

Understanding Global Perspective Development in First-Year Engineering Students: Determining Educational Impact

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***Full Paper: Understanding Global Perspectives Development in First-Year
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Introduction

Every day the worlds of business and engineering become more interconnected and interdependent due to advancements in technology regarding communication and transportation. This has proposed a need for engineering graduates to achieve a reasonably high level of “global preparedness,” which 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 Engineering educators and higher education leadership believe those students who are able to work effectively with colleagues across national, cultural, and ethical boundaries will be more prepared and successful post-graduation. Research has shown that international experiences, like study abroad, have a positive impact on students’ global perspectives.^{5,6} Unfortunately, a variety of barriers exist (perceived and otherwise)⁷⁻⁹ that make it difficult for engineering students to engage in an international experience like study abroad. Even though the most recent data available indicates that STEM majors account for almost 26% of the number of students participating in study abroad in 2016/2017 (up from 17.5% in 2006/2007), STEM majors (especially engineering) still remain underrepresented. This begs the question – how can we prepare the critical mass of engineering students to be successful in cross-cultural and/or multinational environments without the need to participate in education abroad? How can we facilitate global perspective development through co-curricular and extracurricular practice?

As part of a larger internally funded study on how global perspectives of engineering students can be developed through domestic curricular and co-curricular educational opportunities, we administered the Global Perspectives Inventory (GPI) to incoming first-year engineering students. This was done to (1) better understand the global perspectives of our incoming first –year students, and (2) how it is influenced by prior educational opportunities and social experiences. The (GPI) is a nationally normed instrument that measures students’ global learning and holistic development.⁶ The GPI consists of 35 Likert scale items, covering three dimensions that are each divided into two subscales (see Table 1).

Table 1. GPI Dimensions and Subscales¹⁰

Dimension	Subscale	α^*	Description
Cognitive	Knowing	0.66	Degree of complexity of one’s view of the importance of cultural context in judging what is important to know and value
	Knowledge	0.77	Degree of understanding and awareness of various cultures and their impact on our global society and level of proficiency in more than one language
Intrapersonal	Identity	0.74	Level of awareness of one’s unique identity and degree of acceptance of one’s ethnic, racial, and gender dimensions of one’s identity
	Affect	0.73	Level of respect for and acceptance of cultural perspectives different from one’s own and degree of emotional confidence when living in complex situations, which reflects an “emotional intelligence” that is important in one’s processing encounters with other cultures
Interpersonal	Social Responsibility	0.73	Level of interdependence and social concern for others
	Social Interaction	0.70	Degree of engagement with others who are different from oneself and degree of cultural sensitivity in living in pluralistic settings

*Cronbach’s alpha is an estimate of the reliability of a test’s scores and score interpretation

This paper presents our findings from this descriptive, exploratory study in which we have analyzed 227 incoming first-year engineering students from ROWAN University to begin to answer question regarding the level of global perspectives of entering first-year students, and how these levels are influenced by prior educational experiences. In addition, we are interested in learning about the relationship between global perspective levels and desired educational experiences while in college. Preparing engineering students to be effective in an increasingly global economy and workforce remains a daunting task that educational institutions must adapt their ways to achieve. Because traditional study abroad programs have been difficult for engineering students to participate in, it is imperative that we investigate how we can leverage existing educational practice to help students develop global perspectives. In doing so, the following research questions will be addressed:

1. How do global perspective levels of first-year engineering students relate to **prior educational opportunities?**
2. How does global perspective of first-year engineering students relate to **desired college educational opportunities?**

Here we provide preliminary recommendations for engineering educators, including the need to identify incoming first-year engineering students with lower levels of global perspectives, as well as how global learning can be promoted in and around the first-year engineering classroom.

Methodology

Participants and Instrumentation

To collect data for our descriptive study of incoming first-year engineering students global perspectives, a survey that included the 35 GPI items (Likert Scale) was administered to 227 engineering students at ROWAN University. The survey also included a set of questions soliciting student's prior high school educational experiences and the educational experiences that they wish to pursue in college. Demographic information was also captured to further tease out global perspective relationships, but the analysis of said relationships is not included in this paper.

