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A Cross-Sectional Study of Engineering Student Perceptions and Experiences Related to Global Readiness

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Abstract

Colleges of Engineering have increasingly emphasized the importance of engineering students obtaining professional skills relating to global readiness. This paper describes progress in a cross-sectional, longitudinal study to examine the impact that a College of Engineering at a large, mid-Atlantic public institution has on students' global readiness and related constructs. Data were collected from first-year and senior undergraduate engineering students for two years (2012-2013 and 2013-2014). Research questions examined: 1) previous international experiences of incoming students, 2) international experiences that undergraduates have during their academic careers, 3) students' perceived value of global readiness, 4) activities students perceive to be most impactful on global readiness, and 5) the impact of international experiences on students' cultural dispositions. Results showed that a large proportion of both incoming and senior students have had international experiences. While seniors perceived themselves to be more globally ready, first-year students rated themselves more highly on items relating to the professional importance of global readiness. Senior students felt that interacting with international students in their courses most strongly impacted their global readiness. Students who studied or worked abroad had stronger perceptions of their global readiness and more positive cultural dispositions. Implications of the results for engineering education are discussed.

Introduction

In the past several decades, there has been an increasing emphasis on the importance of engineers possessing important professional skills, including global readiness or awareness. In 2004, the National Academy of Engineering (NAE) described the *Engineer of 2020* as being proficient in "interdisciplinary teams [with] globally diverse team members" (p. 55).[1] As the NAE stated, "While certain basics of engineering will not change, the global economy and the way engineers will work will reflect an ongoing evolution that began to gain momentum a decade ago." (p. 4). Engineering graduates will be called to solve increasingly global problems and to work in teams that contain members who are either from international locations or are globally distributed.

Across the United States and globally, more universities are paying attention to the curricular and co-curricular activities that could potentially impact students' acquisition of skills necessary to compete in an increasingly global work environment. As [the authors] note, "Given that many of the challenges are global in nature, engineers also need to be able to communicate and lead in an international context, which underlies the importance of gaining international or multicultural experiences while they are students."[2] While some students are able to take advantage of study or work abroad programs, some institutions are implementing non-travel based programs in order to expose a greater number of students to global experiences.[3-4]

The purpose of this study is to discuss the strategies implemented at a large research intensive institution aimed at fostering global readiness and to describe the corresponding assessment to determine the impact of these strategies. In 2012, the College of Engineering at a large mid-

Atlantic research university began a cross-sectional study of engineering students' perceptions and experiences relating to global readiness. The purpose of the proposed four-year long study was to examine the impact of various activities implemented in the College, such as an increased focus on non-travel based international activities. The current study examines the following: 1) previous international experiences of incoming students, 2) international experiences that undergraduates have during their academic careers, 3) students' perceived value of global readiness, 4) activities students perceive to be most impactful on global readiness, and 5) the impact of international experiences on students' cultural dispositions. This paper will be of interest to those who are implementing changes relating to internationalization in their curriculum and want to develop an assessment or research study to examine the impact of these changes.

Literature Review

Universities have been increasingly urged to provide training to engineering students relating to the professional skill set. In addition to the acquisition of technical skills, professional skills such as creativity, global readiness, leadership, and entrepreneurship are increasingly being emphasized in the engineering curricula. One of ABET's required student outcomes is that graduates are able to "understand the impact of engineering solutions in a global, economic, environmental, and societal context" (p.3).[5]

Engineering colleges take varied approaches in helping to promote students' global readiness skills. Study and work abroad programs have been in place for many years. However, Parkinson, who collected information on the variety of different types of programs available in engineering colleges, estimated that only 7.5% of engineering graduates engage in some sort of study abroad program.[6] While some universities have set ambitious goals for increasing the number of students who engage in these types of programs, various challenges, such as the cost, timing of semesters, and convincing parents of the benefit, make it difficult to scale. Abel and Specking found that certain characteristics of study abroad programs, such as offering a program in the students' native language, allowing courses to count towards students' degrees, and providing a timing for the program that does not interfere with other opportunities, increased the feasibility and facilitated the implementation of such programs.[7] Another possible solution for scaling is to offer short-term study abroad programs, such as those described by Schubert and Jacobitz.[8] The authors describe how these short term programs, which are intensive in terms of the engineering experiences, can be a helpful solution to "underrepresentation of engineering students in study-abroad programs" through "acceptable levels of time and cost while providing both technical content and an international experience" (p. 10). Although these types of programs may help to increase the number of students who are likely to study abroad, scalability is still an issue for many universities, particularly those that are very large. Because of the cost, many students will not be able to participate unless financial support is provided.

Universities have recently begun to explore alternatives to travel-based initiatives by exploring how students can have significant international experiences while remaining in the United States. Some faculty have used embedded course assignments or activities with elements relating to global issues. For example, [the authors] incorporated the use of authentic cases, some of which had an international focus, in a civil engineering hydrology course.[9] In a 2007 paper, Bland described how he was able to incorporate global topics into a first-year engineering course.[10] Example activities

in this course included inviting guest speakers from a "local third world community development institution" and visiting "artisans from the mountains of Guatemala" (p. 6). Other universities have taken a broader course-focused approach, in which students are able to enroll in courses whose focus is on global issues in engineering. For example, Holloway describes a general education course in which engineering undergraduates were able to learn about global energy issues.[11]

[Authors] presented a model in which students are able to engage in "various international humanitarian engineering and social entrepreneurial ventures" (p. 1).[12] As part of the model, students worked on common international humanitarian projects in a variety of roles through credit-bearing courses, volunteer opportunities, honors theses, or short, intensive travel-based experiences. This unique model lets students obtain some of the benefits of engaging in internationally-themed, authentic experiences while not requiring the expense of travel or interfering with full engineering course schedules. While the authors found that students who engage at the highest level of participation (travel-based) had the most positive perspectives of themselves in terms of global awareness and multidisciplinary teamwork skills, students who engaged at less intensive levels (non-travel course-based) tended to have more positive (although not significantly different) perceptions of global readiness and multidisciplinary teamwork as compared to a comparison group.[13]

Another approach to non-travel based international experiences is the use of globally distributed teams in which students in the United States participate in a common project with other students who are located in an international location. A search of "distributed teams" for papers published in the proceedings of the annual meetings of the American Society for Engineering Education yields multiple examples of programs at various universities utilizing globally distributed teams in their engineering design courses. For example, Hovsapian and colleagues discuss how students in mechanical engineering senior design teams were able to participate in a globally distributed design teams, with US students collaborating with other engineering students in either Brazil or Armenia.[14] While the use of globally distributed teams in a university setting continues to grow, challenges exist that make scaling of these teams and programs difficult. Sheppard, Dominick, and Aronson state that globally distributed teams have the challenges associated with teams diverse in terms of language and culture but also can suffer from other issues due to the fact that the teams are physically separated and must connect through technological tools.[15] The authors present a process model in which performance of the group can be impacted by affective moderators (such as team member morale and trust), virtual team dynamics (such as conflict management and role clarity), process inputs (such as individual differences in technical expertise and quality of information linking technology, and contextual factors (such as cultural norms and international awareness). Zaugg and colleagues present a set of best practices that should be considered for globally distributed teams.[16] The authors present these best practices in terms of what the institution, the faculty, and the students need to do in order to maximize the chances of success in a globally distributed team. These likely will be helpful to universities as the use of globally distributed student teams continues to increase in engineering education settings.

The approaches that universities take to improve engineering students' skills relating to global readiness may vary. However, in order to best understand the impact of these approaches, effective assessment needs to be employed. This paper details a study to broadly understand the impact of global initiatives at one university.

Context of Study

The study is currently being conducted at the College of Engineering at a large mid-Atlantic research university. In 2009, the Global Engineering Education Faculty Advisory Committee was formed in the College of Engineering. Termed GLEE (for **GL**obal **E**ngineering **E**ducation), the committee is composed of department faculty representatives, the assistant dean responsible for global programs, the coordinator of global programs, and a member of the College's teaching and learning center. The purpose of the GLEE committee is to "define and refine the College's internationalization goals and objectives" and to "serve as an advisory group regarding College policies for global courses and program." The intention is for the committee to advise the Dean on issues relating to internationalization. The committee was tasked to focus attention on both travel-based and non-travel based initiatives.

