

## **Comparative Assessment of Scaled Global Engineering Initiatives**

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## ABSTRACT

Accreditation is an important aspect of contemporary engineering education and globalization impacts what is being taught and assessed. The ABET EC-2000 criteria that currently guide engineering accreditation program review processes include both “hard” skills (e.g., “an ability to apply knowledge of mathematics, science, and engineering”) and “professional” or “soft” skills. In the area of soft skills, attention to “global competence” has proliferated in higher education since the 1990s – including definitions, assessment criteria, and proposed mechanisms. However, little agreement exists regarding how to assess the effects of global engineering education or, relatedly, on the scale and type of global engineering mechanisms needed to meet competency goals. Analysis of recent PEOs from 48 programs in 36 institutions (235 PEOs total) suggests an almost complete lack of attention to global competence: the PEOs analyzed include the words global, international or world less than 7% of the time. The word culture or cultural was not present.

Recently, Jesiek, Shen, and Haller (2012) proposed that the Miville-Guzman Universality-Diversity Scale-Short form (MGUDS-S), originally designed to assess cross-cultural competency, can also be used as one method to assess the global competency of engineering students and provide an efficient, effective, sufficient, and consistent protocol for assessing global competency. Specifically, the MGUDS-S evaluates individual’s Universal-Diverse Orientation (UDO), defined as an “an attitude of awareness and acceptance of both similarities and differences that exist among people.” Specific measures included within the MGUDS-S UDO: 1) diversity of contact with others (behavioral); 2) relativistic appreciation of oneself and others (cognitive); 3) degree of emotional comfort with differences (affective).

In this paper, we report on our efforts to initiate an assessment project employing the MGUDS-S to establish a baseline of global competency of engineering students at our university. Three student groups participated in this study: two groups of students who have voluntarily participated in global engineering programs at Cal Poly and one group that has not. The voluntary programs are Engineers Without Borders (EWB) and an interdisciplinary three-quarter senior project course focused on international collaborations; additional participants were drawn from a required junior level course in the Aerospace Engineering (AERO) major. The scores of respondents indicate that all students evaluated display a moderate UDO (average of 4.7/6) or “an attitude of awareness and acceptance of both similarities and differences that exist among people.” Overall, EWB students scored significantly higher than other participants (a combined UDO of 5.0), compared to 4.59 for the senior project students and 4.52 for the AERO students. Differences were found in each UDO measure of these baseline results between engineering students who choose to opt-in – or choose not to opt-in – to global engineering programs.

We conclude by tentatively concurring with Jesiek, Shen and Haller (2012) that the MGUDS-S is an efficient, effective, sufficient, and consistent protocol for assessing global competency. Future research includes the exploration of how the MGUDS-S can serve as a tool in efforts to

integrate attention to global competency and cultural competency into ABET accreditation processes and assessments of Program Educational Objectives.

## INTRODUCTION

Accreditation of current engineering education practices occurs through analysis of multiple student outcome criteria. The assessment creates a data driven blueprint for continuous curriculum improvement and “provides assurance that a college or university program meets the quality standards established by the profession for which the program prepares its students.” Thus, examination of accreditation criteria and program review processes offers insight into what is valued within contemporary engineering education practice and related initiatives. Interventions at the level of accreditation and program review can also have widespread impact.

The EC-2000 criteria that currently guide ABET accreditation program review processes include both “hard” skills (e.g., “an ability to apply knowledge of mathematics, science, and engineering”) and “professional” or “soft” skills. The latter include criterion 3.h: “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.” While this is the only time “global” is mentioned within the (a-k) criteria, many additional criteria can be assessed through a global lens (e.g., 3.c, 3.j, and 3.k).

Since the 1990’s, attention to “global competence” has proliferated in higher education – including definitions, assessment criteria, and proposed mechanisms. However, little agreement exists regarding how to assess the impacts of global engineering education or, relatedly, on the scale and type of global engineering mechanisms needed to meet competency goals. Despite the open opportunity to include global competencies within accreditation processes, evaluation of Program Educational Objectives (PEOs) from diverse institutions demonstrates very limited adoption by programs. Analysis of recent PEOs from 48 programs in 36 institutions (235 PEOs total) suggests an almost complete lack of attention to global competence: the PEOs analyzed include the words global, international or world less than 7% of the time. The word culture or cultural was not present. We thus believe that the project to develop efficient, effective, sufficient, and consistent global competency assessment protocols remains open.

