

Outcomes Assessment in International Engineering Education: Creating a System to Measure Intercultural Development

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Abstract

The University of Michigan College of Engineering has developed a comprehensive evaluation system to ensure a formative assessment of its programs, the climate for participation in international programs, and the outcomes assessment of the intercultural development of its student participants. In collaboration with the University of Michigan School of Education, a mixed method design with a combination of qualitative and quantitative methods was employed. Findings from the initial interviews yielded the following reasons for limited participation in international programs: a) rigid curricula and demanding courses, b) financial implications connected with a longer time to degree, and c) difficulty convincing faculty to accept transferred technical credit from international institutions. The climate survey results indicated that the pre-college experiences combined with a supportive infrastructure mean students place a greater value on international education and lead to greater participation, particularly if these overseas experiences better position them for careers in engineering. The level of intercultural awareness of student participants in international programs is similar across race, gender, department, academic level, and cumulative grade point average. Participants behave in tolerant ways toward other cultures but must learn more about their own culture by trying to see it in the way it is seen by people from different cultures.

I. Introduction

In 2000, the International Programs in Engineering (IPE) office of the University of Michigan (UM) College of Engineering (CoE) launched its Program in Global Engineering (PGE) with the support of funding from the Department of Education's Fund for Initiatives in Post-Secondary Education (FIPSE). The PGE was designed to focus the humanities and social sciences portion of the undergraduate engineering degree requirements to help students gain a global perspective and in-depth knowledge of the language and culture of a chosen region of the world. Students are also required to participate in an overseas work or study experience as well as take part in cross-cultural training activities. The goals of the PGE are as follows:

- To understand the importance of globalization of engineering technology, resources, and markets
- To appreciate people, culture, and engineering practices of other nations
- To study one's self within a global context

- To develop students' capacities for intercultural sensitivity
- To integrate global perspectives into students' working engineering philosophies

Program evaluations of international experiences have illustrated that students acquire a variety of desired global competencies as a result of participating in cross-cultural learning opportunities¹, such as an appreciation of other cultures, growth in independence and maturity, greater self-awareness, greater tolerance for different people and ideas, growth in interpersonal skills²; and development of a multicultural perspective.³ In addition, intercultural communication researchers have derived numerous empirical factors believed to derive intercultural competence that resulted from experiences abroad that include: the abilities to communicate interpersonally, adjust to different cultures, deal with different societal systems;⁴ establishing interpersonal relationships,⁵⁻⁷ empathy, cooperation, adaptiveness;⁸ acquiring an awareness of self, awareness of the implications of cultural differences, interpersonal flexibility, the ability to facilitate communication;⁹ and the ability to deal with psychological stress.¹⁰⁻¹²

The CoE engaged expertise from the UM's School of Education to measure student cross-cultural awareness and gather information on barriers to participation in international programs in general. The School of Education employed a mixed method design, combining qualitative and quantitative methods. Student interviews helped determine factors impeding undergraduate engineers from participating in international programs and resulted in the design of a survey that is now regularly administered to assess barriers to international programs participation. Finally, the evaluation system put in place for the PGE program has now been incorporated across most of the international programs activity in CoE in order to assess educational outcomes obtained by student participants.

Most of the students surveyed (66%) were at sophomore or junior level at the time of the survey and 70% are US citizens. Fifty-eight percent of the students were male. 32% of the students identified themselves as Asian and one-third had either an Asian mother or father. A majority of the students reported that their parents had received at least a bachelor's degree. 62% of the surveyed students came from the following departments: industrial and operations engineering, mechanical engineering, or electrical engineering.

This paper focuses on the development of the evaluation system, outlining changes and expansion to the evaluation program beyond its original purpose. Advantages and disadvantages of individual measures will be discussed in addition to the benefit of engaging other academic units in the evaluation process. Finally, we will discuss how the outcomes of this assessment have led to programmatic changes in international programs offerings.