The committee has made multiple substantial contributions to the College of Engineering regarding issues of internationalization. Some of the accomplishments of the committee since its establishment include the following:

- Development of guidelines for establishing and enabling collaborations with international institutions;
- Modifications to promotion and tenure dossiers to allow faculty to specifically report their participation in international activities;
- Create resources and enable consultations for faculty who want to learn about specific international education issues or include travel in their courses;
- Create recommendations for students to study abroad and to enroll in courses that offer non-travel based international experiences.

Additionally, one of the accomplishments of the committee was to define global readiness and to launch a cross-sectional, longitudinal study of students' global readiness. This research study is the focus of this paper.

Across the College of Engineering, departments have made significant strides in implementing both travel and non-travel based international education. Multiple departments have implemented or are in the process of implementing collaborative projects with geographically dispersed teams in their engineering courses.[17] Faculty across the college engage in travel-based activities, leading students on trips relating to social entrepreneurship projects or other educational experiences internationally.[13] The College's teaching and learning center has provided support for some of these projects, in the form of funding and assessment support. The teaching and learning center has also offered workshops and seminars to help faculty embed international activities in their engineering courses. In the past few years, topics of these workshops and seminars have included, "Integrating International Topics into Your Course," "Globally Distributed Design Teams," and "Integrating Globally Focused Assignments into Engineering Courses."

Methodology

In order to assess the impact of the College of Engineering activities, a cross-sectional, longitudinal study of students in the College of Engineering is currently being conducted. In the fall of 2012 and 2013, all first-year students were asked to complete an online survey asking about their activities relating to global readiness. Seniors were asked to complete a similar online survey in the spring of 2013 and 2014. This report makes comparisons between the first-year and senior students and provides descriptive data for questions asked of seniors during the spring 2013 and 2014 administrations. The intention for the study is to collect cross-sectional data from first-year and senior students each year for four years. Data are currently being compared across years and cohorts. Eventually, when the full study is complete, data collected from first-year students in fall of 2012 will be compared to data collected from the same set of students who will be seniors in 2016. Because of the cross-sectional nature of the study, the results are reported separately for each year and for each class standing level (first-year versus senior students).

In the study, the following research questions are examined:

1. What previous international experiences, including both travel-based and non-travel based experiences, do first-year engineering students have prior to enrolling at the university? What international experiences do senior students have during their undergraduate careers?
2. How strongly do first-year and senior engineering students value global readiness, both personally and professionally?
3. What activities do seniors feel most impacted their global readiness?
4. What is the cultural disposition (as measured by the Cultural Dispositions Index[18,19]) of first-year and senior students?
5. What is the relationship between students' value of global readiness and cultural disposition among those engaged in study/work abroad?

Participants

First-year Students, 2012: In the fall of 2012, all first-year students who indicated that they intended to major in engineering were asked to complete an online survey. Because of the unique experiences that international students have, only resident students (US citizens or permanent residents) were invited to participate. The justification for this selection of participants is that international students are thought to be already having significant international experiences, mostly by studying abroad at the university. The students received an invitation to complete an online survey which was administered through Qualtrics, a commercial survey software tool.[20] As an incentive to participate, ten respondents were randomly selected to receive a $25 gift certificate. The first page of the online survey consisted of an implied consent form in accordance with the university's Institutional Review Board (IRB).

A total of 2,596 first-year students from all campuses were invited to participate. A total of 865 students started the survey for a response rate of 33.3%. Of the 865 respondents, 760 students completed the survey in its entirety for a completion rate of 29.3%. A total of 63.7% of the respondents were from the university's main campus. The remaining students were enrolled at one of the other campuses of the university. The most frequently endorsed intended major was mechanical engineering (25.1%).

Of the total respondents, 199 or 23% were female; 666 students or 77% were male. The following provides the breakdown of reported ethnicity: 78.7% Caucasian, 8.8% Asian, 4.7% Hispanic, 3.6% African American or Black, and 2.5% two or more ethnicities. Ethnicity information was not available for 1.6% of the respondents.

First-year Students, 2013: The same procedure was conducted for all first-year students in the fall of 2013. A total of 2,808 first-year students from all campuses were invited to participate in the survey. A total of 835 students started the survey; this resulted in a response rate of 29.7%. Of the students that started the survey, 703 completed the survey in its entirety; this resulted in a completion rate of 25.0%. A total of 64.2% of the respondents were from the university's main campus. As with the first-year students in the fall of 2012, the remaining students were enrolled at one of the campuses. The most frequently endorsed intended major was again mechanical engineering (22.5%).

Of the total respondents, 22.8% or 160 were female and 77.2% or 543 were male. The following provides the breakdown of reported ethnicity: 77.5% Caucasian, 12.1% Asian, 5.4% Hispanic, 2.1% African American or Black, 0.43% Hawaiian or Other Pacific Islander, and 0.28% American Indian. Ethnicity information was not available for 2.1% of the respondents.

Seniors, 2013: Midway through the spring, 2013 semester, all senior students who were majoring in engineering were asked to complete a similar version of the online survey. As with the previous administration, only resident students were invited to participate. The same survey invitation procedures and incentives were used for this administration.

A total of 1,316 senior students were invited to participate. Most engineering undergraduate students transition to the main campus at the start of their junior year; therefore, all respondents were from the main campus. A total of 378 students started the survey for a response rate of 28.7%. Of the respondents, 332 students completed the survey in its entirety for a completion rate of 25.2%. The most frequently endorsed intended major was mechanical engineering (25.1%).

The gender breakdown was consistent with the first-year sample; of the total respondents, 93 or 24.6% were female; 285 students or 75.4% were male. The following provides the breakdown of reported ethnicity: 85.7% Caucasian, 7.4% Asian, 2.9% Hispanic, 2.6% African American or Black, and 0.5% American Indian or Alaskan Native.

Seniors, 2014: In the spring of 2014, all senior students who were majoring in engineering were also asked to complete a similar version of the online survey. Only resident students were invited to participate. The same survey invitation procedures and incentives were again used for the administration.

A total of 1,227 seniors were invited to participate. Again, all students were from the university's main campus. A total of 337 started the survey, resulting in a response rate of 27.5%. Of the 337 respondents, 282 completed for survey, resulting in a completion rate of 23.0%. The most frequently endorsed major was again mechanical engineering (24.8%).

Of the total respondents, 25.2% or 71 were female and 74.8% or 211 were male. The breakdown for reported ethnicity is as follows: 86.5% Caucasian, 6.4% Asian, 4.6% Hispanic, .71% African American or Black, 0.36% Hawaiian or Other Pacific Islander, and 0.36% American Indian. Ethnicity information was not available for 1.0% of the respondents.

Instrument and Measures

In both years, students were asked questions about their previous international experiences and perceptions regarding global readiness. A 6-item scale assessing the perceived value of global readiness was included in the survey. Also included in the survey was a 15-item scale assessing cultural dispositions, which was developed by researchers at Brigham Young University.[18,19] The items for the first-year and senior versions of the survey were nearly identical, with appropriate changes made to verb tense based on time of study and completed activities. On the senior version of the survey, students were asked to reflect on their experiences while at [the authors' institution]. Seniors were also asked questions relating to their study and work abroad experiences. Data are summarized below separately for Year 1 (2012-2013) and Year 2 (2013-2014) of the study.

Results

The results for each research question are detailed below.

1. *What previous international experiences, including both travel-based and non-travel based experiences, do first-year engineering students have prior to enrolling at the university? What international experiences do senior students have during their undergraduate careers?*

Travel outside United States

Year 1: The proportion of seniors who traveled outside the United States was higher than first-year students, as displayed in Figure 1. In 2012, a total of 71% of first-year students reported traveling outside of the United States. In 2013, for seniors, this percentage was significantly higher at 78% [$X^2(1, N = 1163) = 5.70, p = 0.02$]. Seniors were asked when their travel occurred. A total of 73% of the seniors who had traveled internationally stated that they had traveled prior to starting their undergraduate career. A total of 52% of seniors who had traveled internationally had done so while they were undergraduates.

