AC 2010-565: AN INVESTIGATION OF FIRST YEAR STUDENTS' PERCEPTIONS OF GLOBAL AWARENESS

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An Investigation of First Year Students' Perceptions of Global Awareness

Abstract

Most engineering educators recognize the importance of emphasizing the so-called "soft-skills" in the undergraduate curriculum in order for graduates to be competitive in the global workforce. Of increasing interest for many engineering programs is engaging students in educational experiences that will increase their global awareness, cultural understanding, and cultural sensitivity. For many universities, requiring all students to work or study internationally is not an option due to the high financial cost. Therefore, other methods must be used to engage students in international experiences without requiring international travel.

In order to inform planning related to non-travel based international experiences, data was collected from 435 first-year engineering students from all campuses of Penn State University. Survey questions asked students about their perceptions of global awareness, including a self-assessment of their current awareness, their desire to improve their global awareness, and how they anticipated improving global awareness while an undergraduate. The results indicated that approximately one-third of the freshmen felt that global awareness was very important to them personally while over one-half believed global awareness to be very important to them professionally. Over half of the students hoped to greatly improve their global awareness during their undergraduate career. When asked how students anticipated increasing their global awareness, the most frequently endorsed responses included interacting with international students in and out of the classroom, completing assignments that focused on international issues, and studying abroad.

Penn State University has begun to take steps to provide students with non-travel based international experiences to help students' meet the needs of the global workforce. One example of such experiences is the use of cross-national engineering student teams at the capstone level.

Introduction

> *"In the United States the oceans that bound our coasts no longer insulate us from other nations. In this dynamic global economy and political environment, engineering must adjust to the new world view." (National Academy of Engineering, 2004)*[1]

> *"Every day the men and women of this workforce will face the stress of competing in the fast-paced world of change we call the knowledge-based global economy of the twenty-first century. They will also face even larger challenges because the nation and world will need to call on them to seize opportunities and solve global problems of unprecedented scope and scale." (Charles Vest, 2008)*[2]

In the past several decades, universities have seen a growing need to train engineering students to be able to function in the increasingly global environment. Colleges of Engineering going through accreditation processes need to provide evidence that graduates are able to "understand

the impact of engineering solutions in a global, economic, environmental, and societal context."[3] The National Academy of Engineers, in their pivotal *Engineer 2020* text, state that "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."[1]

The problems that engineers are called upon to solve and the composition of teams will likely have a strong international character. Engineers will be called upon to work on international projects, such as those relating to environmental crises. In a 2008 National Science Foundation summit on why engineers need to be educated as global citizens, several "urgent" global problems were listed that need engineers with global training. These problems included the population of space, global climate change, sustainable development of the under-developed regions of the world, terrorism, and outsourcing of manufacturing jobs.[4,5]

In order to work on challenges such as these, engineers will increasingly work on globally dispersed teams, where engineers in the United States may be working virtually with other individuals around the world. Graduates of engineering programs need to be prepared to work on projects that may be physically located in another country. They must also be able to work on diverse teams with other engineers who may be from a different culture or country. As NAE notes, "Many advanced engineering designs are accomplished using virtual global teams – highly integrated engineering teams comprised of researchers located around the world. These teams often function across multiple time zones, multiple cultures, and sometimes multiple languages."[2]

Employers of engineers have expressed the need for graduates to have skills working with a diversity of people. For example, in a 2009 special edition of the *Journal of Engineering Education,* Ray Almgren, Vice-President at National Instruments lists globalization as a major challenge for graduates: "The products they design will probably be co-designed with someone in another region of the world, and then very likely be produced at yet another location. Today's engineers must be technically competent and skilled at working on and managing teams of engineers with diverse cultural backgrounds."[6]

Universities need to prepare graduates for the changing need in the engineering workforce. Programs need to be implemented that train students for working on international projects, working in diverse teams, and working in globally dispersed teams. Many universities and colleges offer international travel-based experiences, such as study-abroad, international co-ops or internships, and international humanitarian projects. However, most universities and colleges cannot require all undergraduates to participate, given the high cost and difficulty with scalability.[4] International experiences that do not require travel provide an alternative that should be lower in cost and more scalable.

