AC 2011-1992: CULTURAL ORIENTATION AND GLOBAL COMPETENCY: A COMPARATIVE ASSESSMENT OF ENGINEERING STUDENTS

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Chang started her professional career as the Study Abroad Director at Western Kentucky University from 2001-2006, where she drove a 3X increase in overseas educational experiences, working with a predominately local/in-state student population that does not have a natural inclination for study abroad (many being the first in their family to attend college). This work experience has become her focus and engagement of under-represented population in Education Abroad, focusing on students in science and engineering disciplines. Her main responsibilities include engagement of both students and faculty members at Purdue University to embrace global engineering mindsets and practice.

During the first 2 years at Purdue University, she drove a 2X increase in the number of engineering major participating in both short-term and long-term overseas study. At her current position as the assistant director of the Purdue Office of Professional Program, Chang expands her expertise area to concentrate on developing global professional and research internships for students in the Engineering, Technology and Business disciplines. In 2010, she became the Program Director of International Research and Education in Engineering (IREE), a NSF funded program that sent 58 U.S. engineering researchers to conduct research in China. Chang has been an active NAFSA member for over 10 years. Currently, she serves as the 2009 network leader of the International Education Leadership Development network of NAFSA. She has organized numerous workshops and conferences with National Science Foundation, American Society of Engineering Education, and the Colloquium of International Engineering Education. In the past, she served on the Board of Trustees (2002-06) of the Cooperative Center for Study Abroad, as Fulbright Advisor, and as a Selection Panelist for the national-level scholarship program for International Institute of Education. Chang research interest is a derivative from her professional experience in global engineering education, with an emphasis on global engineering competencies and the impact of internationalization on the engineering profession.

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Cultural Orientation and Global Competency: A Comparative Assessment of Engineering Students

Abstract

Global educational experiences can help engineering students attain intercultural skills and understand how cultural differences impact engineering practice. Effective global programs make appropriate links and project meaningful pathways for students from the advancement of cultural orientation to the development of global competency.

This study examines the extent of current engineering students' awareness and potential acceptance of cultural similarities and differences. We conducted survey assessment using the Miville-Guzman Universality-Diversity Scale short form (MGUDS-S) to measure and compare orientation toward diversity among four groups of engineering student populations, including those entering three different types of global engineering programs and a baseline population of first-year engineering students. We proposed and tested a set of research hypotheses for multiple group comparisons of MGUDS-S results, including across three subscales, and concluded with a series of significant results.

In particular, significantly higher levels of universal-diverse orientation (UDO) among students opting into global programs suggest that these individuals are predisposed to participate in global experiences due to their more advanced cultural outlook. Further, significant differences in UDO among student populations participating in different types of international program suggest a self-selection factor at work among the participants when choosing the type, duration and orientation of global engineering programs. These results are useful for instructors and administrators as they recruit students into global programs and then tailor orientation and program activities based on different levels of cultural awareness and appreciation among participants.

These results also point to new opportunities for further research. Particularly, this study represents a significant step towards developing and testing an integrated assessment model for global engineering programs that brings together measures of readiness assessment, orientation toward diversity, and global engineering competency.

1. Introduction

For more than a decade, a growing roster of influential stakeholders have argued that global competency is imperative for a new generation of "global engineers" who must be ready to practice in an increasingly diverse, interconnected, and rapidly changing world.[1,2,3,4,5] Yet as noted in many of these same commentaries and reports, most degree courses and programs are failing to train the global engineer of tomorrow. Even the most optimistic of estimates suggests that only about 7.5% of engineering students study abroad, and Shulman estimates that just 10-15% of engineering schools are taking global education seriously.[6,7]

In response, many authors have passionately argued for a thorough internationalization of engineering education. As the nineteen signatories of the "Newport Declaration" declared, "[W]e call on engineering educators, engineering administrators, and engineering policy leaders to take deliberate and immediate steps to integrate global education into the engineering curriculum to impact all students, recognizing global competency as one of the highest priorities for their graduates."[5] Nonetheless, there remain questions about what kinds of educational experiences are most effective in promoting global competency, including interventions as diverse as relevant on-campus activities like coursework and extracurricular activities, short-term study abroad trips, and longer-term immersive programs involving study, research, and/or internships abroad.