Year 2: In 2013, a total of 70% of first-year students reported traveling outside of the United States. This is compared with 82% of seniors in 2014 that reported traveling outside of the United States. The difference in travel rates was found to be statistically significant [$X^2 (1, N = 983) = 13.04, p < 0.001$]. The number of seniors traveling internationally increased slightly in Year 2.

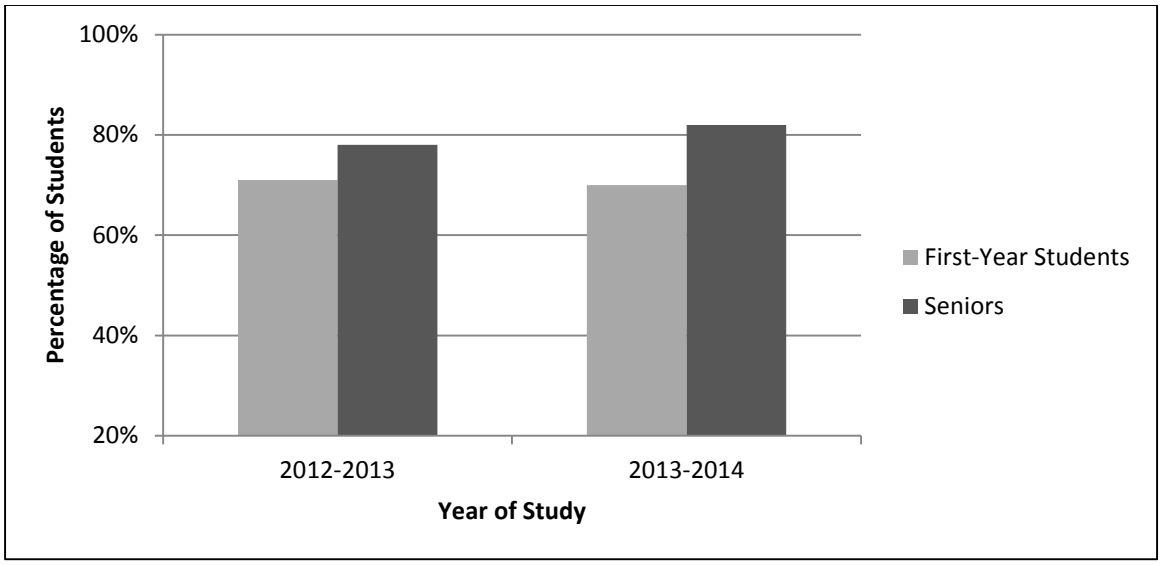

Figure 1: Proportion of first-year and senior students who reported traveling outside the United States (2012-2013; 2013-2014)

Length of Time Spent Outside the United States

Year 1: Figure 2 displays the percentages of students who traveled outside the United States by length of time for the 2012-2013 year. A chi-square test confirmed that significant differences existed in the various lengths of time that first-year versus senior students spent outside the United States [$X^2(4, N = 848) = 25.51, p < 0.001$]. The percentages of students who spent less than one week, 3-4 weeks, or more than one year were similar. A total of 49% of first-year students spent 1-2 weeks outside the United States. A slightly smaller proportion of seniors (40.4%) spent this amount of time outside the United States. The category where the proportion was most substantially different occurred in the range from 1 month to 1 year. A total of 6.7% of first-year students and 17.3% of seniors selected this category. The reason for this difference may be due to the number of students who study abroad for a semester during their college experiences.

Year 2: Figure 3 displays the percentages of students who traveled outside of the United States by length of time for the 2013-2014 year. A chi-square test was also conducted to examine differences in the lengths of time spent outside the United States between first-year students and seniors for the fall of 2013 and the spring of 2014. A significant difference was found in the length of time spent outside the United States [$X^2(4, N = 724) = 40.025, p < 0.001$]. A total of 47% of first-year students reported spending 1-2 weeks outside the United States; 43% of seniors reported the same amount of outside-the-United States travel. As with the 2012-2013 year, the length of time for which the largest difference was detected was the 1 month to 1 year time interval. A total of 9.5% of first-year students reported traveling outside of the United States for 1 month to 1 year, while 25% of seniors reported traveling outside of the United States for the same time interval. When compared with Year 1, a higher percentage of seniors reported traveling outside of the United States for the 1 month to 1 year time interval.

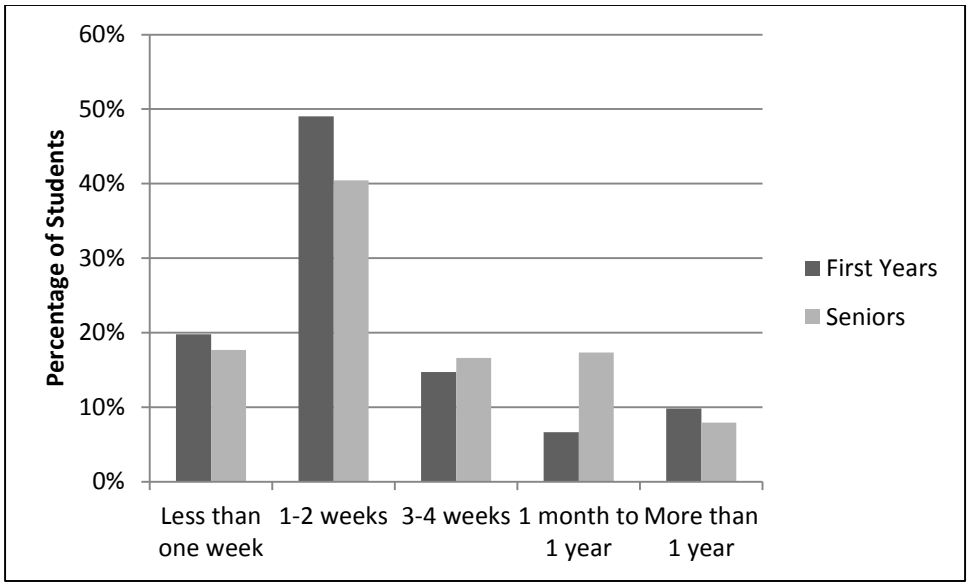

Figure 2: Length of time first-year students and seniors spent outside of the United States in Year 1 of Study

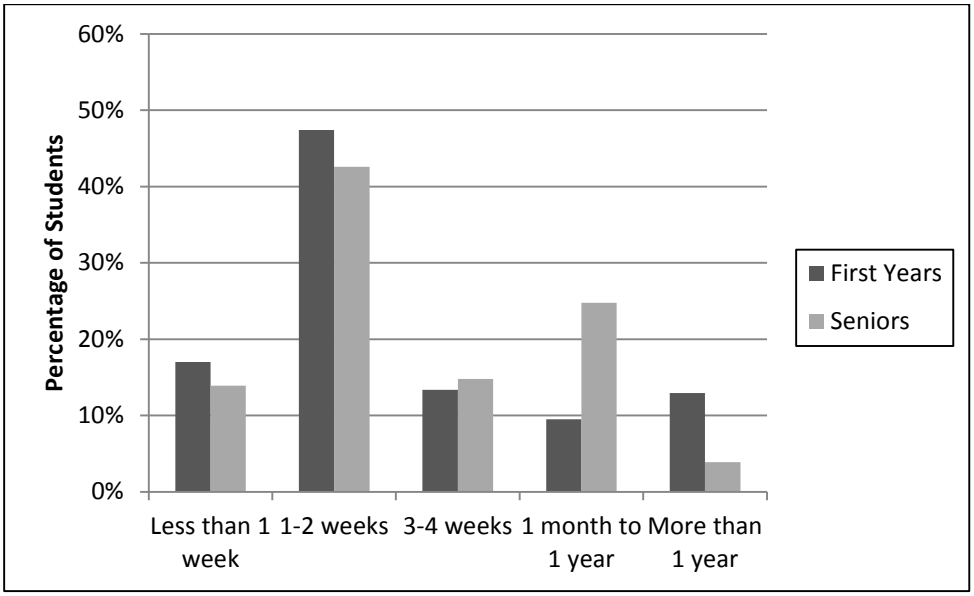

Figure 3: Length of time first-year students and seniors spent outside of the United States in Year 2 of Study

Non-travel based experiences

The students were asked to select from a list of activities in which they participated. First-year students were asked about their experiences that they had in high school; seniors were asked to respond regarding experiences that they had during their undergraduate careers. Items that show data for only seniors or first-year students were items specific to their standing.