Such experiences are now being implemented at a large research institution in the Northeast, which has set the strategic goal that <u>all</u> students have a substantive non-travel international experience. As Penn State began to implement these non-travel international experiences, questions emerged regarding the nature of students' attitudes towards the global context of engineering. Specifically this project examined the following question: Are students who are just starting their engineering studies alert to the need to be globally aware? In order to explore

this question, first-year students were asked to complete a survey consisting of questions relating to global awareness.

Methods

An online survey was administered to first-year students at Penn State University. The beginning of the survey included a definition of global awareness taken from the university's general education requirements. The statement on global awareness on the survey was:

> "As defined in Penn State's goals for General Education, key elements of global awareness include:
>
> - Understanding international interdependence and cultural diversity, and
> - Appreciating that many people, in the US and abroad, have values, lifestyles, and traditions that differ from your own."

The survey asked students a total of 17 questions (available in the Appendix). Of these questions, a total of five questions concerned basic demographic information such as gender and campus location. The remaining questions asked students their perceptions of global awareness, including the extent to which they felt that global awareness was important to them personally and professionally, the extent to which they felt they had already developed global awareness, and the extent to which they hoped to improve this skill. Additional questions asked students about their activities related to international experiences. All items were rating scale or check-list items. Respondents were entered into a drawing for one of two $25 gift cards. The survey procedures were approved by the university's institutional review board. Students provided consent for their responses to be used for research purposes.

The survey was administered during March of the 2009 academic year. At this point in time, students would be in their second semester of study. Depending on their intended majors, most respondents would have completed an introductory engineering design course which would have given them an introduction to engineering concepts and potentially the importance of global awareness.

Out of the 2,395 invited students, a total of 435 completed the survey yielding a response rate of 18.2% percent. The survey was administered to students enrolled at both the main campus and the 19 smaller campuses in the state. Slightly more than half (245 or 57.2%) of the students reported being enrolled at the main campus. The remaining respondents were enrolled at one of the smaller campuses. The number of respondents at the other campuses was quite small, ranging from 3 (5.6%) to 25 (5.8%) students.

Of the 427 who completed the demographic information in the survey, a total of 81 (19%) students were female and 346 (81%) were male. This gender breakdown is consistent with the demographics for first year students at the university.

Table 1 displays the number of respondents by intended major. Students at the university are not officially in the major until their junior year. Therefore, the response counts in this table reflect students' intended major. The intended major selected by the greatest number of students was

mechanical engineering (23%), which is consistent with a university-level survey of all entering first-year students.

Table 1: Frequency of respondents by major

Major	Response Count	Response Percent
Aerospace Engineering	50	11.7%
Architectural Engineering	47	11.0%
Bioengineering	21	4.9%
Biological Engineering	3	0.7%
Chemical Engineering	39	9.1%
Civil Engineering	61	14.3%
Computer Engineering	11	2.6%
Computer Science	28	6.6%
Electrical Engineering	29	6.8%
Engineering Science	4	0.9%
Industrial Engineering	10	2.3%
Mechanical Engineering	98	23%
Nuclear Engineering	11	2.6%
Other	15	3.5%

Results

Students were asked questions about the types of international experiences that they have had. Approximately 63% of the students (n=260) had traveled abroad for personal reasons. Over 15% had lived abroad for a month or more. One quarter (25.1%) of the students felt that they could converse comfortably in at least one other language besides English. A total of 23.4% had at least one parent or grandparent who was born outside of the United States. The majority of students (83%) had interacted with international students in the United States. Half of the students (51%) had worked on a team project with at least one international student.

Figures 1 and 2 display pie charts summarizing students' responses to the following questions: "How important is global awareness to you personally?" and "How important will global awareness be to you as an engineer in your chosen field." Approximately one-third of the students felt that global awareness was personally very important to them. About half of the respondents thought that global awareness would be very important for them professionally. Very few students felt that global awareness was not all important either personally or professionally.