Further, we know relatively little about the baseline global competency of our students, much less how different types of learning experiences impact various facets of global competency. To begin filling these gaps, our study examines awareness and potential acceptance of cultural similarities and differences among current engineering students. The main instrument used to collect data for this study was the Miville-Guzman Universality-Diversity Scale – Short Form (MGUDS-S), which is designed to measure a construct called Universal-Diverse Orientation (UDO) across three subscales: diversity of contact, relativistic appreciation, and comfort with differences. Our data collection and analysis addresses two major research questions:

1. How do MGUDS-S scores vary among different engineering student populations, including those entering different types of global engineering program?
2. Can we detect any significant difference in MGUDS-S scores between baseline populations, such as first-year engineering students, and students participating in international engineering programs?

Below we describe a set of research hypotheses proposed and tested to address our research questions, using multiple statistical techniques for data analysis. We intend our findings will help improve our understanding of cultural development and global competency among today's engineering students, lead to suggestions for developing more effective programs and experiences, and stimulate further research.

2. Literature Review

While many definitions of global competency have been proposed, intercultural skills are often viewed as crucially important for working effectively across countries and cultures. For instance, a 2004 report by the National Association of State Universities and Land Grant Colleges' Committee for International Education (NASULGC) listed five key characteristics for globally competent students, including cross-cultural sensitivity, adaptability, and communication skills.[8] Similar descriptions have been put forth in the realm of global engineering education. Parkinson, for one, identified thirteen attributes for globally competent engineering graduates, including the ability to "appreciate other cultures," "communicate across cultures," work in diverse teams, and understand how cultural differences impact engineering practice.[9] More generally, Downey et al. propose that globally competent engineering students should have the "knowledge, ability, and predisposition to work effectively with people who define problems differently than they do."[10]

Beyond definitions there remains the question of how to measure inter/cross-cultural sensitivity. The Intercultural Development Inventory (IDI) has been especially popular in ongoing efforts to perform such measurements. Based on a developmental model pioneered by Milton Bennett, the IDI is a valid and reliable instrument designed to measure perceived and "actual" levels of intercultural sensitivity, on a scale ranging from denial and defense/reversal to minimization and then acceptance and adaptation.[11] While many studies have reported IDI data, recent reports from Georgia Tech and Purdue University are especially relevant given their focus on engineering students.[12,13] Researchers at both schools found higher levels of sensitivity for women as compared to men, and tentatively indicated that students entering global programs (the International Plan at Georgia Tech and GEARE program at Purdue) had higher IDI scores.

IDI has also been used to study changes in intercultural development resulting from global educational experiences. The Georgetown Consortium study, for example, used data from 1,300 students in 61 different programs to show that the largest pre/post increases in IDI scores could be found among students in study abroad programs that were 13-18 weeks duration and/or very well structured and planned.[14] However, attempts to detect similar changes in IDI scores among engineering students have been somewhat less successful. Researchers at Worcester Polytechnic Institute (WPI), John Brown University, Michigan Technological University (MTU), and University of Michigan, for example, have failed to detect significant gains.[15,16,17,18,19] On the other hand, Georgia Tech's efforts to systematically collect and analyze large amounts of IDI data appears to be generating more favorable results, as they tentatively report significant gains in scores for students who have spent a semester abroad (work or study).[20]

In the analysis that follows we discuss yet another instrument, the Miville-Guzman Universality-Diversity Scale short form (MGUDS-S), which measures a construct called universal-diverse orientation (UDO). In the realm of engineering education, Bielefeldt and High pioneered the use of MGUDS-S to study the cultural orientation of various engineering student populations.[21,22] However, little has been published on the use of MGUDS-S to measure changes in UDO resulting from specific learning experiences. One exception is Longerbeam and Sedlacek's use of MGUDS-S to study the impacts of service-learning on student attitudes toward diversity, although they were unable to measure any significant pre-post changes in MGUDS-S scores.[23]

