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Assessing the Intercultural Competence of Sophomore Mechanical Engineering Students: Baseline Data and Analysis

Keywords: IDI, intercultural development, global competency, global engineering education, mechanical engineering, sophomores

Abstract

This paper presents baseline analysis of Intercultural Development Inventory (IDI) results for approximately five hundred sophomore mechanical engineering students at Purdue University. The IDI is a statistically reliable and cross-culturally valid measure of an individual’s actual and perceived intercultural development. This instrument is being used by Purdue’s School of Mechanical Engineering, particularly to assess students who are involved in global educational programs such as Global Engineering Alliance for Research and Education (GEARE). In this paper we examine IDI results for Purdue sophomore mechanical engineering students, including comparisons based on gender, amount of time spent living abroad, and whether or not they later participated in GEARE. We intend that our results will provide valuable baseline data for sophomore mechanical engineering students, thereby paving the way for cross-institutional comparisons, and enhancing the ability of university staff to design courses and experiences for students that match their current levels of intercultural sensitivity. We conclude with suggestions for further research and analysis, such as collecting and analyzing post-experience IDI data for students who have participated in global educational experiences.

Introduction

Given dramatically changing technologies and increasingly globalized markets, leading stakeholders have declared that “it is imperative that all engineering students develop the skills and attitudes necessary to interact successfully with people from other cultural and national environment.”¹ Universities throughout the world are now establishing curricula and programs to help prepare students for this new reality. One common avenue for this preparation is giving students the opportunity to study and/or work abroad. In the United States, it is now estimated that up to 7.5% of engineering students spend time abroad during their undergraduate studies and many schools have made commitments to increase this number.²

Purdue University is no different in this regard. In 2001, Purdue’s School of Mechanical Engineering launched Global Engineering Alliance for Research and Education (GEARE).³ This program involves collaboration between Purdue and the University of Karlsruhe in Germany, Shanghai Jiao Tong University in China, IIT Bombay in India, and Monterrey Tech in Mexico. Participating students study and intern abroad, and work on team projects with students at partner schools. Yet as programs like GEARE develop and mature, questions remain about what specific skills and competencies participating students can and should develop. There is also the issue of finding the most appropriate and effective assessment mechanisms, to ensure students are achieving these outcomes.

One of the more common anticipated outcomes for global engineering education is enhanced intercultural sensitivity and skills. One assessment mechanism often used to examine this
competency is the Intercultural Development Inventory (IDI). To date, however, little data has been published on IDI results from engineering student populations, including engineering students who participate in global programs.

For a number of years, Purdue’s School of Mechanical Engineering has been collecting IDI data from sophomore-level mechanical engineering students, as well as post-experiential data from GEARE participants. In this paper we present aggregate IDI results for the sophomore student population. Our hope is that this data can provide a baseline that can be generally compared with results from other schools, and more specifically used to examine how global experiences impact the intercultural development of engineering students.

**Literature Review**

Many U.S. universities have established a global focus within engineering coursework and use the IDI as a tool to measure intercultural development and sensitivity, including John Brown University and Georgia Tech. John Brown, for example, offers a freshman course that introduces students to global issues. Using IDI, Bland assessed students taking this course to get a general sense of who the students were and where they stood coming into the engineering program. After organizing the results based on different levels of intercultural development, he found there was a large gap between the perceived and actual intercultural sensitivity of students in this population, though the actual numbers of students and detailed results were not published.

Georgia Tech has created a degree designation called the International Plan (IP) that prepares students for a global work environment. The university is collecting large amounts of relevant evaluation data, including to examine the intercultural development of students in the program based on various demographic and other variables. To date, the school has reported IDI data from 3,781 incoming students. In their baseline results, they found that intercultural sensitivity was generally higher among women as compared to men. In addition, intercultural sensitivity was notably higher among men who opted to enter the International Plan, but for women there was less variation between the IP and non-IP subgroups.