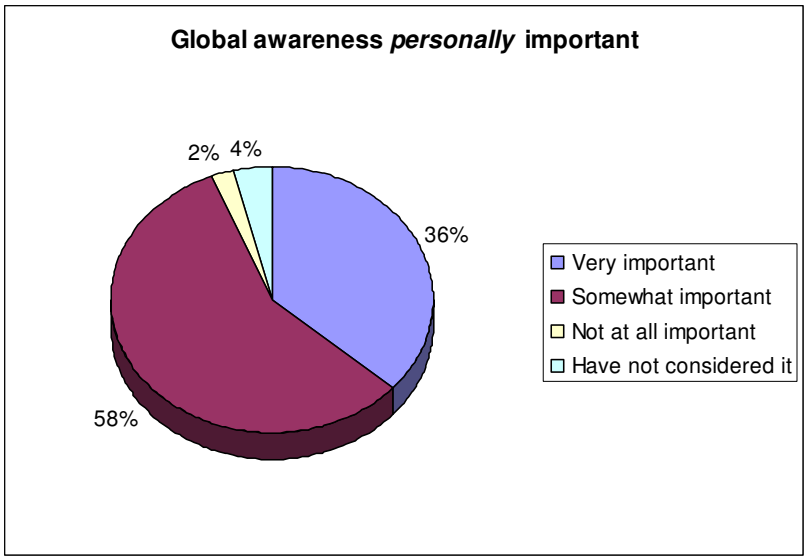

Figure 1: Students' perceived personal importance of global awareness

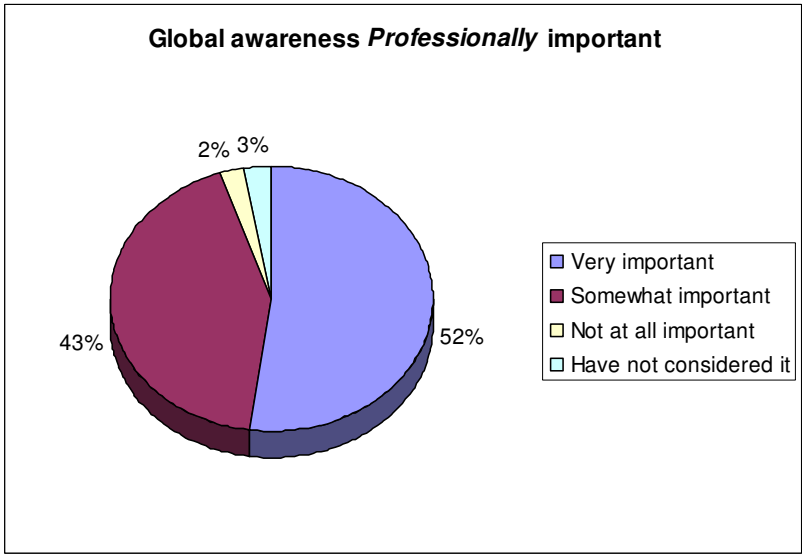

Figure 2: Students' perceived professional importance of global awareness

Students were asked to what extent they felt they had already developed the attribute of global awareness. Half of the respondents felt that they have already developed their global awareness fairly well. In addition, over 10% of the students felt that they have developed global awareness very well. The remaining students felt that they were just starting to or had not yet developed the attribute. Figure 3 displays a pie chart of the responses to this survey item. Although many students rated themselves fairly high on this scale, students did report that they expected to see an improvement in this attribute after their undergraduate years, as displayed in Figure 4. Over half of the respondents hoped to greatly improve their global awareness. An additional 40% of the students hoped it would improve somewhat. Only a few students (16) stated that they did not expect to improve their global awareness skills while at Penn State.

