48	3.56	3.47	3.49	3.49	3.48	3.56
Intrapersonal	3.81	3.89	3.85	3.82	3.87	3.84	3.85	3.82
Interpersonal	3.18	3.28	3.25	3.22	3.14	3.13	3.21	3.25
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%)
Cognitive	3.64	3.65	3.65	3.62	3.72	3.57	3.61	3.67
Intrapersonal	3.95	3.98	3.85	3.95	4.09	3.95	3.95	3.92
Interpersonal	3.36	3.53	3.46	3.41	3.42	3.28	3.42	3.44
Percent with Travel Experience	**67%**	**72%**	**82%**	**67%**	**67%**	**40%**	**63%**	**77%**

In analyzing the data sets, we have used separate network structures for freshmen and seniors to disaggregate the data as shown in Figures 3 and 4

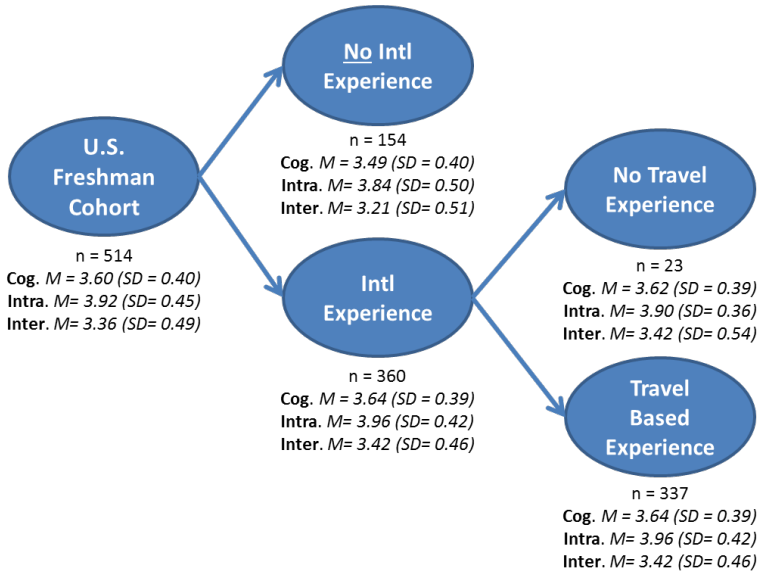

Figure 3. GPI Scores for Freshmen Engineering Students (School A)

Figure 3 gives the breakdown for entering first-year students at one partner school. The figure clearly shows that students who entered with international experience had higher GPI scores in all three domains compared to those students who had not participated in an international experience prior to entering the university. Figure 4 presents the same type of breakdown for seniors. Again, in all cases, seniors who had participated in at least one international experience, either pre-college or while in college, had higher GPI scores in all three domains than seniors who had no international experience. Further those that had international experiences both pre- and in college exhibited the highest GPI scores. Note that "no travel" refers to students whose experience was limited to mastering a second language.

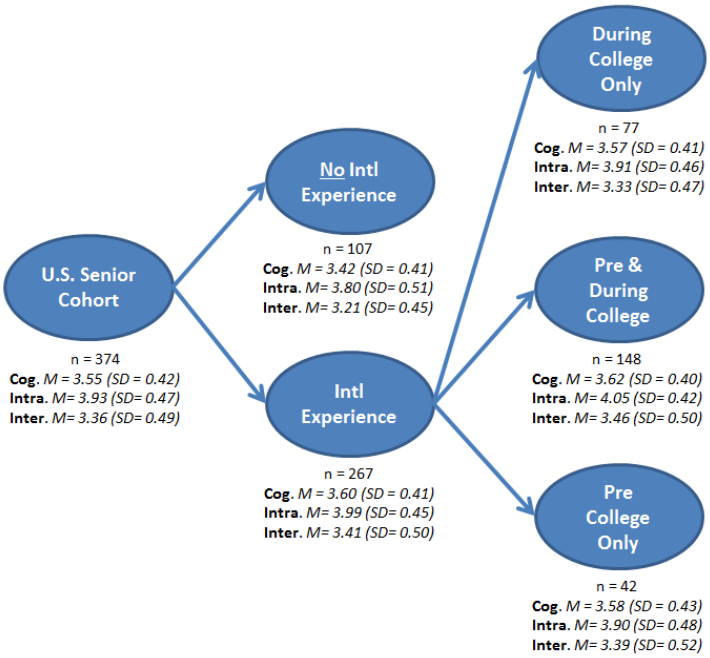

Figure 4. GPI scores for Senior Engineering Students (School A)