How to proceed? In this paper, we undertake two projects. First, we employ an assessment mechanism recently proposed by Jesiek, Shen, and Haller<sup>1</sup> to initiate the project of assessing the baseline global competency of engineering students at our university: the Miville-Guzman Universality-Diversity Scale-Short form (MGUDS-S). Jesiek, Shen, and Haller argue that, “cross-cultural competence is a key facet of global competency for engineers” (p. 144) and that, therefore, existing mechanisms for assessing cross-cultural competence, such as the MGUDS-S, can serve as an efficient, effective, sufficient, and consistent protocol for assessing global competency. In the study described in the 2012 paper, Jesiek, Shen, and Haller use the MGUDS-S to assess the cross-cultural competence of students who opt into global engineering programs (primarily at Purdue University) as compared to the cross-cultural competence of first-year engineering students also at Purdue University. Analysis of the data suggest to Jesiek, Shen, and Haller that the “MGUDS-S is an appropriate instrument for assessing the cross-cultural

competence of engineering students, especially in the context of global engineering programs,” and that “MGUDS-S also has the advantage of being relatively easy and quick to administer,” along with being “freely available for use its unmodified form” (p. 153).<sup>1</sup>

Second, we explore the significance of these baseline findings for engineering students who choose to opt-in – or choose not to opt-in – to global engineering programs. Our primary goal here is to continue the work initiated by Jesiek, Shen and Haller to explore whether the Miville-Guzman Universality-Diversity Scale-Short form is an effective, sufficient, and consistent assessment mechanism. We conclude by reflecting on explanations for the results of the MGUDS-S in our baseline assessment, and implications for future use of the MGUDS-S are explored.

## **GLOBAL COMPETENCY FOR ENGINEERS**

In his book *Clash of Civilizations*, Samuel Huntington writes, “It is my hypothesis that the fundamental source of human conflict in this new world will not be primarily ideological or primarily economic. The great divisions among humankind and the dominating source of conflict will be culture.”<sup>2</sup> As described above, attention to the “soft skill” of global competency for engineers is now a visible and growing component of engineering education and practice. The establishment of the International ASEE Forum in 2012, for example, speaks to the importance of and attention to this area.

However, just as the meaning of engineering varies across both time and nation, the idea of “global competency” differs from one academic institution to another. For the purposes of this paper, we align our understanding of global competency with the definition offered by Downey et al, 2006<sup>3</sup> – “global competency” for engineers is the “knowledge, ability, and predisposition to work effectively with people who define [engineering] problems differently than they do” (p. 4). That is, cultural competency is an integral component of global competency.

## **GLOBAL COMPETENCY WITHIN PROGRAM EDUCATIONAL OBJECTIVES**

While there are ideas of what global competency means and there are proposed ways of educating global engineers, assessment of the success of these ideas and methods is currently still in development.<sup>4</sup> For example, Purdue University, has been a leader in the development of an internationally focused field of engineering, and Penn State and Worcester Polytechnic also offer engineering programs overseas designed to immerse engineers into a diverse and educational engineering setting.<sup>5</sup> These programs are encouraging examples of how to increase global competency in engineering education, yet there is still much to be done in the development of a standard of outcomes for educating globally competent engineers, particularly in terms of Program Educational Objective and assessment.

Some efforts exist to explore what it would look like to incorporate global competency more fully with ABET criteria, and to assess global competency via ABET accreditation. One method

involves organizing global competency in terms of awareness, perspectives and participation.<sup>6</sup> However, the lack of agreement within the research literature is mirrored by a lack of attention to global competency within PEOs/program assessment. ABET's Criterion 2 requires programs to define the persona of a successful graduate via Program Educational Objectives (PEOs). From the Criteria these are "broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies." ABET also requires a justification that the PEOs are consistent with the mission of the program's institution. As we see in the definition, ABET encourages self-reflection on the part of the program to set the direction for its graduates and to seek the appropriate context when defining these goals for alumni, by considering critical constituencies and campus attributes. Furthermore these goals must be published as a public declaration of the program's intent for their alumni.