The survey questions regarding high school ask about the students' coursework and co-curricular activities and the frequency of their involvement with each. The questions asking about courses also require the student to mark how many courses of that category they have taken, while the questions asking about high school activities ask how often they participated in each in a Likert scale fashion with the responses: *never*, *rarely*, *sometimes*, *often*, and *very often*. This allowed, not only, for the courses and activities that affect GPI to be analyzed, but how much of these experiences are necessary to make a difference. The questions regarding desired college experiences simply offer the responses *yes*, *no*, and *maybe*, since the students have not participated in them yet.

The students were asked how many high school courses they have taken within six different areas, if they participated in any of twelve global activities in high school, and if they desired to participate in any of twelve global activities in college. Those course and activities are presented in Table 2.

Table 2. List of Prior Educational Opportunities and Desired College Opportunities

Prior HS Courses	Prior HS Events/Activities	Desired College Opportunities
<ul style="list-style-type: none"> • Multi-cultural (addressing issues of race, ethnicity, gender, class, religion, or sexual orientation) • Foreign Language • World History • Service Learning • Global Issues • One with opportunities for dialogue with students of different backgrounds 	<ul style="list-style-type: none"> • Ones sponsored by groups reflecting their own cultural heritage • Ones sponsored by groups reflecting a cultural heritage different from their own • Religious or spiritual • Leadership programs that stress collaboration and teamwork • Community service • Lectures, workshops, or campus discussion with a global focus • Reading the newspaper • Watching the news • Following an international crisis • Discussing current events with students • Interacting with students from a country different from their own • Interacting with students a different race/ethnic group from their own 	<ul style="list-style-type: none"> • First-year seminars • Learning communities • Engineers Without Borders • Undergraduate Research Experience • Internship/Co-op • Engineering conferences • Engineering courses with a global focus • Study abroad • Engineering professional societies • Student government • Volunteer work

Analytic Strategy

The average GPI scores across all six subscales were calculated and analyzed based on the courses, or experiences students had participated in during high school and desired educational opportunities in college. This gave a general idea of which courses, activities, or desired experiences resulted in higher GPI scores in students. ANOVA tests were then run on this data to test for the statistical significance of these means and determine which courses, activities, or desired experiences have more of a statistically significant effect on GPI score than the rest. After the ANOVA testing, post-hoc test was run on the high school course and activity data to test the significance between the frequency of these experiences each student had. For the course questions, the effect of the quantity of each type of course students took was tested for significance and for the activity questions the effect of the frequency of each activity was tested for significance through the post-hoc testing. Lastly, Spearman’s correlations were run between both the courses and GPI and the activities and GPI to see which held the strongest relationship. P-values were also obtained in order to see just how significant the relationships were. ANOVA tables and eta-squared values were generated in the analysis to determine statistical significance and effect sizes. Eta-squared values were then converted to Cohen’s d value since the sample size was large enough and standard deviations do not greatly vary from one another. These tests were finally run on whether the students were interested in participating in an international experience. Post-hoc tests

were run on the GPI subscales that were statistically significant to identify between which student responses the significance was present.

Results and Discussion

Global Perspectives of Incoming First-Year Engineering Students

The average GPI subscales were calculated and analyzed for significant differences when divided in several ways. These scores can be compared not only to each other, but to the “national norms,” found in Table 3 below. These values were developed by Braskamp by collecting a large sample of college student GPI scores.¹⁰ These normative values are based on a sample of ~20,000 undergraduate students mostly from liberal arts universities. The GPI normative values thus can be used as a frame of reference as we begin to situate our findings in context.

Table 3. Average GPI Scales for ROWAN University and GPI Normative Values Established by Braskamp

	N	Social Responsibility	Social Interaction	Identity	Affect	Knowing	Knowledge
GPI Norms ¹⁰	5296	3.69	3.42	4.05	4.10	3.51	3.62
ROWAN University	227	3.36	3.15	3.77	3.90	3.52	3.44
Standard Deviation	--	0.69	0.71	0.58	0.51	0.48	0.57

Overall, first-year engineering students scored lower than first-year students reported by Braskamp. This suggests that our first-year engineering students are coming to college less prepared in terms of their global perspectives than their non-engineering student counterparts. This combined with the fact that international experiences are historically more difficult for engineering students to participate in means engineering educators need to develop curricular and co-curricular opportunities to help prepare the critical mass of engineering students. It’s important to also understand what types of experiences first-year engineering students are coming in with, as well as how to utilize existing programming to help their global perspective development. This is explored in the subsequent sections.