Year 1: Figure 4 shows completed activities for first-year students in the fall of 2012 and seniors in the spring of 2013. As compared to first-year students, more seniors reported interacting with

international students in the United States and working on group projects with international students. Similar numbers reported having an international conversation partner and being involved in an international student group. Although it may appear that more first-year students traveled abroad, it is important to note that the questions for seniors specifically asked about their experiences during their undergraduate experiences. For seniors, a total of 35.2% (n = 133) reported working on assignments or activities that focused on international issues. A total of 13% (n = 49) of the seniors had worked on globally distributed teams.

Year 2: Figure 5 shows completed activities for first-year students in the fall of 2013 and seniors in the spring of 2014. A total of 79.1% of seniors reported interacting with international students in the United States compared with 61.3% of first-year students. Similarly, 68.4% of seniors reported working on a group project with international students; only 28.4% of first-year students reported this experience. These findings are consistent with those for the 2012-2013 year.

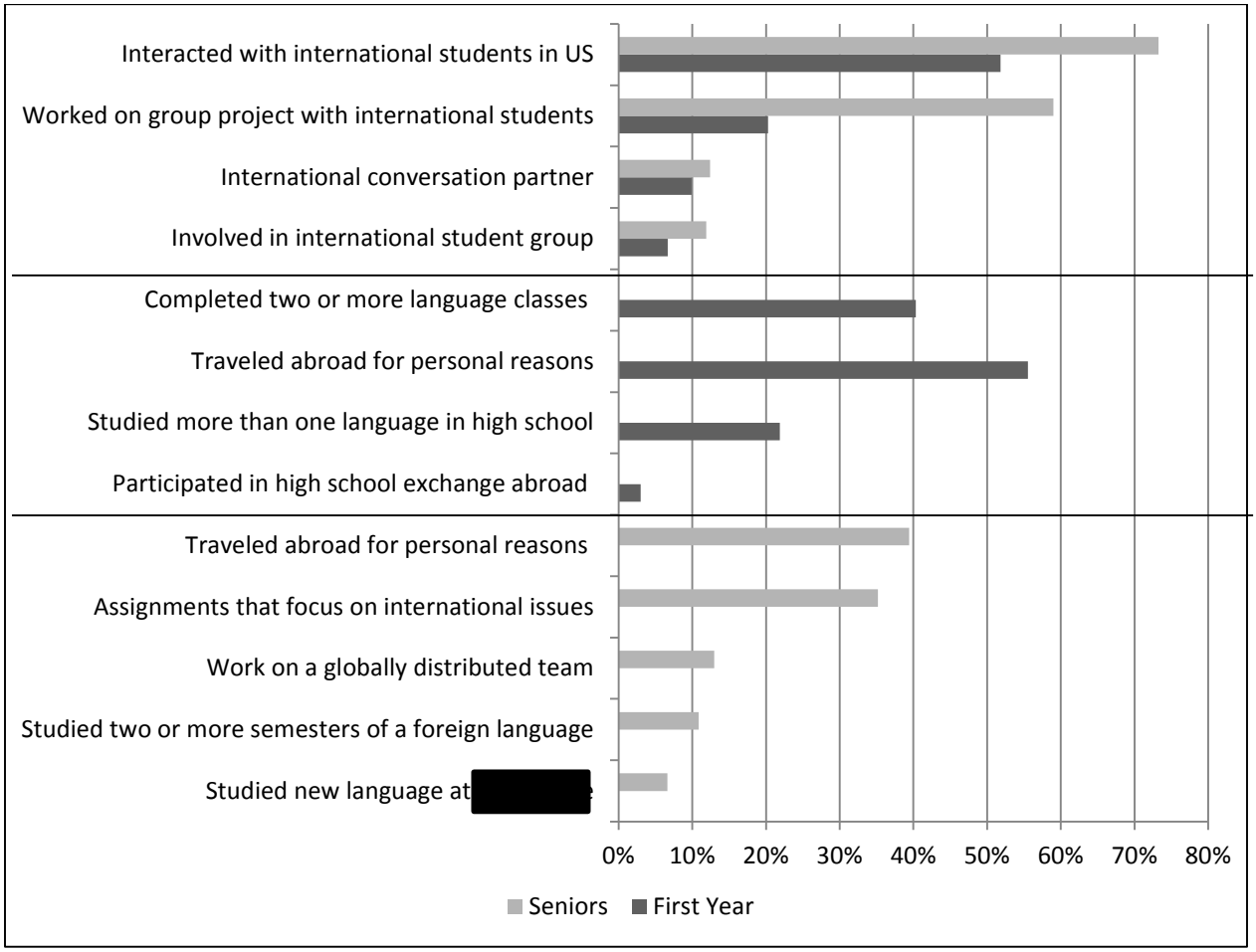

Figure 4: Participation in globally-related activities (Year 1)