Essentially, engineering programs have a blank slate when defining PEOs. The objectives for the program can be completely defined and assessed by the program. This is markedly different than the tone set by ABET's Criterion 3 which defines the abilities of students at the time of graduation. Criterion 3 establishes outcomes (a-k). Although programs can define their own outcomes, ultimately coverage of (a-k) is still required. The blank slate of PEOs is an opportunity for programs to identify goals for their graduates that establishes a unique character. With the long-standing interest in global competencies, have programs seized on the opportunity to publically declare goals that reflect international considerations? Sadly, we find that this is not the case.

Analysis of recent PEOs from 48 programs in 36 institutions (235 PEOs total) suggests an almost complete lack of attention to global competence: the PEOs analyzed include the words global, international or world less than 7% of the time. Specific examples of phrases from the PEOs that did mention global, international, or world include:

1. globalized professional environment
2. contribute to the state, nation, or global community
3. respond to global changes
4. function in a global environment
5. remain globally competitive
6. global involvement and awareness
7. prepared for global issues
8. engagement locally and globally
9. aware of impact nationally and globally
10. success in international activities

Clearly, some universities are actively incorporating international experiences into a requirement in their curriculum. However, the word culture or cultural was not present in any of these PEOs, suggesting that cultural awareness is not a dominant theme within assessment work related to global competency in engineering education.

The vacancy of an international emphasis in PEOs, as well as a lack of attention to culture in particular, is surprising. We suggest that programs may wish to consider their PEOs in light of

any ‘global’ gap. Realizing that a gap exists might pave the way for a program improvement (which are also mandated by ABET in Criterion 4). In terms of a process to modify PEOs, ABET requires involvement of program constituencies during the review and potential update of PEOs. Constituents may be defined by a program, but often include industry advisory boards. In future research, we are interested in exploring how industry advisors at the major, college, and university level at our university rank the relative importance of global competency, and its assessment, on our own campus.

## **BACKGROUND ON MGUDS-S**

As described above, a recent publication by Jesiek, Shen, and Haller (2012)<sup>1</sup> argues that, “cross-cultural competence is a key facet of global competency for engineers” (p. 144) and that, therefore, existing mechanisms for assessing cross-cultural competence, such as the Miville-Guzman Universality-Diversity Scale-Short form (MGUDS-S), can serve as an efficient, effective, sufficient, and consistent protocol for assessing global competency.

The MGUDS is a 45-item instrument designed to measure an individual’s Universal-Diverse Orientation (UDO) which is defined as “an attitude of awareness and acceptance of both similarities and differences that exist among people” (p. 38). The three goals of the MGUDS are to identify:

1. diversity of contact with others (behavioral)
2. relativistic appreciation of oneself and others (cognitive)
3. degree of emotional comfort with differences (affective)

The short form of MGUDS is a 15-item survey that likewise focuses on the above attitudes. Past research and evaluation has suggested that the use of a 15-question “short form” of the MGUDS – the MGUDS-S – is validated.<sup>1</sup> As described above, Jesiek, Shen, and Haller argue that, “cross-cultural competence is a key facet of global competency for engineers” (p. 144) and that, therefore, existing mechanisms for assessing cross-cultural competence, such as the MGUDS-S, can serve as an efficient, effective, sufficient, and consistent protocol for assessing global competency. Jesiek, Shen, and Haller (2012) conclude that the “MGUDS-S is an appropriate instrument for assessing the cross-cultural competence of engineering students, especially in the context of global engineering programs,” and that “MGUDS-S also has the advantage of being relatively easy and quick to administer,” along with being “freely available for use its unmodified form.”<sup>1</sup>

## **BASELINE ASSESSMENT OF GLOBAL COMPETENCY AT CAL POLY USING THE MGUDS-S**

In this analysis, we employ the assessment mechanism recently proposed by Jesiek, Shen, and Haller (2012) to initiate the project of assessing the baseline global competency of engineering students at our university: the Miville-Guzman Universality-Diversity Scale-Short form (MGUDS-S).