The Georgetown Consortium study, on the other hand, looked at 1,300 students in 61 different programs to determine what specific aspects of a student experiences abroad helped develop their intercultural sensitivity, with particular emphasis on examining how students develop culturally when either a program is designed to cultivate cultural integration or students are allowed to create their own experience. This study used two approaches for assessing students, namely IDI and Simulated Oral Proficiency Interview, which is another validated and widely used instrument. There were three main conclusions drawn from the IDI portion of this study. First, women on average had higher cultural sensitivities as compared to their male counterparts. Second, planned study abroad experiences resulted in higher gains, especially when they involved features such as host families and/or cultural mentors. And third, the length of the duration effected sensitivity gains, with the optimal period being 13-18 weeks.

While not used as widely as IDI, others have proposed other strategies and instruments to evaluate the cultural development and intercultural skills of engineering students. For example, Del Vitto proposes assessing the attainment of “cultural intelligence” among participants in
global engineering education using instruments such as the Cross-Cultural Adaptability Inventory (CCAI) or Global Awareness Profile (GAP) test. Bielefeldt, on the other hand, has used the Miville-Guzman Universality-Diversity Scale short form (MGUDS-S) to examine cultural competence in a variety of engineering student populations.

Downey et al., by contrast, have defined global competency as being able to work with others who define and solve problems differently, including across national and culture boundaries. To evaluate attainment of this competency, they developed a scenario-based writing exercise to gauge student awareness of how engineering cultures and identities differ across countries. Their approach is unique because of its emphasis on evaluating intercultural knowledge and skills in the context of global engineering practice. They also reported statistically significant increases in student performance on this exercise when it was administered before and after Engineering Cultures, an undergraduate elective course designed to enhance students’ global competency.

**Methods**

**Participants**

For the present study, the IDI was given to sophomore mechanical engineering students enrolled in a technical writing course, Mechanical Engineering 290 (ME290). A small number of juniors and seniors were also in the course due to timing constraints in their sophomore year. In total, 527 tests were given to students, but 27 were not complete, leaving n=500 total valid responses. Complete demographic information was collected for n=138 respondents. The semesters that were included were Spring 2007 (n=80), Fall 2007 (n=138), Fall 2008 (n=140), GEARE Spring 2008 (n=13), and Spring 2009 (n=129). Thirteen valid respondents were identified as students who later participated in the GEARE program. All data was collected under Purdue IRB #0503001816.

**Instrument**

The IDI consists of 50 questions that assess an individual’s intercultural sensitivity. The measured level of sensitivity is based on Bennett’s Development Model of Intercultural Sensitivity (DMIS), where an individual is presumed to go through six world views while establishing cultural sensitivity, namely: denial, defense/reversal, minimization, acceptance, adaption, and integration. The instrument measures perceived intercultural sensitivity, as well as “actual” intercultural sensitivity. The tool has been rigorously tested and proven valid.
Figure 1. Stages of Intercultural Sensitivity and Associated Survey Scales

<table>
<thead>
<tr>
<th>Denial</th>
<th>Defense/Reversal</th>
<th>Minimization</th>
<th>Acceptance</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D- Denial and Defense/Reversal</td>
<td>M- Minimizations</td>
<td>A- Acceptance and Adaptation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>85</td>
<td>100</td>
<td>115</td>
<td>130</td>
</tr>
</tbody>
</table>

Figure 1 shows the five different levels (excluding integration, the penultimate level) of cultural sensitivity, along with the three corresponding subcategories of the IDI instrument. The first category, Denial and Defense/reversal (D), includes all of the scores showing that respondents are either in denial or defense/reversal. A common thought process of an individual in this level is that one culture is better than another, whether it be an individual’s own culture or another culture. The second category, Minimization (M), encompasses a fraction of defense/reversal, all of minimization, and part of the acceptance scale. A common outlook of individuals in this category is to feel that people are pretty much the same everywhere. The third category, Acceptance and Adaptation (A), comprises the majority of the acceptance level and all of the adaptation level. Individuals falling in this category understand cultural differences and are more likely to adapt their behaviors accordingly in various cultural environments.

Data Analysis

To find the IDI scores for each respondent, the IDI software, Version 2, was used. This Microsoft Access add-on takes raw survey data and uses it to generate reports detailing individual and/or group results. All results were then exported to Microsoft Excel 2007, which was used to examine different populations of students, such as by cohort, gender, etc.