II. Evaluation Plan

A. Year 1

During the first year of evaluation activities, the graduate student research assistant engaged for the evaluation project interviewed 28 students to determine their pre-dispositions to participating in international programs activities. Eighteen of these students were enrolled in a newly designed cross-cultural engineering course; 5 were participants in various study abroad programs, and 5 were attendees at international programs information meetings who did not deploy their interest in international programs. Participants were asked over the course of a 30-60 minute interview to

discuss the value they placed on cross-cultural experiences, which people and experiences influenced their values, and how they decided to become engaged in a cross-cultural experience. In addition, they were asked about their experiences in the CoE and how the CoE impeded or supported their decisions to participate in international experiences.

Concurrently, the evaluation team researched existing quantitative measures that would best assess the climate issues surrounding students' participation in international programs. Upon reviewing the data from the interviews, the evaluation team created and administered a climate survey in order to allow the IPE office at the CoE to assess the institutional and departmental climates as well as students' pre-college international experiences and determine these influences on a student's decision to engage in cross-cultural programs.¹³

The themes that emanated from these interviews and surveys included:

- Pre-college travel or study abroad experience positively influenced student participation
- Positive influence of institutional climate for diversity – structural diversity
- Negative influence of department related to time to degree and acceptance of transfer credit
- Students valued cross-cultural experiences personally and professionally.

Finally, a short-answer qualitative survey was administered to the participants of the cross-cultural engineering course to assess the course's impact on the learning outcomes described in the program objectives.

B. Year 2

The evaluation team continued with the final portion of their qualitative analysis by conducting follow-up interviews with 5 students returning from overseas sojourns. The climate survey which was developed at the end of year one was adapted from a diversity climate survey developed at the Higher Education Research Institute (HERI) at the University of California, Los Angeles. The instrument is designed to capture information about the institution's climate for international diversity (experiences with and perceptions of international peers, faculty, and staff). In addition, a series of questions included in this measure were designed to assess specific program objectives. The instrument takes only 20 minutes to complete.

Findings from successive administrations of the climate survey reinforced the themes listed earlier. Further, the following experiences were influential in a student's decision to take part in international programs:

- Interacting with diverse peer groups leads students to consider participation in international programs.
- College and pre-college mentors who spoke highly of cross-cultural experiences led to student perception of international experience as an invaluable component of education.
- Students decide on cross-cultural opportunities based on how the opportunities better position them for careers in engineering.¹⁴
- The majority of students who took part in information sessions on international programs were those with more than one pre-college international experience.

As shown in Fig. 1, 61% of those who participated in informational meetings concerning international programs were students with more than one pre-college international experience.

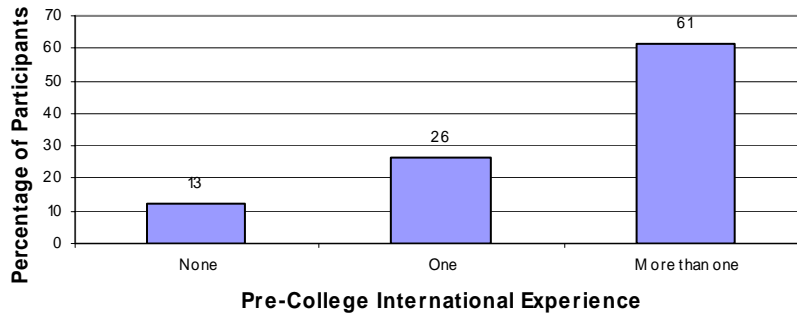


Fig. 1 Relationship Between Participation in International Programs Information Sessions and Pre-College International Experiences.

The University of Michigan College of Engineering successfully sent three students on internships to Germany in the German fiscal year of 2004. All internships were coordinated by the students, without making use of the internship openings that were arranged by DAAD. Two students found internships through CDS International and the third student obtained an internship with the help of her home department at the College of Engineering. More information about the individual students and the amount of funding distributed to them is provided in the attached spreadsheet.