3. Methods

3.1 Participants

The participants for this study were engineering students recruited from the following courses and programs: 1) a first-year honors engineering course (n=50), 2) Maymester China, a one-month study abroad program (n=26), 3) Global Engineering Alliance for Research and Education (GEARE), a seven-month study and internship abroad program (n=16), and 4) International Research and Education in Engineering (IREE) 2010 China, a 10-12 week research abroad program (n=57). The first-year honors population was identified as a suitable "baseline" population to compare with other groups. Students from the first three groups were enrolled at Purdue University, while those in the fourth group (IREE) were from a variety of U.S. universities. Demographic characteristics are summarized in Table 1. All appropriate human subjects procedures were approved and followed under Purdue IRB protocol #1004009220.

Table 1: Demographic Characteristics of Study Populations

	First-Year Honors Engineering	Maymester China Study Abroad	GEARE Study and Intern Abroad	IREE 2010 China Research Abroad
Number of Students (n)	50	26	16	57
Academic Level	First-year: 34 Sophomore: 13 Junior: 3	First-year: 1 Sophomore: 9 Junior: 11 Senior: 5	Junior: 15 Senior: 1	First-year: 1 Sophomore: 2 Junior: 4 Senior: 14 Masters: 18 Doctoral: 18
Gender	Male: 44 Female: 6	Male: 18 Female: 8	Male: 11 Female: 5	Male: 32 Female: 25
Ethnicity	White/Caucasian: 41 Asian: 4 Other/Multiracial: 5	White/Caucasian: 20 Asian: 4 African American: 1 Other/Multiracial: 1	White/Caucasian: 14 Asian: 1 African American: 1	White/Caucasian: 34 Asian: 13 African American: 2 Hispanic: 1 Other/Multiracial: 7
Have Lived Abroad (2+ months)	10	4	4	32

3.2 Hypotheses

To address our research questions as described above, hypotheses were formulated and tested with respect to the Total MGUDS-S score, as well as each MGUDS-S subscale. These include:

Total MGUDS-S:

- **H1.** The IREE participants present a more advanced overall cultural outlook than the first-year engineering students
- **H2.** The Maymester students present a more advanced overall cultural outlook than the first-year engineering students
- **H3.** The GEARE students present a more advanced overall cultural outlook than the first-year engineering students

Subscale 1. Diversity of Contact:

- **H4.** The IREE students indicate broader diversity of contact than the first-year engineering students
- **H5.** The Maymester students indicate broader diversity of contact than the first-year engineering students
- **H6.** The GEARE students indicate broader diversity of contact than the first-year engineering students

Subscale 2. Relativistic Appreciation:

- **H7.** The IREE students express more relativistic appreciation than the first-year engineering students
- **H8.** The Maymester students express more relativistic appreciation than the first-year engineering students

H9. The GEARE students express more relativistic appreciation than the first-year engineering students

Subscale 3. Comfort with Differences:

H10. The IREE students report a higher level of comfort with differences than the first-year engineering students

H11. The Maymester students report a higher level of comfort with differences than the first-year engineering students

H12. The GEARE students report a higher level of comfort with differences than the first-year engineering students

3.3 Instruments

The original Miville-Guzman Universality-Diversity Scale (M-GUDS) is a 45-item instrument designed to measure an individual's universal-diverse orientation (UDO), which the developers define as "an attitude of awareness and acceptance of both similarities and differences that exist among people."[24] It uses three subscales to systematically assess the cognitive, behavioral, and affective dimensions of UDO. The development of the 15-item short form version of the survey (MGUDS-S) led to a minor refinement of the instrument subscales, which were defined as: 1) seeking *diversity of contact* with others, 2) having *relativistic appreciation* of oneself and others, and 3) degree of emotional *comfort with differences*. The survey uses a six-point Likert scale ranging from strongly disagree to strongly agree, which gives the instrument a scoring range of 15-90 (with scaled three reverse-scored). The development and statistical analysis of MGUDS-S has been very rigorous, and early evidence of its reliability and validity is strong.[25] We used the MGUDS-S instrument for our study because it is relatively short, can be freely reused in its unmodified form, and is well aligned with our research interests. A demographic survey was also used to collect data about the subject populations, as summarized in Table 1 above.