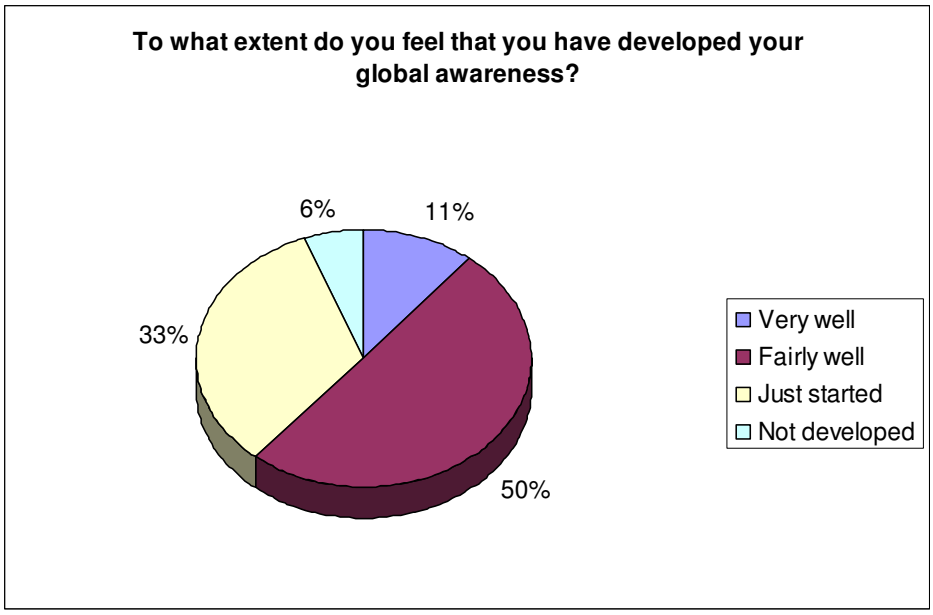

Figure 3: Self-reported development of global awareness

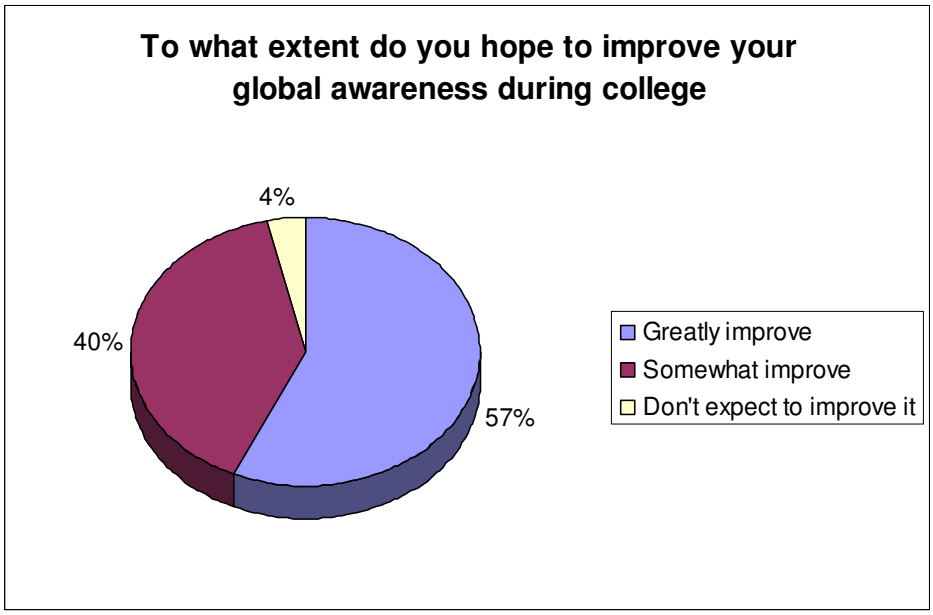

Figure 4: Students' reported expectations regarding improved global awareness after college

Participants were asked to check the activities which they hoped would improve their global awareness, as displayed in Figure 5. The most frequently endorsed responses concerned activities that would take place in the university setting within the United States: interacting with international students within courses (69.5%), course activities and assignments that focus on international issues (61.5%), and interacting with international students outside of class (i.e. class projects or student groups) (56.3%). Fewer students reported that they planned to study abroad (47.6%) or work abroad (29.3%).