We have created a webpage dedicated to DAAD-GAIST on our website:

<http://www.engin.umich.edu/ipe/workabroad/daadgaist.html>. We are currently uploading student stories to the site to attract prospective applicants.

With the help of a German faculty member in our department of Mechanical Engineering, we succeeded in bringing one German student from our partner university TU Berlin to Ann Arbor for an internship. However, he can not be officially counted as a GAIST student as he did not pay the 500 Euro fee for entry into the DAAD program. We anticipate that the reduction in the 500 Euro fee to 100 Euros, combined with the 500 Euro premium which can be used for inbound German students to the US, will help to increase the numbers of inbound students to Ann Arbor. This same faculty member has begun to create an internship pipeline between the University of Michigan, IAV (a local German company), and TU Berlin (the location of the main office of IAV is in Berlin).

Research on reliable quantitative measures resulted in the administration of Hammer and Bennett's Intercultural Development Inventory (IDI) to all students taking part in international

programs. The IDI is a theoretically derived measure, based on Bennett's model of intercultural sensitivity,¹⁵ which measures general orientation toward cultural differences. The instrument generates developmental scores with individual and group profiles, placing these scores on a scale ranging from denial/defense to acceptance/adaptation. The instrument is a 60-item survey that measures five of the six developmental stages in Bennett's model from denial, defense, minimization, acceptance, and two forms of adaptation. The instrument measures both perceived and actual scores of intercultural awareness. The test was originally developed from 40 directed interviews with subjects representing cross-cultural and situational diversity. The IDI was selected to measure intercultural sensitivity for its emphasis on assessing the cognitive structures that make meaning of intercultural-related phenomena, its ease of administration, and its ability to generate a graphic profile and interpretation of the predominant stage of development of a subject or group.

The evaluation team planned to administer the IDI in pre- and post-test fashion to all students taking part in international programs.¹⁶

The IPE office utilized pre-departure orientation programming and return debriefing sessions for all students traveling abroad to create a structured opportunity to ensure that students would take part in the evaluation activities. The IDI was administered to four different cohorts of students: 47 study abroad (SA) students, 32 PGE students, 25 students in an honors academic program, the Engineering Global Leadership (EGL) Honors Program, and 11 students taking part in a short-term overseas research project, the Global Intercultural Experience for Undergraduates (GIEU). Analysis of these pre-test results determined that the students fell in the minimization zone of intercultural sensitivity.¹⁷ The findings included:

- Students minimize differences and focus on the similarities between different cultures
- Students perceive themselves to be more culturally sensitive than they are.
- Intellectual level did not mean greater cross-cultural sensitivity (Honors students did not receive highest actual IDI scores).

Fig. 2 shows the developmental and perceived scores for cross-cultural sensitivity, by participant cohort. The scores for all cohorts fell in the minimization range of the intercultural sensitivity spectrum.