To capture the relative impact of international experiences, we used effect sizes as discussed above. These are presented in Table 4. Note that for entering freshmen, those who had participated in an international experience exhibited significant, but small effect sizes across all three domains compared to those who did not. Further, when comparing those same freshmen who entered with international experiences to seniors who graduated with no experience, again, small but significant effect sizes were observed. In both cases these gains were largest for the cognitive and interpersonal domains. The table also shows that seniors who had an international experience only in college also exhibited significant but small effect sizes compared to those seniors who had no international experiences. As expected, the largest gains (medium) across all three domains was observed for seniors who had international experiences both prior to coming to college and while in college compared to those seniors who never had an international experience by graduation. Finally, when comparing freshmen who entered with no experience to seniors who graduated with no experience, no practical global perspective differences exist.

Table 4. Effect Sizes for Engineering Students at School A

Comparison	Cognitive	Intrapersonal	Interpersonal
Freshmen no experience *(n=154)* vs. Freshmen with international experience *(n=360)*	.38 (small)	.26 (small)	.43 (small)
Freshmen no experience *(n=154)* vs. Seniors no experience *(n=107)*	-.17 (no effect)	-.08 (no effect)	.00 (no effect)
Seniors no experience *(n=107)* vs. Seniors pre-college only *(n=42)*	.38 (small)	.20 (small)	.37 (small)
Seniors no experience *(n=107)* vs. Seniors college only *(n=77)*	.37 (small)	.23 (small)	.26 (small)
Seniors no experience *(n=107)* vs. Seniors with both pre-college and college experiences *(n=148)*	.49 (small/medium)	.54 (medium)	.53 (medium)

Examining 13 Participating Schools

To date we have obtained survey data from thirteen different engineering schools. We have randomly selected 200 cases from School A, so that the sample size is consistent with the other 12 schools. In total, the sample consists of 319 freshmen and 1665 seniors. Of these, 233 of the freshmen and 1319 of the seniors had at least one international experience either pre-college, in-college or both. Table 5 provides a breakdown of the international experiences of the seniors.

Table 5. International Experiences of Seniors (13 Schools)

All Seniors – International Experiences	All	Students w/ Intl Exp Pre-College Only	%	Students w/ Intl Exp During College Only	%	Students w/ Intl Exp Pre and During College	%
Personal tourism	1014	162	58%	112	21%	740	27%
Second language course	671	67	24%	55	11%	549	20%
U.S. based research project that examines a global issue	123	0	0%	18	3%	105	4%
Non-engineering focused service learning program	170	12	4%	18	3%	140	5%
University housing with international focus	73	1	0%	15	3%	57	2%
Engineering focused service learning program	130	2	1%	26	5%	102	4%
Study Abroad	428	3	1%	104	20%	321	12%
Engineering course with a global focus	259	2	1%	54	10%	203	7%
Non-engineering course with a global focus	335	5	2%	54	10%	276	10%
U.S. engineering course with an international project	66	3	1%	13	2%	50	2%
Internship/co-op/technical research project conduced internationally	121	3	1%	36	7%	82	3%
Dual degree program with an international university	11	0	0%	3	1%	8	0%
Other	110	18	6%	15	3%	77	3%
Total	3511	278	100%	523	100%	2710	100%

As shown in Table 5, the 1319 seniors had a total of 3511 different international experiences. For students whose only experience was pre-college, over half (58%) were for personal tourism; and almost a quarter (24%) was achieving fluency in a second language. A small number (4%) were involved in some form of service learning. In total, these students averaged 1.4 experiences each. In contrast, when examining the seniors who only had international experiences during college, only 21% of those experiences were classified as personnel travel compared to 20% that were for study abroad programs. These students averaged almost two experiences each (1.9). Another 20% were for coursework with an international focus (both engineering and non-engineering), with 11% being second language acquisition. When examining those seniors who had international experiences both before entering and during college, the major activity was

personal travel (27%) followed by a second language (20%); 12% of the experiences could be considered study abroad, and 10% non-engineering coursework with a global focus. This cohort averaged 3.2 experiences per student. While we don't know the percentage of the graduating seniors that each of these cohorts represent, it is clear that some students are graduating with a substantial number of international experiences.