3.4 Data Collection and Analysis

Data was collected from the first-year engineering cohort toward the end of their first academic semester. All other subject populations completed the surveys during one of the first orientation meetings for each of their respective global programs. In addition to MGUDS-S and demographics, other surveys were also given to each population. However, none of these other instruments were focused on cultural competency. All surveys were completed using paper forms, and all data entry and analysis was performed using Microsoft Excel and SPSS. Multiple statistical techniques were employed for data analysis, as described in more detail below.[26]

4. Findings and Interpretation

Below we present our findings, beginning with a comparative description of MGUDS-S scores across the four subject populations. We then describe the results of our hypothesis tests to discuss whether statistically significant differences in scores were found across the four groups.

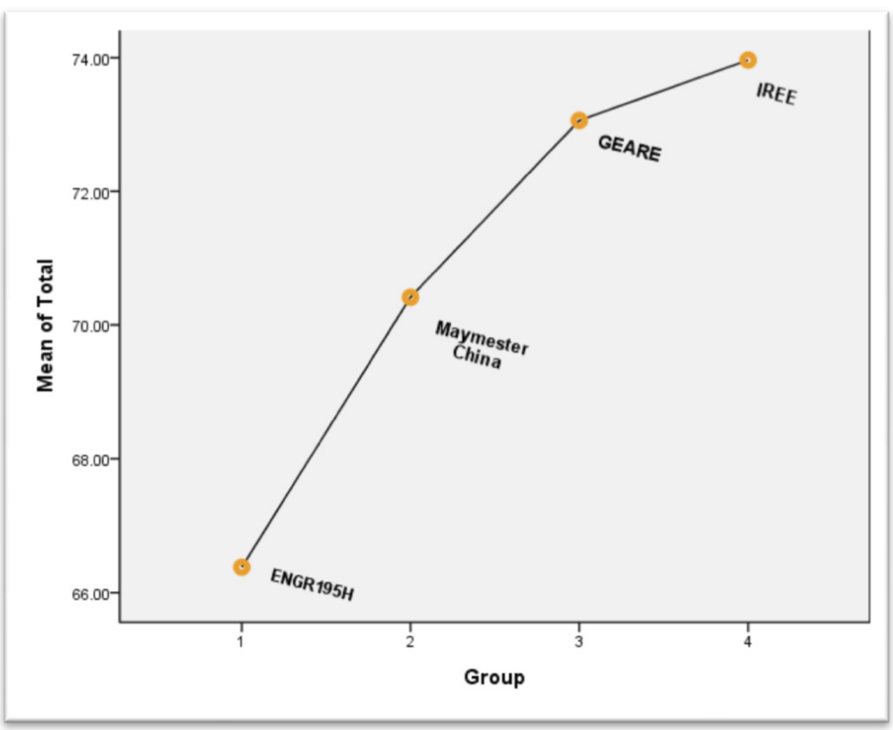
Descriptive Statistics of MGUDS-S Scores Across Groups

Descriptive statistics for the Universal-Diverse Orientation (UDO) profiles of the four target groups of engineering students were evaluated to address the first research question. To begin, we observe that MGUDS-S scores from our baseline population of first-year engineering students (Mean = 66.38) are consistent with findings from other schools. For example, a group of undergraduate students at James Madison University (n=101) had a mean total score of 66.5 (σ=9.71).[27] Additionally, the students in all three of our global program groups demonstrated a higher level of overall cultural orientation than the baseline population. Further, as the intensity and duration of the international program increased, the average level of UDO among participants also increased, from Maymester China (Mean = 70.42) to GEARE (Mean = 73.06) and IREE (Mean = 73.96). Table 1 presents descriptive statistics for the total MGUDS-S scores across the four groups, with Figure 1 illustrating comparison of mean scores across the groups.