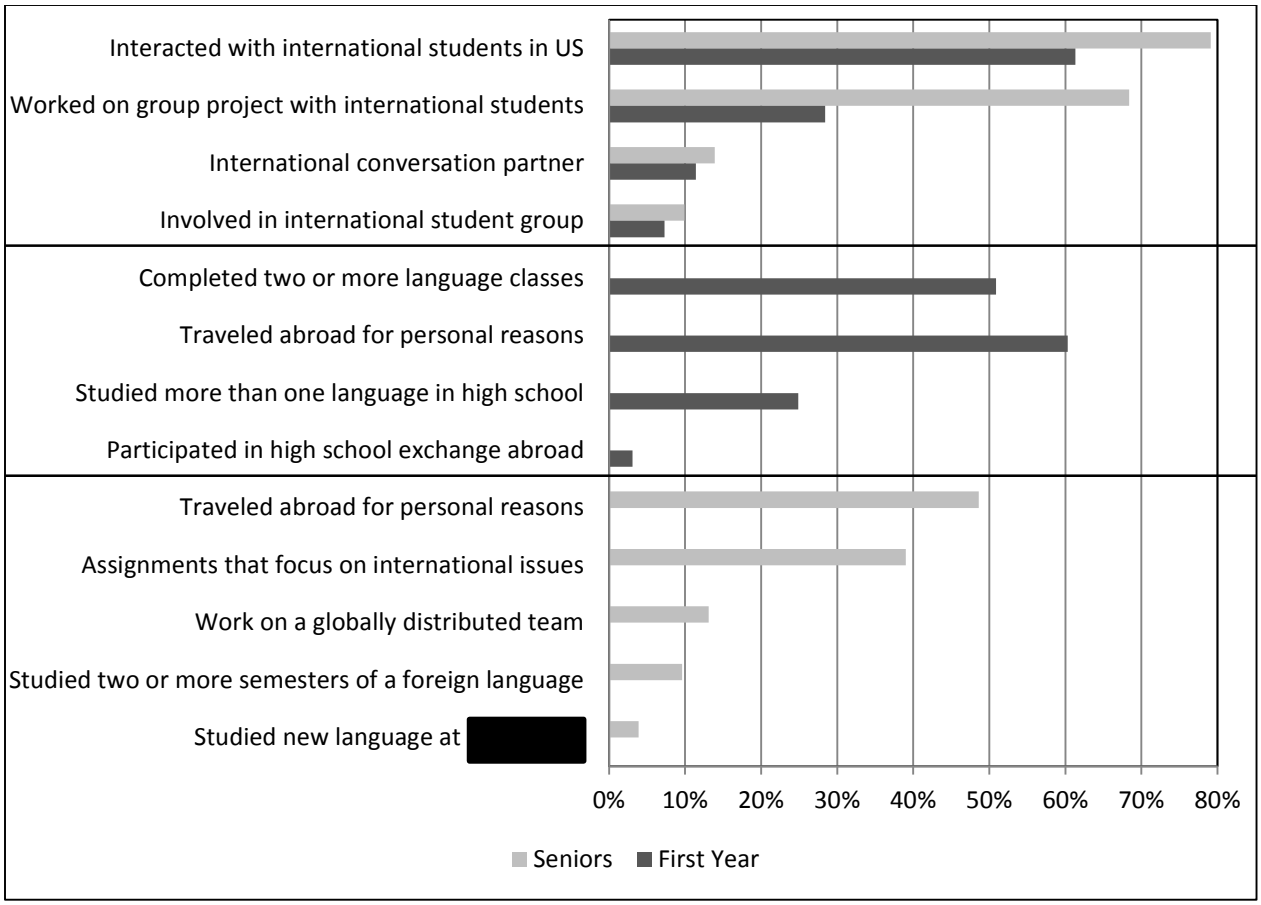

Figure 5: Participation in globally-related activities (Year 2)

2. *How strongly do first-year and senior engineering students **value global readiness** both personally and professionally?*

The Perceived Value of Global Readiness scale was developed as part of an earlier assessment in the College of Engineering. The students were first presented with a definition of global readiness, which was written by the GLEE committee. The definition stated the following:

> "Global readiness can be defined as the following: 1) Having the knowledge and appreciation of the global nature of engineering and related professions; 2) Having the knowledge of the challenges and opportunities associated with contemporary worldwide issues; and 3) Being ready to practice your profession in a global context by being sensitive to and respectful of the differences that affect professional practice throughout the world."

Following this definition, students were presented with the six items from the Perceived Value of Global Readiness scale. For each item, students were asked to rate each statement using a scale ranging from Strongly Disagree (scored as 1) to Strongly Agree (scored as 5). An examination of the scale across the entire sample (n = 2077; 2012-2014) indicated adequate reliability (α = .81). An examination of the factor structure of the scale, by way of exploratory factor analysis, across the entire sample yielded evidence of a one factor scale structure (extraction method: principal

component analysis), accounting for 53.58% of the variance. It should be noted that the language of one item (I hope to improve/I have improved my global readiness while at [redacted]) varied between the two levels and thus was not included in the statistical analysis. The data for the other five items were analyzed using the Wilcoxon signed-rank test, based on the possibility of item distribution non-normality, to determine if there were statistically significant differences on the items between first-year and senior students.

Year 1: Figure 6 displays the averages for each item on the Perceived Value of Global Readiness scale for first-year and senior students in the fall of 2012 and spring of 2013 respectively. In examining item-level differences, seniors had a significantly higher mean rank for the item "I feel that I am globally ready." ($Z = 5.24$, $p < 0.001$). However, first-year students had higher mean ranks on the items, "Being globally ready is important to me professionally." ($Z = 3.11$, $p < 0.01$) and "I feel that global readiness is a competency that employers look for in engineering graduates." ($Z = 8.42$, $p < 0.001$).

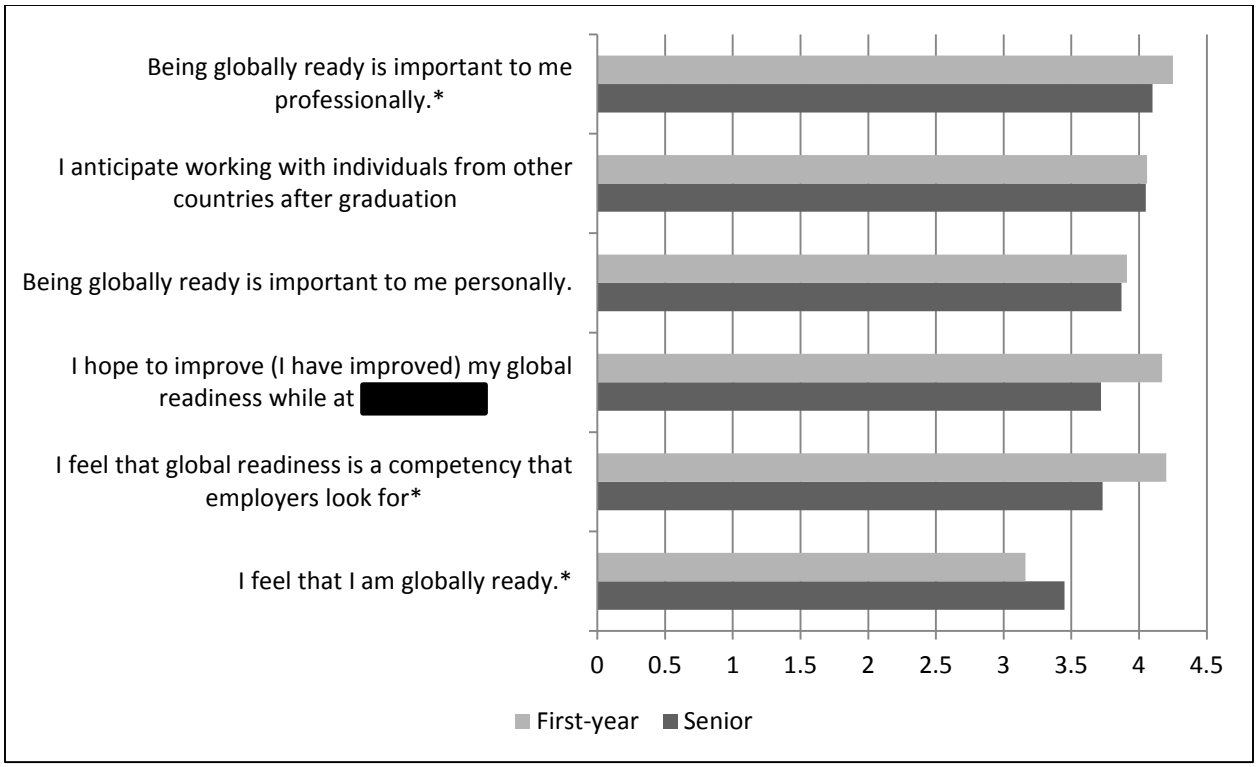

Figure 6: Item averages for first-year and senior students on the perceived value of global readiness scale (Year 1). Asterisks indicate mean ranks among items that are significantly different between first-year and senior students.

Year 2: Figure 7 displays the averages for each item on the global readiness scale for first-year and senior students in the fall of 2013 and spring of 2014. In examining item-level differences, seniors had a significantly higher mean rank for the item "I feel that I am globally ready." ($Z = 7.15$, $p < 0.001$). First-year students had a significantly higher mean rank for the following items: "Being globally ready is important to me professionally." ($Z = 5.04$, $p < 0.001$); "I anticipate working with individuals from other countries after I graduate." ($Z = 2.11$, $p < 0.04$); and "I feel

that global readiness is a competency that employers look for in engineering graduates." ($Z = 9.65$, $p < 0.001$).