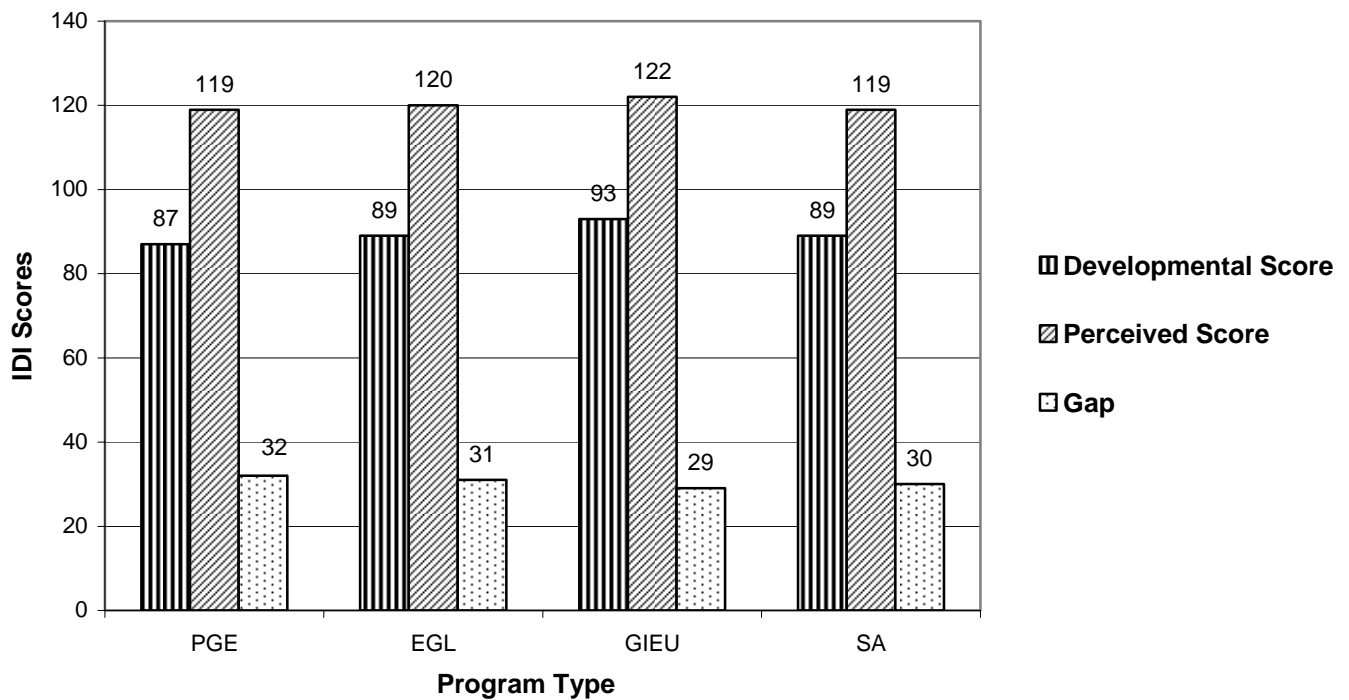


Fig. 2 Developmental and Perceived Scores by Program Membership.

At the close of year 2, the evaluation team finalized the climate survey and began plans to create a control or matched sample group for evaluation. They also recommended the creation of a survey administration schedule for the upcoming year.

C. Year 3

In year three, the evaluation team created and implemented a control sample design. The control group would match participants in the sample by academic level (credits toward program in similar ranges), gender, race, engineering major, and grade point average (in same range). The students in the control group would be administered the IDI as well as the climate survey.

The survey administration schedule was outlined as follows: Students taking part on study abroad programs would receive the IDI as part of a pre-departure orientation session. Upon returning from their sojourn, they would re-take the IDI as well as the climate survey. Administration of the climate survey upon return would allow the students a point of comparison between their host institution and the UM regarding the extent to which international activities/staff/faculty are supported. Students taking part in long-term academic programs such as the PGE would be administered the survey at the first orientation meeting for new program participants. Students would be required to complete the measure again as part of their final program audit.

After obtaining approval from the UM's Institutional Review Board, the evaluation team used the UM's main centralized student records database to match each student based on the criteria

outlined above. Survey administration was scheduled individually with each targeted participant, based on their availability. A \$10 incentive was offered to take the survey.

The results of the climate survey and IDI scores were compared between the program participants and matching control group. Our findings were:

- There was no significant difference in developmental scores on the IDI between program participants and the control group.
- The control group students were more likely to study with someone from their own background than the program participants.
- International programs participants were more likely to cite the importance of learning a foreign language to help communicate with engineers from other countries than the control group.

As seen in Fig. 3, the developmental IDI scores of both program participants closely matched the scores of the control sample.