Figures 5 and 6 provide breakdowns of the 13 school sample for freshmen and seniors respectively. As shown in Figure 5, students who entered with at least one international experience had GPI scores in all three domains higher than those students who did have an international experience. Further, the set of students whose international exposure was being able to converse or take a course in a second language had even higher GPI scores.

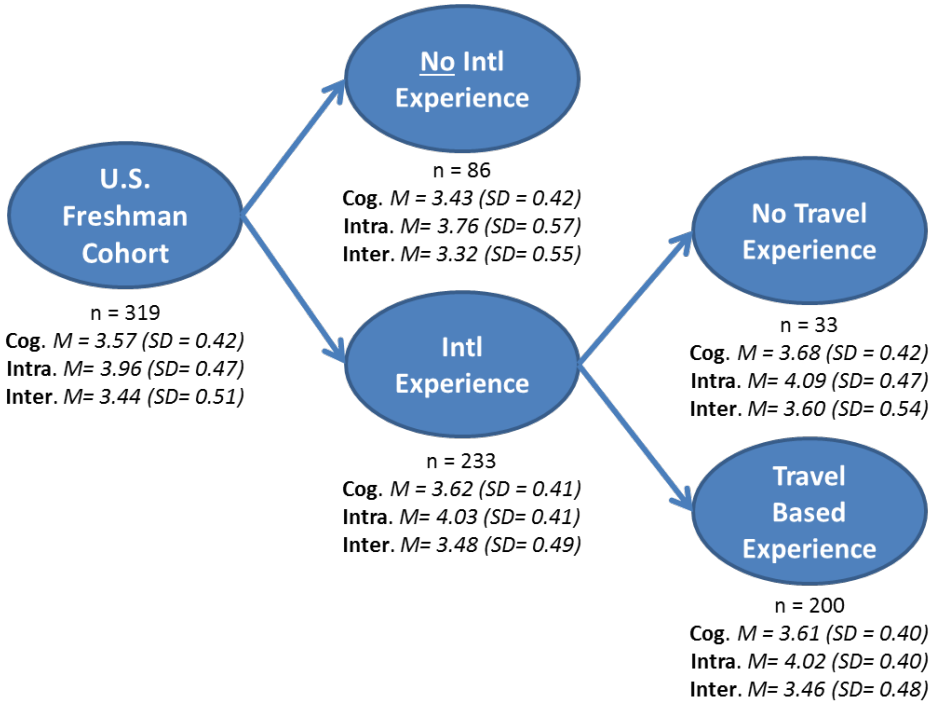

Figure 5: GPI Scores for Freshmen Engineering Students (13 Schools)

As shown in figure 6, those seniors who with an international experience had higher GPI scores in all three domains compared to seniors who had no international experience or language acquisition. Those seniors who had experiences both pre-college and in college exhibited the highest GPI Scores. In general, seniors whose only international experience was language acquisition scored lower that those who actually traveled, but, these scores were still higher than those who had no international exposure.

Although the GPI scores are extremely consistent, and agree with intuition, do to the large sample sizes, the differences are generally statistically significant, even if they are not practically significant. To adjust for the large sample sized, we have again calculated effect sizes to estimate the relative impact of international activities. These results are presented in Table 6. As shown, when comparing entering freshmen with experience to those without, a medium effect for Intrapersonal (0.54), a small to medium for cognitive (0.46) and a medium for interpersonal

(0.31) were found. Seniors who entered with at least one experience pre-college, but had no experiences while an undergraduate engineering student did show small effects for the cognitive and intrapersonal domains but no effect for interpersonal compared to seniors with no experience. However seniors who only had experiences while in college exhibited small effect sizes in all three domains compared to seniors with no experience. Seniors with experiences at both the pre-college and college levels demonstrated a medium to large effect for cognitive, a medium effect for intrapersonal and a small effect for interpersonal when compared to seniors with no experience. Further, when we compared seniors with only one experience to seniors with no experiences, we also observed significant but small gains for all three domains. Finally freshmen with no experience when compared to seniors with no experience indicated negative, but not significant effects for cognitive and interpersonal and no effect for intrapersonal.