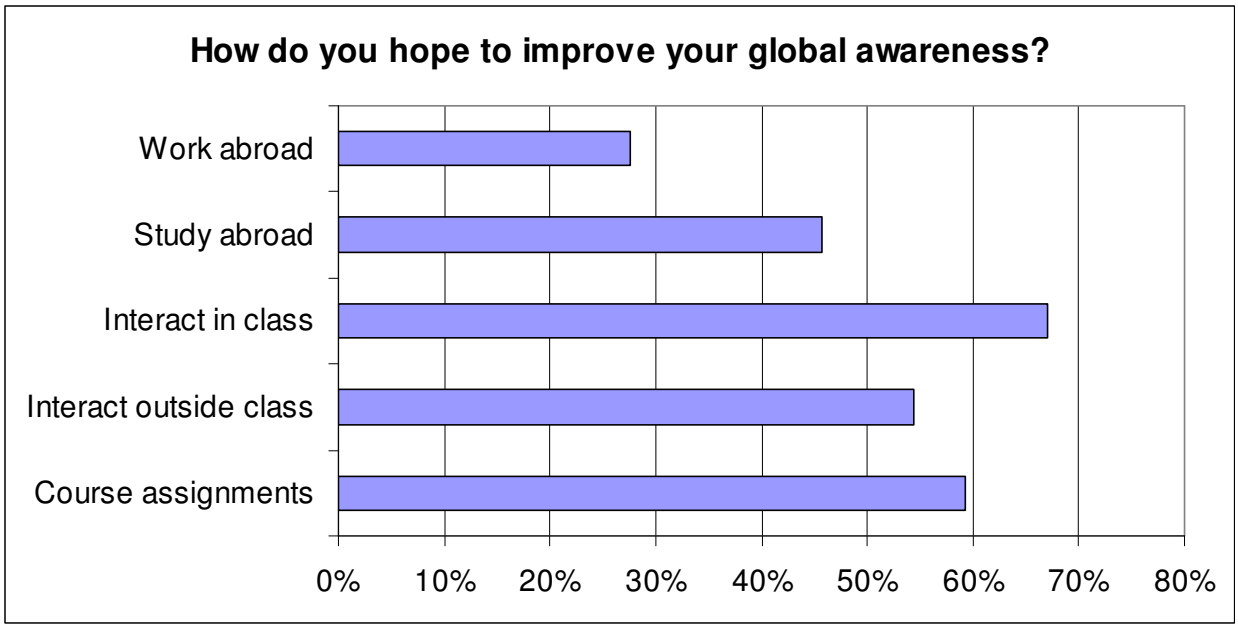

Figure 5: Students' expectations regarding how they intend to improve global awareness

Table 2: Student responses to Likert-type questions

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Average
I anticipate working with individuals from other countries/cultures after graduation.	4 (0.9%)	9 (2.1%)	59 (13.8%)	221 (51.6%)	135 (31.5%)	4.11
I enjoy interacting with people from different countries/cultures.	2 (0.5%)	9 (2.1%)	64 (15.0%)	224 (53.3%)	129 (30.1%)	4.10
I am well informed about what is going on in the world.	3 (0.7%)	47 (11.0%)	147 (34.3%)	178 (41.6%)	53 (12.4%)	3.54
I feel that global awareness is a competency that employers look for in engineering graduates.	4 (0.9%)	22 (5.2%)	69 (16.2%)	220 (51.6%)	111 (26.1%)	3.97
I can envision myself working outside of the US for a year or more after graduation.	24 (5.6%)	66 (15.4%)	120 (28.0%)	110 (25.7%)	108 (25.2%)	3.50

Students completed five Likert-type items in which they were asked to rate their level of agreement. Frequency distributions and item means are available in Table 2. Over 80% of the students agreed or strongly agreed that they anticipate working with individuals from other cultures or countries after graduation and that they enjoyed interacting with people from different

cultures or countries. Just over half (54%) of the students agreed or strongly agreed that they felt well informed about what is going on in the world. Almost 80% of the students felt that employers will look for global awareness as a competency in hiring new employees. Approximately half of the students reported that they could envision themselves working outside the United States after graduation.