Prior Educational Experiences

Amongst the high school data, it is important to look at the correlations between each high school experience to understand their effect on the variability of each of the GPI subcategories (i.e., higher correlations indicate a stronger relationship between the experience and global perspectives). Tables 4 and 5 show the correlations between frequency of particular high school courses and high school activities, respectively, with each GPI subscale. The correlations with a yellow background have a p-value of 0.01 or less, and correlations with an orange background have p-levels less than 0.05.

Table 4. Correlations between frequency of high school courses and GPI subscales

	Social Responsibility	Social Interaction	Identity	Affect	Knowing	Knowledge
Multicultural Course	0.193	0.069	0.165	0.108	0.080	0.115
Foreign Language Course	0.107	0.017	0.052	0.084	0.034	0.021
World History Course	-0.030	-0.056	0.169	-0.080	-0.135	0.055
Service Learning Course	0.107	0.034	0.160	-0.096	-0.070	0.152
Global Issues Course	0.060	0.084	0.145	0.049	0.013	0.194
Dialogue Opportunity	0.034	0.069	0.208	0.085	.131*	0.202

Yellow: p-value < 0.01; Orange: p-value < 0.05

The correlations between the courses and the GPI subcategories displayed in table Table 4 show that courses with opportunity for dialogue had the most statistically significant correlations and they were in the subscales of identity and knowledge with correlations of 0.208 and 0.202, respectively. Both categories were significant at a p-value of less than 0.01. The next two that showed highly significant correlations were multicultural courses and global issues courses. Multicultural courses showed significance levels below 0.01 in the subcategory social responsibility with a correlation of 0.193 and global issues courses showed significance in the knowledge subcategory with a correlation of 0.194. Table 4 also shows that identity and knowledge have the most significant correlations with HS courses with some global/cross-cultural component.

Table 5 displays the correlations between high school activities and the GPI subscales. Significant correlations are present in activities that reflected a heritage different from the students' own, leadership programs, reading the news, discussing current events, and interacting with students from a country different from the students' own. Among all of the activities, the subscales that showed the strongest relationship to prior HS activities are social responsibility, social interaction, affect, and knowledge. This data is evidence that exposing students to these types of activities during their first year of college can improve their GPI scores overall, but more significantly in the aforementioned GPI subscales.

Table 5. Correlations between frequency of high school activities and GPI subscales

	Social Responsibility	Social Interaction	Identity	Affect	Knowing	Knowledge
Reflected Own Heritage	0.265	0.103	0.157	0.107	-0.028	0.210
Reflected Different Heritage	0.231	0.263	0.124	0.261	0.146	0.264
Religious Activity	0.241	0.137	0.258	0.031	-0.048	0.115
Leadership Program	0.382	0.234	0.275	0.148	0.024	0.243
Community Service Act	0.424	0.127	0.181	0.215	0.090	0.093
Global Lecture	0.243	0.135	0.075	0.087	0.104	0.200
Read News	0.177	0.057	0.134	0.202	0.198	0.244
Watched News	0.081	0.115	0.060	0.100	0.004	0.142
Followed International Crisis	0.127	0.087	0.155	0.215	0.128	0.309
Discussed Current Events	0.137	0.111	0.197	0.208	0.206	0.329
Interacted with Students of Different Country	0.208	0.491	0.061	0.204	0.112	0.245
Interacted with Students of Different Race	0.140	0.461	-0.006	0.319	0.146	0.163

Yellow: p-value < 0.01; Orange: p-value < 0.05

Desired College Educational Opportunities

Additionally, students were asked if they currently participate or are interested in participating in 12 different college experience (first-year seminars, learning communities, Engineers Without Borders, undergraduate research experiences, internships/co-ops, additional writing intensive courses, engineering conferences, engineering global course, study abroad, engineering professional societies, student government, and volunteer regularly). Table 6 provides the Cohen's d values from 2-sample T-tests and statistical significance for each experience in relation to the six GPI subscales.