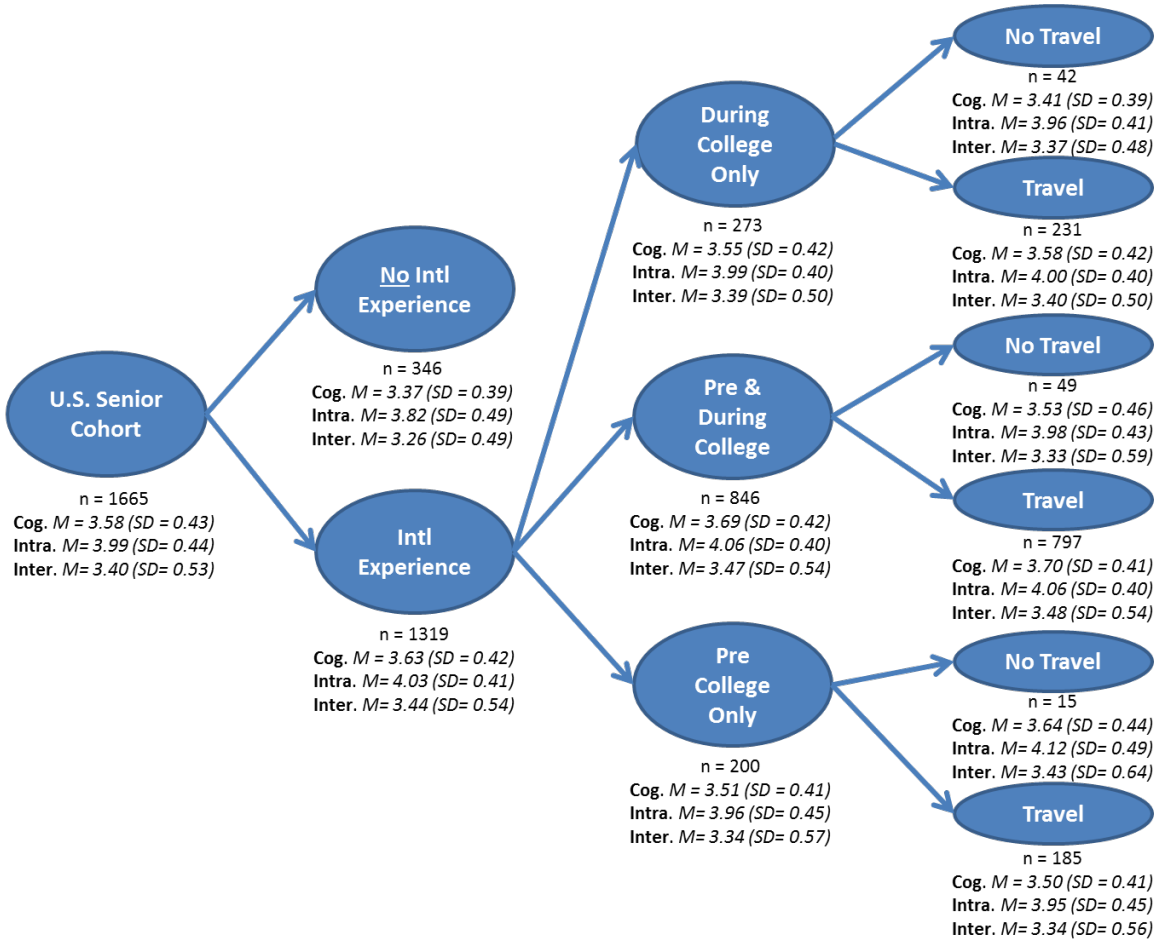

Figure 6: GPI Scores for Engineering Seniors (13 Schools)

Table 6. Effect Sizes for Engineering Students (13 Schools)