Discussion

The results of the survey on global awareness to first year students yielded some interesting, and to some extent surprising, results. For the most part, those who responded to the survey seem to be aware that the global nature of the economy and the future of engineering will have an impact on them. They seem to understand that in order to be a successful engineer, they will need to be globally aware.

Surprisingly, at such an early stage of their academic careers, many students feel that they have already developed global awareness. This finding is probably consistent with general findings in psychology that students tend to be overly confident in their self-ratings of various characteristics.[7,8] Qualitative research using focus groups or interviews of first-year students would yield additional information on why many students feel that they have already developed their global awareness and provide information on how to structure the curriculum to ensure that important topics relating to global awareness and engineering are sufficiently targeted. Another method of gaining additional insight on students' acquisition of global awareness would be to administer a knowledge test of major things going on in the world. The difficulty with this method is that the events constituting global awareness change so rapidly.

Even though students come into the university setting feeling already globally aware, they do set some expectations that the university will better prepare them for this attribute. The vast majority of the students hoped that their undergraduate career would greatly or somewhat improve their global awareness skills. Students' expectations for how they would improve their global awareness are realistic and in line with what Penn State's College of Engineering is striving for. The majority of the students selected activities that would take place in the United States rather than traveling or working abroad. Large institutions, such as the one in this study, cannot make it mandatory for all students to increase their global awareness by traveling internationally. While many opportunities exist for study or work abroad, given the large size of the student body, meeting learning objectives related to increasing global awareness must be done through non-travel based opportunities.

The study did have some limitations. Given that the sample size is less than 25%, it is possible that the sample may be potentially biased. The invitation to participate used a subject line with the words global awareness. Those students who have a greater interest in global awareness issues may have been more likely to participate. Based on the demographic questions relating to the types of international experiences students have had, there does seem to be potentially a bias, given the large proportions of students who had traveled internationally, conversed comfortably in a second language, and who had at least one parent or grandparent born outside of the United States. Therefore, the ability to generalize to the population of all first year students at the

university is limited. A follow-up study is necessary in order to obtain a greater proportion of the population.

A second limitation of the study is that the survey only captures students' perceptions at one point during their undergraduate career. It is not possible to answer the questions of whether students' perceptions are different before their first semester or whether their perceptions change by the end of the senior year. These questions suggest the need for a longitudinal study of students' perceptions of global awareness.

In response to the changing nature of the world and the need for graduates to be globally aware, the university has responded in several ways. In 2009, the College of Engineering wrote a strategic plan with an emphasis on increasing the integration of the non-travel based international experiences in academic programs so that all students would have such an experience before completing their degree. Small numbers of students are currently gaining such experience through extra-curricular projects and through the honors version of a first-year design class that includes cross-national teams of students in the US and France.

Two departments are leading the way in developing courses within the majors that will provide non-travel international experiences. In 2009, a faculty member in Industrial Engineering collaborated with a colleague at Seoul National University to offer a design course for seniors and graduate students. The course was taught synchronously and the students worked on two projects in cross-national teams. The Industrial Engineering course provided learning experiences for all involved, including the instructors. Faculty members have had to work through cultural (i.e. differences in student expectations) and pragmatic differences (i.e. calendar and semester variations) in order to make the cross-national course, even possible. Assessment data was collected from students enrolled in the courses to provide insight on how to successfully structure these types of cross-national projects.

At the beginning of 2010, the Mechanical Engineering Program at Penn State launched a pilot project in collaboration with Shanghai Jiao Tong University (SJTU). Two teams composed of Penn State and SJTU seniors are working on an industry-sponsored project. The pilot is being evaluated with the assistance of colleagues who are experts in cross-cultural communication.