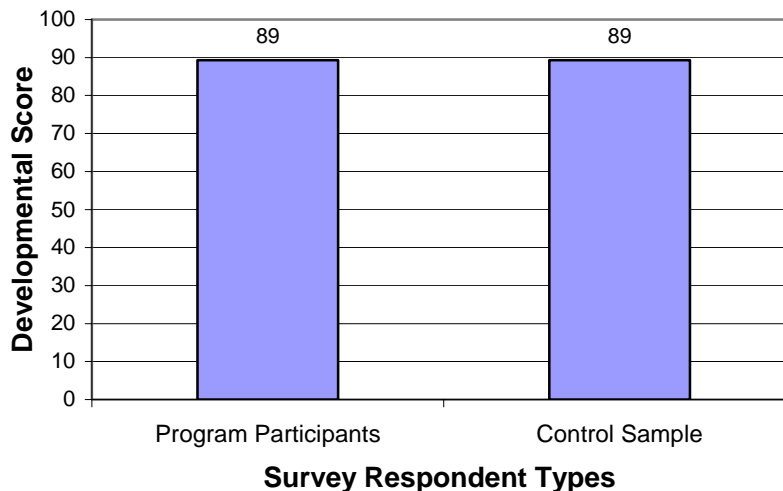


Fig. 3 Comparison of IDI Developmental Scores for Program Participants with Control Groups.

In anticipation of reduced resources, the evaluation team researched alternate surveys measuring similar dimensions of cross-cultural sensitivity which were not as expensive. The team administered the Revised Ethnocentrism Scale¹⁸ and Personal Report of Intercultural Communication Apprehension (PRICA)¹⁹ surveys together to determine reliability of the scales with the IDI and found high reliability in the Revised Ethnocentrism Scale. The Revised Ethnocentrism Scale contains 22 items, 15 of which are scored. The other 7 items are included to balance the number of positively and negatively worded items. Alpha reliability estimates range from .80 to .90 in most cases. The PRICA was developed to address communication apprehension in the intercultural context. Alpha reliability estimates are expected to be above .90 when completed by native English speakers, although they may be lower when this instrument is translated into another language. In order to control for the effects of cognitive development on the development of intercultural sensitivity, the evaluation team suggested administering a measure of cognitive complexity, the Need for Cognition Scale (NCS)²⁰. In this way, we could

ensure that students are developing their capacities for intercultural sensitivity as a result of participating in international programs and that developmental change is not occurring as an artifact of students' "getting smarter." The NCS is an 18-item survey with high internal consistency; alpha levels are typically greater than .85. High-scoring individuals enjoy thinking abstractly while low-scoring individuals tend to dislike thinking on an abstract level.

III. Design Benefits and Concerns

The evaluation design as a whole addresses the criteria outlined by the Accreditation Board for Engineering and Technology (ABET) in their accreditation of general programs. In response to the need for globally competent engineers, ABET has developed indicators for evaluating engineering programs' ability to provide opportunities for students to develop certain competencies. Specifically, among its eleven evaluation criteria, ABET articulated outcomes such as multidisciplinary team functioning, communication skills, and "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context."²¹ Finally, the administration of both IDI and Climate survey upon completion of the program do not take inordinate amounts of time. Students spend roughly 35 minutes for the heavier post-test portion of evaluation and a mere 15 minutes for the pre-test.

The IDI was a valuable measure for evaluation of student outcomes for a number of reasons: it is theoretical and empirical; it allows for measuring both individual and group development, and reflects the desired learning outcomes and objectives of the PGE specifically and the IPE office in general. Yet, the costs of the IDI are somewhat prohibitive. Each survey costs \$10 and the survey administrator must be trained to use the instrument. Software costs for analysis of the data are also expensive. Because of the reliability established with the Revised Ethnocentrism scale, the IPE office has chosen to continue measuring outcomes with this new instrument. Results indicated that the IDI and Ethnocentrism scales are significantly related, suggesting that the students with more ethnocentric worldviews are less interculturally sensitive. In addition, the measure of ethnocentrism shares a very significant negative relationship with the need for cognition scale, suggesting that students who enjoy thinking abstractly have the least ethnocentric worldviews. The PRICA was not significantly related to the IDI, most likely because the two assessment tools measure two different constructs, namely intercultural sensitivity and intercultural communication. Thus, the PRICA instrument will not be used.