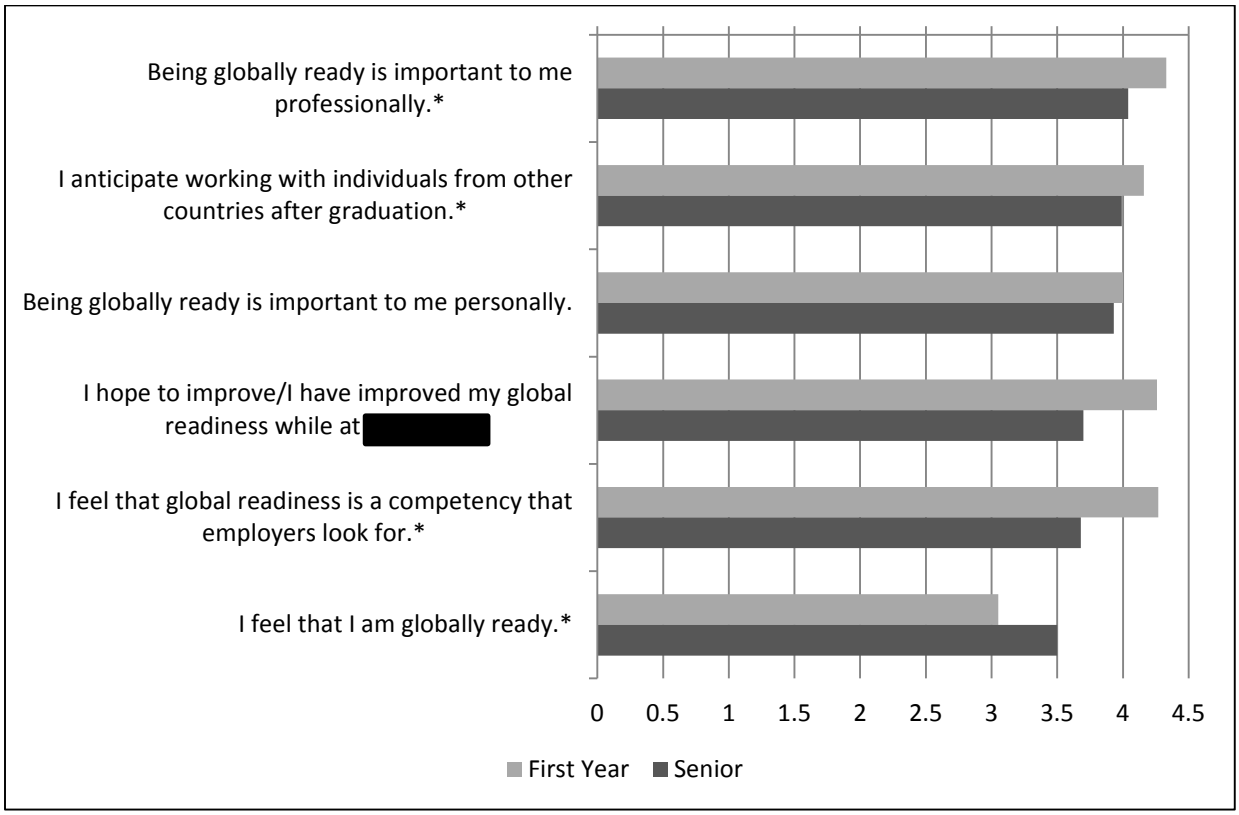

Figure 7: Item averages for first-year and senior students on the perceived value of global readiness scale (Year 2). Asterisks indicate mean ranks among items that are significantly different between first-year and senior students.

3. *What activities do seniors feel most impacted their global readiness?*

Year 1: Seniors were asked the following follow-up question about their global readiness: "What activities did you participate in at [redacted] that most improved your global readiness?" The most frequently selected item was "Interacting with international students in courses" with 68.8% ($n = 260$) of seniors selecting this item. A total of 51.3% ($n = 194$) of the students stated that they felt that interacting with international students outside of class most improved their global readiness. Figure 8 displays the activities that seniors reported most impacted their global readiness.

Year 2: In year 2, the most frequently occurring response was again "Interacting with international students in courses" (75.5%; $n = 213$). A total of 55% ($n = 155$) of seniors indicated that "Interacting with international students outside of class" improved their global readiness. Figure 9 displays the activities that seniors reported most impacted their global readiness.

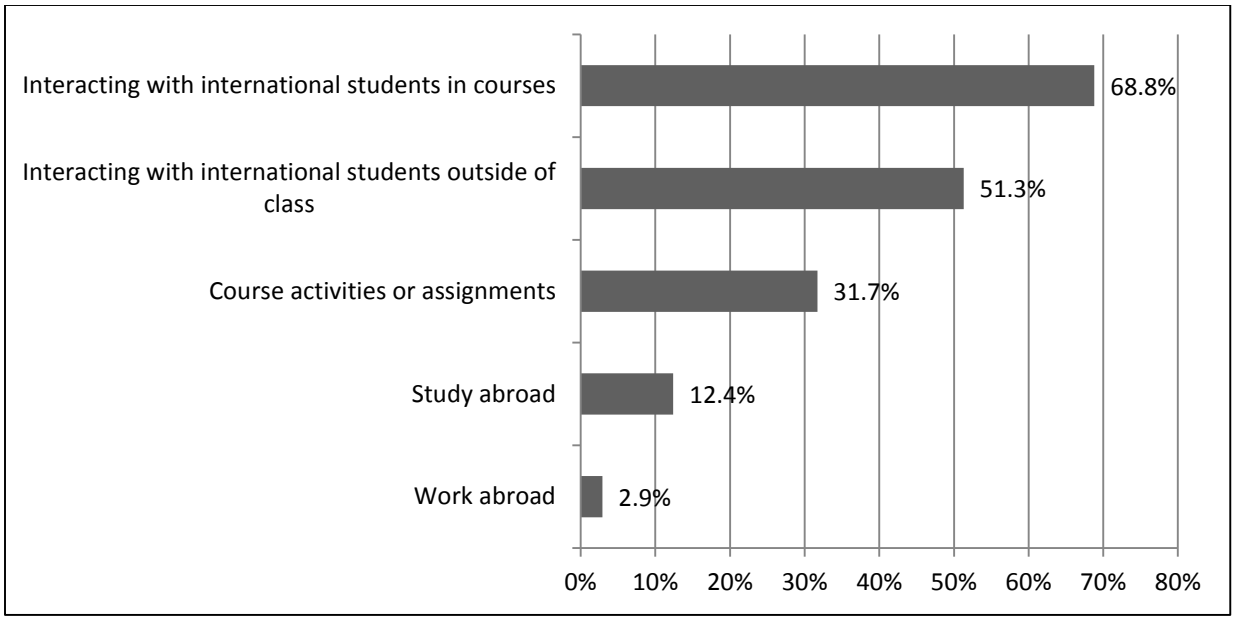

Figure 8: Activities that seniors reported most impacted their global readiness (Year 1)

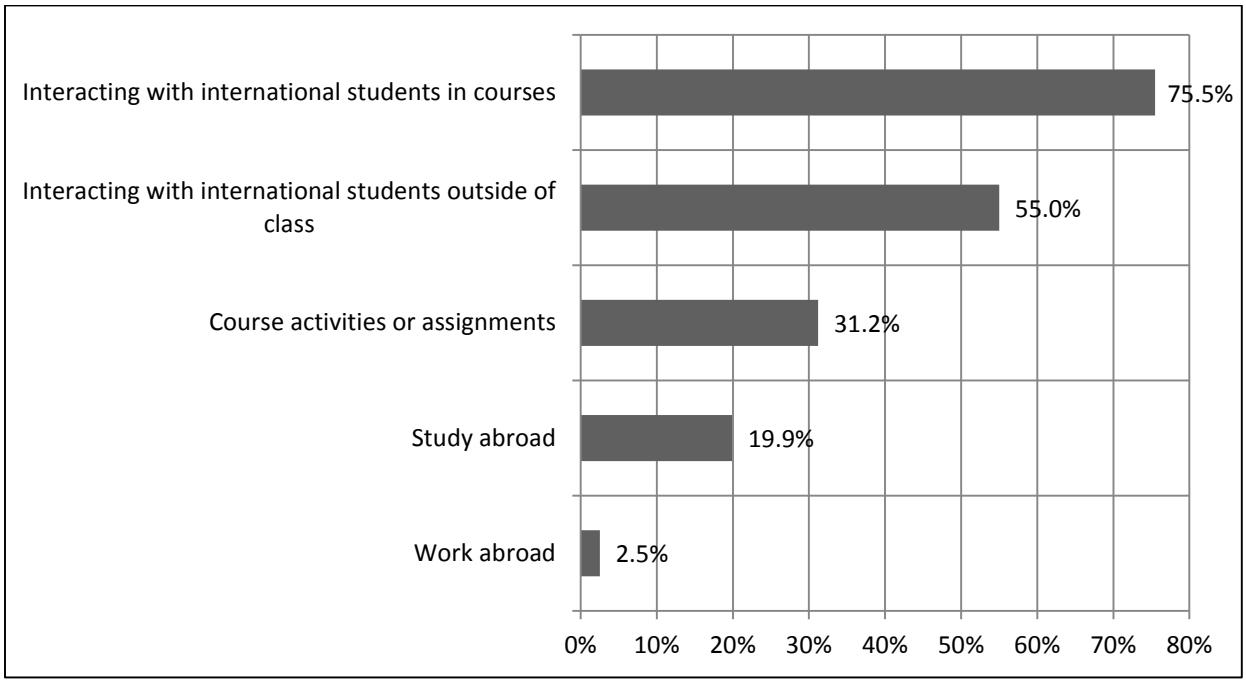

Figure 9: Activities that seniors reported most impacted their global readiness (Year 2)