An assessment has been conducted, in which 186 students completed the MGUDS-S in Spring 2012. Three groups of students were surveyed. First, 32 students enrolled in a required junior level experimental aerothermodynamics course in the Aerospace Engineering major were surveyed. The Aerospace Engineering Program does not explicitly address global competency in this or other courses, and none of these students were participants in Engineers Without Borders, one of the primary mechanisms for supporting global competency currently in place at our university. Thus, we consider these students as functioning as a baseline for the purposes of this study. Second, 36 students active in the Cal Poly Chapter of Engineers Without Borders were surveyed. Third, students involved in an interdisciplinary three-quarter senior project course focused on international collaborations (for example, collaborations with students in Nepal and Germany) in the College of Engineering were surveyed. The senior project course is voluntary, and student participants can petition for the interdisciplinary course to replace their traditional senior project series within their major. The results included here for the senior project students include students who, again, were not participants within Engineers Without Borders.

Students indicated how descriptive each statement was about them by circling a number between 1 to 6, with 1 being ‘strongly disagree’, and 6 being ‘strongly agree’ with a statement. Averages for each question and each subscale are reported in Table 1. Note that in Table 1, the scale has been reverse-coded, as required by the MGUDS-S tool, for the *Comfort with Differences* attribute.

The scores of the respondents indicate that all students evaluated display a moderate degree of “an attitude of awareness and acceptance of both similarities and differences that exist among people” (average of 4.7/6). As expected, the two groups of students who are voluntarily participants in global engineering programs at Cal Poly scored higher (5.00 and 4.59) than the students who are not participants in these programs (4.52). Larger scale distinctions can be drawn amongst the student groups by focusing on the specific measures included within the MGUDS-S UDO: 1) diversity of contact with others (behavioral); 2) relativistic appreciation of oneself and others (cognitive); 3) degree of emotional comfort with differences (affective).

Again, as expected, the students who voluntarily participated in either Engineers Without Borders or the interdisciplinary three-quarter senior project course focused on international collaborations scored higher on each of the three axes of the Universality-Diversity Orientation measured by the MGUDS-S. The students voluntarily participating in the senior project course with the global emphasis scored higher than the baseline Aerospace students in the *Diversity of Contact* and *Comfort with Differences* categories, but lower than the baseline students in the area of Relativistic Appreciation. In particular, the senior project students had a lower score than the baseline Aerospace students on two statements associated with *Relativistic Appreciation*: “I can best understand someone after I get to know how he/she is both similar to and different from me” and “Knowing how a person differs from me greatly enhances our friendship.”

Table 1 – MGUDS-S Results with Subscale Averages

		EWB Participants (n=36)	Senior Project Course (not involved with EWB) (n=118)	Aerospace Students (not involved with EWB) (n=32)
	<b>Diversity of Contact</b> – students' interest in participating in diverse social and cultural activities	<b>4.79</b>	<b>4.22</b>	<b>4.09</b>
1	I would like to join an organization that emphasizes getting to know people from different countries	5.49	4.64	4.61
2	I would like to go to dances that feature music from other countries	4.49	3.76	3.59
3	I often listen to music of other countries	4.27	3.92	3.85
4	I am interested in learning about the many cultures that have existed in this world	5.27	4.92	4.70
5	I attend events where I might get to know people from different racial backgrounds	4.43	3.85	3.73
	<b>Relativistic Appreciation</b> – the extent to which students value the impact of diversity on self-understanding and personal growth	<b>5.05</b>	<b>4.58</b>	<b>4.63</b>
6	Persons with disabilities can teach me things I could not learn elsewhere	5.35	4.89	4.73
7	I can best understand someone after I get to know how he/she is both similar to and different from me	5.05	4.68	4.88
8	Knowing how a person differs from me greatly enhances our friendship	4.69	4.15	4.67
9	In getting to know someone, I like knowing both how he/she is different from me and is similar to me	5.11	4.62	4.58
10	Knowing about the different experiences of other people helps me understand my own problems better	5.05	4.54	4.30
	<b>Comfort With Differences</b> – students' degree of comfort with diverse individuals (all of these items are reverse scored)	<b>5.15</b>	<b>5.00</b>	<b>4.84</b>
11	Getting to know someone of another race is generally an uncomfortable experience for me	5.05	4.94	5.06
12	I am only at ease with people of my own race	5.3	5.05	4.94
13	It's really hard for me to feel close to a person from another race	5.46	5.09	5.03
14	It is very important that a friend agrees with me on most issues	4.22	4.04	4.00
15	I often feel irritated by persons of a different race	5.7	5.1	5.15