In order to continually assess barriers to student participation in programs, the climate survey is a useful instrument. The CoE is currently planning to administer the climate survey via internet to the CoE population at large in order to have a wider response rate pertaining to international programs. Once this change has occurred, the CoE will most likely discontinue administration of the climate survey together with the measure of cross-cultural awareness outcomes, and rely on data gleaned from an annual or biannual release of the climate survey.

Although having a control sample would help gauge whether or not an international program is a causal factor in increase of student cross-cultural sensitivity, the effort required to get a meaningful control group proved to be problematic. If control groups are to be considered in the future, the incentive would need to be more appealing to the students (their \$10 incentive was not attractive and often taxed). In addition, fewer criteria would need to be matched in order to ensure a large enough pool from which to sample. Because initial results indicated that grade

point average did not seem to factor into students' cross-cultural sensitivity development, we would recommend removing it as a sample criterion.

IV. Programmatic Changes and New Directions

The evaluation system put in place by the UM CoE and School of Education has allowed the IPE office to continually monitor and alter its programming to meet the needs of the students. When the climate survey results indicated that the rigidity of the curriculum deters participation, the IPE office researched current offerings at the UM to offer a wider variety of cross-cultural training opportunities that would meet the PGE cross-cultural training requirement. Previously, only one course was offered, and it was offered during the winter semester, when most students choose to study abroad. The variety of options, both credit-bearing and non-credit bearing, allow greater flexibility for the student to complete this requirement.

Because we are also aware that not all students will take part in an overseas sojourn due to time constraints, the IPE office chose to develop cross-cultural modules that would allow students to participate, regardless of whether or not they are pursuing the PGE program. These modules also offer graduate student participation in international programs in much greater numbers than previously.

When students choose to study overseas, they have a multitude of program options from which to choose. Some programs are "island" programs in which a faculty member from the home institution personally leads a group of students overseas. Courses are taught only by that faculty member or other contracted personnel. The opposite end of the spectrum involves direct enrollment by a student at a host institution, where the student takes courses alongside domestic students of the host institution. Overseas academic sojourns may last between one week and an entire academic year. We currently do not have enough data points of pre- and post-test results to determine how program type affects intercultural sensitivity development, but recommend pursuing this as a possible future avenue of research. We hypothesize, however, that deeper immersion in the host culture will result in a greater increase in cross-cultural sensitivity.

V. Recommendations

For those who might consider putting an evaluation system in place, we recommend that the following issues be considered:

- 1) Determine to what extent collaboration with experts from institutional research offices and other resources such as a School of Education might be utilized. They bring with them a wealth of knowledge pertaining to assessment of instruments (or creation of new instruments) for determining to what extent learning outcomes have been achieved.
- 2) If developmental scores are being assessed, there must be a clear and well-kept system of tracking individuals as they go through a program. Find adequate means to ensure that post-testing occurs.
- 3) Determine to what extent institutional databases are accessible and robust enough to provide information in order to develop a control sample. Ensure that adequate resources are made available to fund those responsible for outcomes assessment. One must also ensure that the support of the institution's review board for research with control groups is in place.

- 4) Rally buy-in from faculty for evaluation-based activities. Develop relationships with faculty to inform them of the benefits of participation in international programs. By providing faculty with a framework on how student learning on international programs is assessed, greater support for international programs in general may be engendered. .
- 5) Develop a mixed methods approach to gathering data on student participation in international programs. Ensure that quantitative and qualitative measures complement each other so that findings can enrich our understanding of student decision-making.

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