*4. What is the **cultural disposition** of first-year and senior students?*

The Cultural Dispositions Index (CDI)[18, 19] contains 15 items for which students were asked to rate their level of agreement using a scale from Strongly Disagree (scored as 1) to Strongly Agree (scored as 5). Scale scores were calculated by summing the item scores. One item ("I feel more comfortable living in a neighborhood with similar ethnic backgrounds to my own") was reverse

coded prior to summing the scores. An examination of the index across the entire sample (n = 2077; 2012-2014) indicated adequate reliability (α = .84).

Year 1: Among the 2012-2013 year sample, the difference in the average score between first-year and senior students was not found to be statistically significant (t = 0.75, df = 1128, p = 0.46). The average score for first-year students was 50.8 while the average score for seniors was 50.3. Among the 2013-2014 year sample, the difference in the average score between first-year and senior students was also not found to be statistically significant (t = 0.53, df = 1074, p, = 0.56). The average score for first-year students was 52.38 while the average score for seniors was 52.06.

Year 2: Finally, across the entire sample (2012-2014), first year and senior students did not differ with respect to their openness and interest towards differing cultures (t = 0.84, df = 2014, p, = 0.40). The average score for first-year students across the sample was 52.08; the average score for seniors across the sample was 51.74.

This suggests, overall, that first-year students and seniors rated themselves similarly in terms of their openness, interests, and dispositions towards different cultures.

*5. What is the **relationship** between students' value of global readiness and cultural disposition among those engaged in study/work abroad?*

For the spring of 2013 (Year 1), A total of 44 (11.6%) seniors reported studying abroad while in college. Nine seniors (2.4%) reported working abroad. For the spring of 2014 (Year 2), 58 (20.6%) seniors reported studying abroad; 5 (1.8%) reported working abroad.

Students who had not studied or worked abroad were asked whether they had intended to participate in a study or work abroad program when they started their undergraduate careers. For 2013 (Year 1), of the students who responded to this question, 25.7% (n = 78) responded that they had hoped to participate in a study abroad program. For 2014 (Year 2), 19.9% (n = 56) responded that they had hoped to participate.

Analyses were conducted to determine if the group of students who either studied abroad, worked abroad, or did both differed in their Perceived Value of Global Readiness scale or CDI scores as compared to the rest of the seniors in the sample. In examining the scores on the CDI for seniors in the spring of 2013 (Year 1), students who either studied or worked abroad had a significantly higher mean than those who did not (t = 4.725, df = 346, $p < 0.001$). Students who had studied or worked abroad had a mean score of 56.18. The average CDI score for seniors who did not study or work abroad was 49.34. These results were again obtained for seniors in the spring of 2014 (Year 2). Seniors who had either studied or worked abroad had a significantly higher mean on the CDI than those who did not (t = 3.84, df = 232, $p < 0.001$). The average score for seniors who studied or worked abroad was 56.02; the average score for seniors who did not work or study abroad was 51.24.

Analyses of item-level differences were also conducted. For Year 1, seniors had significantly higher mean ranks for each of the Perceived Value of Global Readiness scale items. Figure 10 displays the Perceived Value of Global Readiness scale items for seniors for Year 1.

For Year 2, seniors had significantly higher mean ranks for the following items: “Being globally ready is important to me.” ($Z = 4.16$, $p < 0.001$), “I feel that I am globally ready.” ($Z = 2.07$, $p = 0.04$), “I have improved my global readiness while at Penn State.” ($Z = 5.13$, $p < 0.001$), and “I feel that global readiness is a competency that employers will look for in engineering graduates.” ($Z = 1.98$, $p < 0.05$). Figure 11 displays the Perceived Value of Global Readiness scale items for seniors for Year 2.

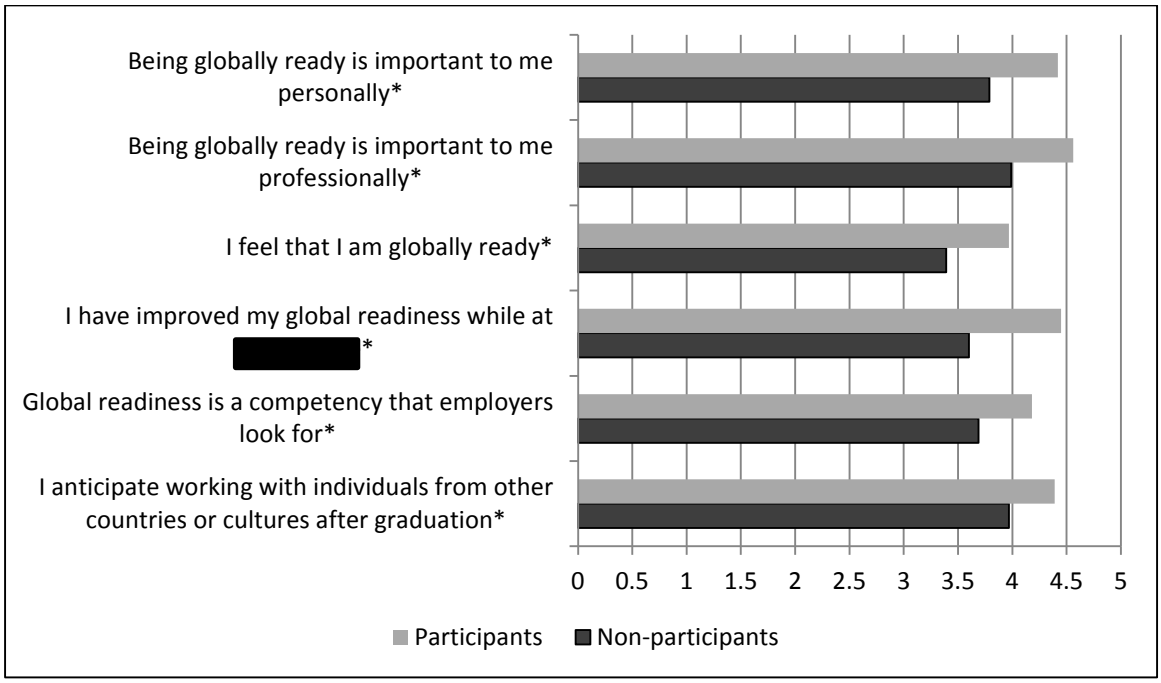

Figure 10. Global readiness item averages for students who studied or worked abroad and those who did not (Year 1). Asterisks indicate mean ranks among items that are significantly different between those who worked or studied broad and those who did not.