Findings and Interpretations

Figures 2 and 3 show average perceived and average actual cultural sensitivity values for all subpopulations and populations. Gender was not specified for 28 respondents. Certain trends appeared within the data set that are worth examining in greater detail. First, average perceived and average actual sensitivities within the largest collection groups have remained very consistent and stable for each class, which suggests the results are generally precise and repeatable within this particular population.

Another trend to note is that students who later participate in GEARE have been coming into the program with higher levels of sensitivity (average perceived of 120.7 and average actual of 91.5 as compared to 117.5 and 85.1 for the non-GEARE population). Yet due to the small size of this subgroup, the results are not statistically significant. Nonetheless, this finding generally agrees with Georgia Tech’s data, which showed similar correlations, especially among male students. These findings suggest higher levels of cultural sensitivity as a possible self-selection factor among GEARE participations. However, additional research is needed, especially with larger populations, to verify this hypothesis. We also observe that female respondents have statistically
significant higher sensitivity scores ($p < 0.005$) as compared to their male counterparts (average actual sensitivity of 89.7 for females as compared to 84.4 for men). These findings are similar to Georgia Tech’s findings and are in agreement to other previous research conducted.\textsuperscript{5,10}

**Figure 2. Average perceived sensitivity levels by sub-group and overall**

**Figure 3. Average actual sensitivity levels by sub-group and overall**
Finally, we note that our data shows relatively large gaps between perceived and actual levels of intercultural sensitivity. Compared to other populations, e.g. political science study abroad populations, the gap in our data larger. Additional research is needed to determine whether these results can be explained by particular factors or characteristics that are unique to engineering student populations. However, these findings suggest that global engineering programs may need to be tailored for a population of students that generally overestimates its intercultural savvy.

Table 1. Intercultural development level by percent of subgroup

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>n</th>
<th>Denial and Defense</th>
<th>Minimizations</th>
<th>Acceptance and Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEARE</td>
<td>13</td>
<td>30.8%</td>
<td>61.5%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Non-GEARE</td>
<td>486</td>
<td>53.4%</td>
<td>44.6%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Male</td>
<td>405</td>
<td>56.3%</td>
<td>41.2%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Female</td>
<td>67</td>
<td>31.3%</td>
<td>67.2%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Less than one year abroad</td>
<td>107</td>
<td>53.3%</td>
<td>43.0%</td>
<td>3.7%</td>
</tr>
<tr>
<td>More than one year abroad</td>
<td>22</td>
<td>59.1%</td>
<td>40.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>52.8%</td>
<td>45.0%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

Table 1 indicates the percent of students in each of three major levels if intercultural development as measured by the IDI instrument, including for specific subgroups and for the population overall. Here again, we observe that students who later elect to participate in the GEARE program tend to test at higher levels of intercultural development as compared to the non-GEARE group. One also finds female students typically testing at higher levels of development. For example, 56.3% of all male students were ranked in the Denial and Defense level based on their actual intercultural sensitivity, while 41.2% were at the Minimization level. By contrast, less than a third (31.3%) of female students were in the Denial and Defense range, while more than two thirds (67.2%) were measured in the Minimization level. Finally, we note that students who report having lived abroad for a year or more have levels of intercultural development that are comparable to those who lived abroad less than a year or not at all. But again, we acknowledge that relatively small sample sizes limit the strength of this finding.

Conclusions

As U.S. colleges and universities continue to develop their global focus, including through global engineering education, developing and examining assessment and evaluation tools becomes more urgent and important. However, we have only begun to understand how various kinds of programs and experiences are linked to specific learning outcomes. Documenting baseline IDI results among incoming student populations may represent a first step toward evaluating how various kinds of global experiences support the intercultural development of our undergraduate
engineering students. In fact, our findings generally follow patterns observed in data collected by Georgia Tech, which suggests some commonality across engineering schools. In future phases of this research we will be analyzing pre/post-experiential IDI results for GEARE participants, including to determine if any gains in intercultural sensitivity are detected. We will also be examining other strategies for assessing global competence that are specifically tailored to engineering student populations.

References