Table 2. Descriptive statistics of Total MGUDS-S Scale by groups

Group	N	Mean	Std. Deviation	Minimum	Maximum
ENGR195H	50	66.3800	8.22363	47.00	85.00
Maymester China	24	70.4167	8.55121	47.00	87.00
GEARE	16	73.0625	5.66238	64.00	83.00
IREE	57	73.9649	6.68144	57.00	90.00
Total	147	70.7075	8.11240	47.00 (min)	90.00 (max)

Figure 1. Group Comparisons of Total MGUDS-S Scores

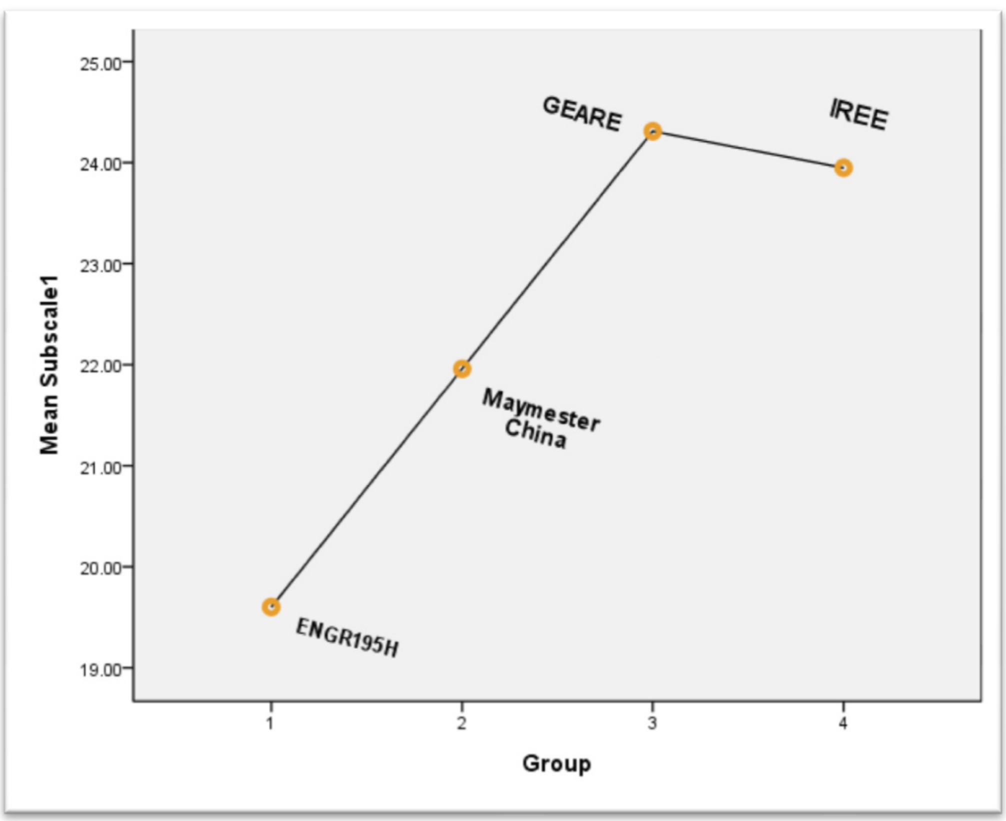


We now turn to each of the MGUDS-S subscales to see if the general patterns are consistent across each of the instrument's three factors. Regarding the first subscale, the students in all three international programs indicated a broader *diversity of contact* than the baseline first-year population (mean = 19.60). Among the three international groups, the students also demonstrated increasing diversity of contact scores as the degree of cultural immersion and duration of their programs increase, from Maymester China (Mean = 21.96) to IREE (Mean = 23.95) and GEARE (Mean = 24.31). Table 3 summarizes the results of the analysis and Figure 2 maps the trend.