Comparison	Cognitive	Intrapersonal	Interpersonal
Freshmen no experience *(n=86)* vs. Freshmen with international experience *(n=233)*	.46 (small/medium)	.54 (medium)	.31 (small)
Freshmen no experience *(n=86)* vs. Seniors no experience *(n=346)*	-.15 (no effect/small)	.12 (no effect)	-.12 (no effect)
Seniors no experience *(n=346)* vs. Seniors pre-college only *(n=200)*	.35 (small)	.30 (small)	.15 (no effect/small)
Seniors no experience *(n=346)* vs. Seniors college only *(n=273)*	.44 (small)	.38 (small)	.26 (small)
Seniors no experience *(n=346)* vs. Seniors with both pre-college and college experiences *(n=846)*	.79 (medium/large)	.54 (medium)	.41 (small)
Seniors no experience *(n=346)* vs. Seniors with one experience (n=105)	.34 (small)	.37 (small)	.20 (small)

Discussion and Conclusion

Based on our analyses, we feel that the GPI is a valid, nationally recognized instrument to measure students' global perspectives, and that it is a suitable proxy measure for global preparedness. The results that we have found tend to be consistent across the 13 schools. Further, our results are consistent with those observed by Braskamp, Engberg and associates in their earlier cited studies[29, 30]. (See also Table 1.)

We have documented across a sample of institutions that international activities either prior to entering college or while an undergraduate can have a significant effect on improving a student's global preparedness as measured by the Global Perspective Inventory. An important finding is the role of pre-college international experiences in students' achieving a high degree of global preparedness as measured by the GPI. We have observed at our partner institutions that a substantial portion of the incoming first-year engineering students have already had at least one international experience, which in general, enables them to score significantly higher on the three GPI domains than those same peers who entered without the benefit of international experience. This appears to be true, even if that experience is personal travel. We also have consistently observed that those engineering students who have participated in international experiences at both the pre-college and undergraduate years, score even higher on the three domains of the GPI (cognitive, interpersonal and intrapersonal) compared to their peers who have never participated in international activities at the pre-college or college level. Although we have not done pre- and post-test studies, our rich data set enables us to project that if those same students who entered college without an international experience, did have such an experience in college, that experience will only bring them up to the level of those peers that entered having had an international experience. In addition, if students continue to avoid international activities, their GPI level will remain where it was upon entrance, or possibly even decline (but not significantly).

As noted, in delving deeper into our data set, we are learning that even the personal international travel which many students have done prior to entering college can tend to raise the GPI level on all three domains. Also, mastering a second language (i.e., confidence to speak or take a course in that language) can raise the GPI level even if the student has not traveled internationally. We are also learning that the most important factor in raising the GPI effect from "small" to

"moderate" or even "large" may be participating in a variety of experiences, rather than simply repeating the same type of experiences. We have observed that the impact of parents, especially if they have an MS or PhD degree is positive. This is consistent with the findings of one of the co-authors (Ragusa) who documented that parental background and experiences are also key factors in achieving global preparedness.[33] Another observation is that engineering students who come from urban environments tend to have proportionally more international experiences than those who were raised in suburban, and especially rural and small town environments.

The implications for engineering faculty and administrators who wish to have all graduates achieve a higher level of global preparedness would be to first consider pre-college experiences as providing a solid starting point. Further, to identify those students who come from more rural or small-town backgrounds, and those whose parents' education is at the high school or associate degree level, and who have yet to have an international experience, as prime targets to encourage participating in an international opportunity, possibly motivated with the use of some scholarship funds. Unless these students are identified and encouraged early, a substantial number of seniors may graduate without the basic knowledge and attitudes to begin to effectively navigate the global engineering environment.

As for those who enter with some international travel experiences and/or have second language ability, they should be encouraged to explore different types of international opportunities in an effort to substantially increase their global preparedness level. It appears to be that the second international experience, especially if different than the first, may have the largest impact on "moving the GPI needle" in a significant upward direction. This may not be as difficult as it sounds. One of our partner institutions has found that over 70% of its graduating seniors will have had an international experience with almost half having had that experience while in college (as well as possibly pre-college), but over 20% had only the pre-college experience, which we now know may be as valid as the single, in-college international activity.

Our study of the effectiveness of various forms of international experiences on engineering students' global preparedness is still in progress as we continue to analyze the extensive data sample from our participating institutions. Next steps include investigating the impact of international program types and factors on students' global preparedness. Further, we are determining how the engineering global preparedness framework can be used to inform decisions around program design and assessment. In our view, the need for globally prepared engineers will continue to grow. The challenge for engineering administrators and faculty is: will our graduates be able to satisfy that need?

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