Table 6. Cohen's d values and statistical significance for desired college educational opportunities

	Social Responsibility	Social Interaction	Identity	Affect	Knowing	Knowledge
First-Year Seminars	0.347	0.153	0.342	0.326	0.180	0.030
Learning Communities	0.242	0.014	0.069	0.450	0.303*	0.049
Engineers Without Borders (EWB)	0.533	0.369	0.122	0.240	0.172	0.317
Undergraduate Research Experiences	0.338	0.306	0.289	0.481	0.477	0.311
Internship/Co-Op	0.077	0.004	0.519	0.239	0.205	0.148
Additional Writing Intensive Courses	0.351	0.192	0.280	0.153	0.089	0.322
Engineering Conferences	0.453	0.152	0.364	0.319	0.243	0.121
Engineering Global Course	0.515	0.261	0.074	0.386	0.274	0.263
Study Abroad	0.309	0.154	0.095	0.364	0.125	0.103
Engineering Professional Society	0.004	0.078	0.085	0.152	0.324	0.114
Student Government	0.439	0.332	0.3034	0.318	0.084	0.213
Volunteer Regularly	0.907	0.408	0.321	0.345	0.106	0.020

Yellow: p-value < 0.01; Orange: p-value < 0.05

The data indicates that promoting first-year students towards undergraduate research experiences shows great potential for higher GPI scores across all subscales. However, the effect sizes for each subscale were small while having close to medium effects sizes for the *affect* and *knowing* subscales (0.481 and 0.477). While not limited solely to this ideal, this finding may be due to research labs offering students the opportunity to work and communicate in diverse environments. Additionally, students who indicate they volunteer or wish to volunteer regularly, as well as participate or have an interest in EWB, demonstrated high scores within the interpersonal dimension. There was a very high effect size for volunteering in *social responsibility* (0.907) and a near medium effect size for *social interaction* (0.408). EWB had a medium and small effect size for *social responsibility* and *social interaction*, respectively (0.533 and 0.369). This suggests that students who currently or have the desire to volunteer or participate in EWB are more likely to accept and want to interact with other cultures. Overall, there seems to exist multiple benefits in first-year students' participation, or desire to participate, in different activities.

Students were further asked if they were interested in pursuing some type of international experience. Table 7 provides the mean and standard deviation values for each response, the Cohen's d values and significance values in relation to the six GPI subdimensions. A post-hoc test that was run showed there existed a statistically significant difference in social responsibility, affect, and knowing GPI scores between students who answered "Yes" and "No."

Table 7. Means, standard deviation, p-values, and Cohen's d values for student interest in an international experience

	Social Responsibility	Social Interaction	Identity	Affect	Knowing	Knowledge
Yes n = 57	3.59 (0.71)	3.34 (0.80)	3.80 (0.55)	4.08 (0.49)	3.62 (0.43)	3.58 (0.56)
Maybe n = 124	3.34 (0.69)	3.09 (0.68)	3.77 (0.58)	3.88 (0.50)	3.52 (0.48)	3.41 (0.55)
No n = 47	3.17 (0.61)	3.06 (0.66)	3.72 (0.61)	3.76 (0.50)	3.37 (0.51)	3.35 (0.59)
Cohen's d	0.428	0.323	0.098	0.449	0.367	0.303

Yellow: p-value < 0.01

Additionally, the results indicate that students should be encouraged to consider international experiences. Students that were interested in international experiences were found to have greater scores in all three GPI dimensions, particularly in the subscales of *social responsibility*, *affect*, and *knowing*. The effect sizes for all three subscales were small under Cohen's d, but are close to the medium effect size threshold (0.428, 0.449, and 0.367). A post-hoc test further found that the significance in the scores existed between students who were not interested in an international experience and those who were. Therefore, engineering schools should be promoting the benefits of international experiences to increase student interest, especially in those students who currently have no interest in an international experience.

Conclusion & Next Steps

The analysis of this data shows that exposing high school and early undergraduate college students to certain courses and activities with global focuses can have a beneficial effect on the global perspectives of students. The data also shows that students interested in pursuing an international experience of some manner while in college showed higher levels of global perspectives. It is clear that for students to develop their global perspectives during their academic career, schools need to do more to promote and offer globally focused coursework and out-of-class activities. To do so, it is important to see what engineering students are experiencing during their college career rather than just seeking to experience. That is why the next steps of this work is to look at senior student level data regarding international experiences and courses they have been through as students at ROWAN University to see how educational opportunities actually affect global perspectives. This data will then be compared to the findings from the data on the first-year students.

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