Although there are many articles addressing why engineering students need to be globally aware, (i.e. 4, 5) few studies have examined students' perceptions of global awareness or examined the effectiveness of various techniques designed to improve global competence. This article begins to explore students' perceptions of global awareness as they start their undergraduate career. More studies are needed to examine students' perceptions of global awareness as they progress through their undergraduate career and beyond. In addition, instruments are needed to measure students' global competence in order to assess the effectiveness of various international experiences. While the ideal student experience would likely involve traveling abroad to study engineering or work in an engineering environment, such a requirement is difficult to implement at many universities due to the logistics and the cost. Therefore, universities need to work to develop scalable, cost-efficient alternatives for students to improve their global competence without traveling.

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Appendix

Questions 1 to 5 relate to **global awareness.** As defined in Penn State's goals for General Education, key elements of global awareness include:

- Understanding international interdependence and cultural diversity
- Appreciating that many people, in the US and abroad, have values, lifestyles, and traditions that differ from your own

Please keep these in mind as you answer questions 1 to 5:

1. How important is global awareness to you <u>personally</u>?

   - ☐ Very important
   - ☐ Somewhat important
   - ☐ Not at all important
   - ☐ Never really thought about it

2. How important will global awareness be to you <u>as an engineer in your chosen field</u>?

   - ☐ Very important
   - ☐ Somewhat important
   - ☐ Not at all important
   - ☐ Never really thought about it

3. To what extent do you feel that you have developed your global awareness?

   - ☐ I have developed this attribute very well.
   - ☐ I have developed this attribute fairly well.
   - ☐ I just started developing this attribute.
   - ☐ I have not developed this attribute yet.

4. To what extent do you hope to improve your global awareness at Penn State?

   - ☐ I hope to greatly improve my global awareness.
   - ☐ I hope to somewhat improve my global awareness.
   - ☐ I don't expect to improve my global awareness while studying at Penn State - *if you picked this option, please skip to question 6.*

5. How do you anticipate improving your global awareness at Penn State? (check all that apply)

   - ☐ Studying abroad
   - ☐ Working abroad
   - ☐ Interacting with international students in courses

- □ Interacting with international students outside of class (for example, student groups or personal activities)
- □ Course activities/assignments that focus on international issues
- □ Other – please explain_____

6. Please rate your level of agreement with each statement in the table below. There are no right or wrong answers. Just answer as honestly as possible.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a) I anticipate working with individuals from other countries/cultures after graduation.	□	□	□	□	□
b) I enjoy interacting with people from different countries/cultures.	□	□	□	□	□
c) I am well informed about what is going in the world.	□	□	□	□	□
d) I feel that global awareness is a competency that employers look for in engineering graduates.	□	□	□	□	□
e) I can envision myself working outside of the US for a year or more after graduation.	□	□	□	□	□

7. Please specify the kinds of international experiences you have had (Check all that apply).

- □ Traveled abroad for personal reasons (for example, a vacation)
- □ Lived abroad for one month or more
- □ Worked on a team project that had one or more international students
- □ Interacted with international students here in the US
- □ Participated in an international student organization
- □ Can converse comfortably in at least one other language besides English
- □ Have at least one of parent or grandparent who was born outside of the US
- □ Other - please explain _____

8. The College of Engineering has written a definition of a World-Class Engineer as it relates to our undergraduate programs. Please indicate how familiar you are with the definition.

- ☐ I know clearly what it is.
- ☐ I am aware of it, but I don't really know what that means.
- ☐ I have never heard of it.

9. What is your intended major?
   - ☐ Aerospace Engineering
   - ☐ Architectural Engineering
   - ☐ Bioengineering
   - ☐ Biological Engineering
   - ☐ Chemical Engineering
   - ☐ Civil Engineering
   - ☐ Computer Engineering
   - ☐ Computer Science
   - ☐ Electrical Engineering
   - ☐ Engineering Science
   - ☐ Industrial Engineering
   - ☐ Mechanical Engineering
   - ☐ Nuclear Engineering
   - ☐ Other_____