	<b>Diversity of Contact</b>	<b>4.79</b>	<b>4.2</b>	<b>4.09</b>
	<b>Relativistic Appreciation</b>	<b>5.05</b>	<b>4.58</b>	<b>4.63</b>
	<b>Comfort With Differences</b>	<b>5.15</b>	<b>5.0</b>	<b>4.84</b>
	<b>OVERALL UDO</b>	<b>5.0</b>	<b>4.59</b>	<b>4.52</b>

Most responses above 5/6 across the three groups occurred in the *Comfort With Differences* category. All three groups showed similar relatively high degrees of comfort with diverse individuals. All three groups correspondingly scored lowest in the *Diversity of Contact* category, although the Engineers Without Borders group average was consistently higher in each statement than that of the other two groups. In addition, the *Diversity of Contact* category was the only category in which all the statements were higher for both the EWB and senior project students than the baseline Aerospace students.

Overall, there was the greatest percentage distinction between the Engineers Without Borders students (4.79) and the other two groups of students (4.22 and 4.09) in the *Diversity of Contact* UDO axis, which measures students' interest in participating in diverse social and cultural activities. However, the Engineers Without Borders student scores for the *Diversity of Contact* (4.79) axis are lower than their scores for the *Relativistic Appreciation* (5.05) and *Comfort with Differences* (5.15) axes, suggesting that all groups of students in this study have an opportunity to grow their interest in participating in diverse social and cultural activities and that efforts to promote cultural competency at our campus should include explicit attention to this behavioral dimension.

## DISCUSSION & IMPLICATIONS

Here, we explore the significance of these baseline findings for engineering students who choose to opt-in – or choose not to opt-in – to global engineering programs. Our primary goal is to continue the work initiated by Jesiek, Shen and Haller (2012) to explore whether the Miville-Guzman Universality-Diversity Scale-Short form is an effective, sufficient, and consistent assessment mechanism. In this section, potential explanations for these differences described above and the implications for future use of the MGUDS-S are explored.

We are most intrigued by the differences in overall UDO and three specific axes of the UDO that exist between the Engineers Without Borders students and the student participants in the interdisciplinary three-quarter senior project course focused on international collaborations. As described above, in each measurement, the EWB students tested as more culturally competent than the students enrolled in the senior project course focused on international collaborations. Given that time spent per academic year in these two programs (EWB vs. the senior project course) is roughly equivalent, questions about why the correlation between EWB participation and a higher UDO exists must be explored. For example, what would analysis of the EWB students' scores by number of years involved with EWB indicate? Would students in their first year of involvement with EWB score more similarly to the senior project students in their first year of sustained attention to international collaborations? Does a distinction exist amongst EWB

students who have had the opportunity to travel with EWB compared to those EWB participants who have not, and, again, do the latter show more similarity in UDO scores to the senior project students? Additional analysis should carefully compare the types of training materials and discussions that occur within the EWB and senior project contexts in order to determine areas of overlap and distinction between these two programs. Lastly, we must better address self-selection – are students who already exhibit a higher UDO more likely to choose EWB, and how do we distinguish this from the impacts of EWB participation on students?

The answers to these new questions have significant implications for the development of global engineering and global competency programs at our and other universities, and should provide insight, for example, regarding curricular vs. co-curricular models of global engineering education. Ongoing research to address the above is currently taking place including more detailed analysis of existing datasets and the addition of different student groups to more fully explore the impacts of these educational interventions over time.

Based on the findings above, we tentatively concur with Jesiek, Shen and Haller (2012) that the “MGUDS-S is an appropriate instrument for assessing the cross-cultural competence of engineering students, especially in the context of global engineering programs” (p. 153) and is an efficient, effective, sufficient, and consistent protocol for assessing global competency. Following this confirmation, we are excited to now explore how the MGUDS-S can serve as a tool in efforts to integrate attention to global competency and cultural competency into ABET accreditation processes and assessments of Program Educational Objectives in collaboration with colleagues at our university and beyond.

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