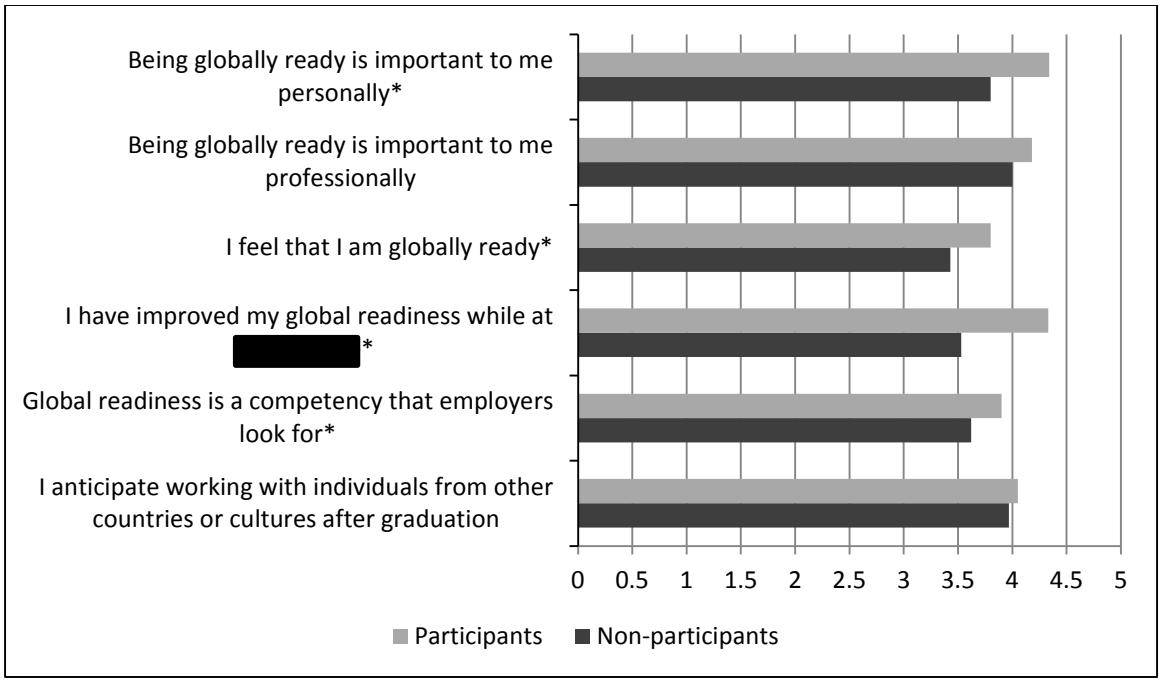

Figure 11: Global readiness item averages for students who studied or worked abroad and those who did not (Year 2). Asterisks indicate mean ranks among items that are significantly different between those who worked or studied broad and those who did not.

A correlational analysis was conducted examining the relationship between scores on the CDI and the Perceived Value of Global Readiness scale among those students who either studied or worked abroad. The correlation between the CDI composite and the Perceived Value of Global Readiness scale score among those students who either studied or worked abroad was .46 ($r = .46$, $p < 0.001$), indicating a significant relationship between perceptions of value of global readiness and cultural disposition among students engaged in study/work abroad.

Discussion

The results of this cross-sectional study show that incoming students have a variety of prior experiences with international activities, including a large proportion who have traveled outside the country. One limitation regarding questions regarding travel is that the students were not asked where they had traveled outside the country. Thus, it is possible that their travel may not have contributed to their global readiness if they have traveled to places such as Canada or spring break locations such as Cancun, which may result in experiences similar to what they may have in the United States. Future research may benefit from asking about the location of their travel. However, the large proportion of incoming students and senior students who had some type of international travel experience is encouraging. Engineering faculty members may want to engage students in the classroom to ask about their international travel experiences and use this information as a launching point for discussions on engineering global readiness.

As students progress through their undergraduate careers, they have a greater number of interactions with other international students as compared to their high school years. This is not surprising as the number of international undergraduate engineering students has continued to

increase at many engineering colleges. At the authors' institution, the number of incoming students who intend to be engineering students is almost 20%. Yet, only about 20-30% of incoming resident students who intend to major in engineering have worked on a group project with international students. The dynamic in student teams with one or more international students may be challenging at times for all team members, as students from diverse cultural backgrounds may have different ways of working or have different values and mindsets. Thus, the potential is perhaps greater for conflicts and miscommunication. However, senior domestic students do acknowledge that interacting with international students in their courses is beneficial, as almost 70% of respondents said that this activity most improved their global readiness. The dynamics of student team composition, as it relates to the inclusion of international students, has not yet been thoroughly explored in the engineering education literature. However, an undergraduate researcher at [the authors' institution] has begun to do so.[21] While neither domestic nor international students saw cultural differences or language barriers as sources of conflict in design teams, the data suggested that domestic students felt their creativity was suppressed due to characteristics of the group composition. Additional research on the impact of culturally diverse teams is necessary in order to maximize the team experiences of both domestic and international students. Given the changing demographics of the undergraduate engineering population and the likelihood that graduates will be engaged in culturally diverse or distributed teams, providing guidance and instruction to students on successful team behaviors has increasing importance.

Some of the results relating to students' perceived value of global readiness are intriguing. One encouraging result is that senior students scored significantly higher on the item, "I feel that I am globally ready." Slightly less encouraging is that first-year students score higher on the following items: "Being globally ready is important to me professionally" and "I feel that global readiness is a competency that employers look for." One possible reason for this difference is that with each passing year, incoming students may be more aware of the changing nature of the engineering profession. The College has made some changes to orientations for incoming students to better inform them of the importance of engineering professional skills as well as the opportunities available for them during their undergraduate career. A less encouraging reason for the difference between first-year students and seniors on these items is that the message regarding the importance of the professional skill set, including global readiness, may not be reinforced during students' academic careers. Additionally, if seniors have participated in job interviews, it may be possible that interviewers do not focus on global readiness skills. These differences in perceptions between first-year and senior students will continue to be monitored and explored.

Despite the College's efforts to increase the number of both travel-based and non-travel based international experiences, there is still work to do. The data from both years of the study show that only about 10-15% of students have worked on a globally distributed team. As mentioned above, several departments are attempting to put these types of experiences into the curriculum. However, these collaborations between US and international institutions can be very difficult and time-consuming. One department in the College of Engineering has been working on such a model for several years and has been unable to implement the experience due to personnel changes both in the US and at the partner international institution. Practical constraints such as differences in academic calendars and time zone differences also present challenges to the success of these models.

Other areas of improvement include increasing the number of students who are able to study or work abroad. While the College of Engineering has been able to increase the number of students who are able to have these experiences, the proportion of students within the College who actually have a substantial international experience is still rather low. In this study, only about 20% of students were able to study abroad; much fewer were able to work abroad. Although the proportion of students who are able to study or work abroad is still fairly small, the results of this study show that these experiences have significant impacts on students' perceptions of global readiness. Students who had these experiences had significantly higher scores on the Cultural Dispositions Index and higher scores on several items on the Perceived Value of Global Readiness scale. Students who studied or worked abroad felt more globally ready, felt that their undergraduate experiences helped them to become more globally ready, and felt that employers will look for these competencies in their search for employees. Although not the focus of this paper, students were asked reasons that they did not study or work abroad. Responses often related to cost and the difficulty with fitting these experiences into an already challenging and packed engineering course plan. Colleges of Engineering may want to provide guidance for students in order to make study or work abroad experiences easier to obtain by providing financing or figuring out ways to fit these experiences into the curriculum.

The current study has several limitations. First, the samples being compared have substantial differences that make comparisons inherently difficult. For example, first-year students have yet to progress into their major. A fairly substantial proportion of these students will leave engineering for other majors. Senior students are those who have made the decision to continue with engineering and have successfully matriculated into a major. Therefore, all comparisons between first-year and senior students need to be interpreted with this caution in mind. With longitudinal data, we can obtain a better understanding of what happens to students as they progress through the engineering curriculum. A second limitation is that a self-selection bias is possible. Students who are interested in international or global issues may be more likely to click on the survey link and perhaps be more likely to complete the survey. Therefore, caution must be exercised in generalizing these data to the entire first-year or senior classes.

Overall, there were few differences between the Year 1 and Year 2 cohorts. Although changes are being made in the College of Engineering, some have not been widespread or impacted many students, such as the globally distributed design teams. The most interesting analyses will be conducted in Year 4 of the study when we are able to compare the matched responses between first-year and senior students. In 2014-2015, data for Year 3 of the study were collected. The Year 4 data will be collected in 2015-2016. The longitudinal component of the study will be critical in better understanding the impact that the undergraduate engineering career has on students' perceptions of global readiness.

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