Table 3. Descriptive Statistics for MGUDS-S Subscale 1 (Diversity of Contact)

Group	N	Mean	Std. Deviation	Minimum	Maximum
ENGR195H	50	19.6000	4.33778	11.00	30.00
Maymester China	24	21.9583	4.52509	13.00	29.00
GEARE	16	24.3125	2.96015	19.00	29.00
IREE	57	23.9474	3.04971	18.00	30.00
Totals	147	22.1837	4.24429	11.00 (min)	30.00 (max)

Figure 2. Group Comparisons of MGUDS-S Subscale 1 (Diversity of Contact)

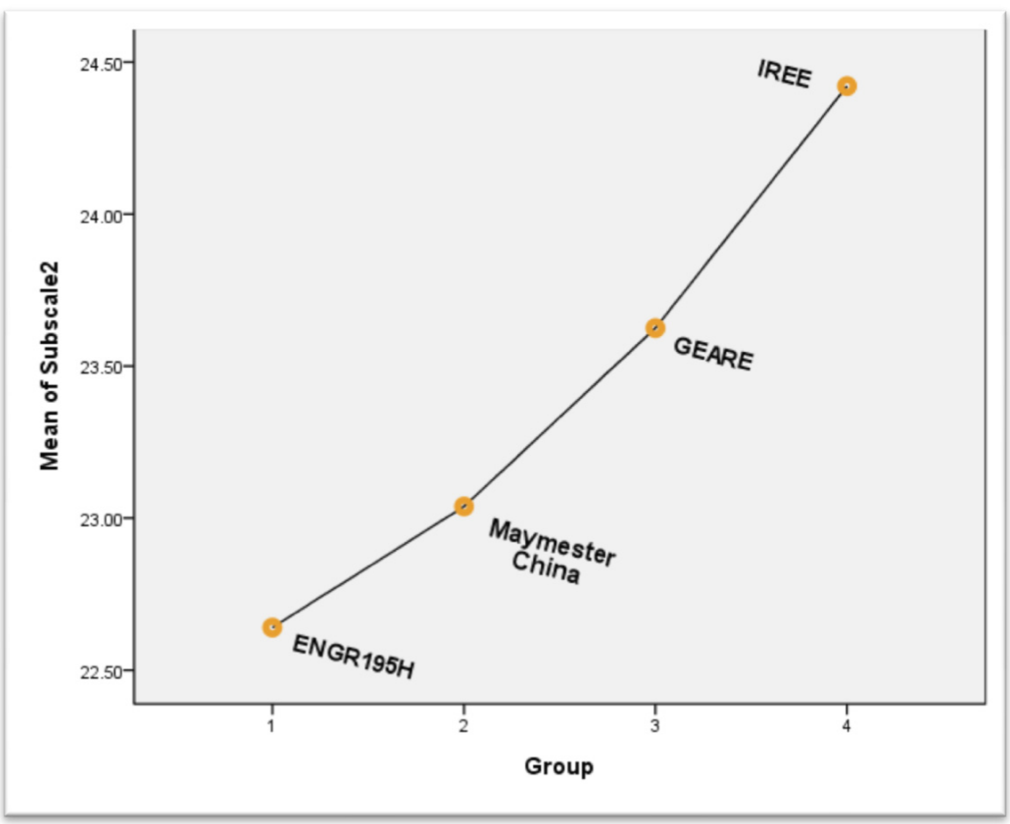


We find similar patterns on the remaining two subscales. Students participating in all three international programs expressed a higher level of *relativistic appreciation* as compared to the first-year engineering students (Mean = 22.64). Among the three international program groups, students also indicated higher levels of relativistic appreciation as the intensity of their program assignments increased, from Maymester China (Mean = 23.04) to GEARE (Mean = 23.63) and IREE (Mean = 24.42). Table 4 summarizes the statistical results and Figure 3 provides a graphical depiction of the trends.

Table 4. Descriptive Statistics for MGUDS-S Subscale 2 (Relativistic Appreciation)

Group	N	Mean	Std. Deviation	Minimum	Maximum
ENGR195H	50	22.6400	3.12828	16.00	29.00
Maymester China	26	23.0385	3.38799	16.00	29.00
GEARE	16	23.6250	1.85742	21.00	27.00
IREE	57	24.4211	3.27298	16.00	30.00
Total	149	23.4966	3.19337	16.00 (min)	30.00 (max)

Chart 3. Group Comparisons of MGUDS-S Subscale 2 (Relativistic Appreciation)

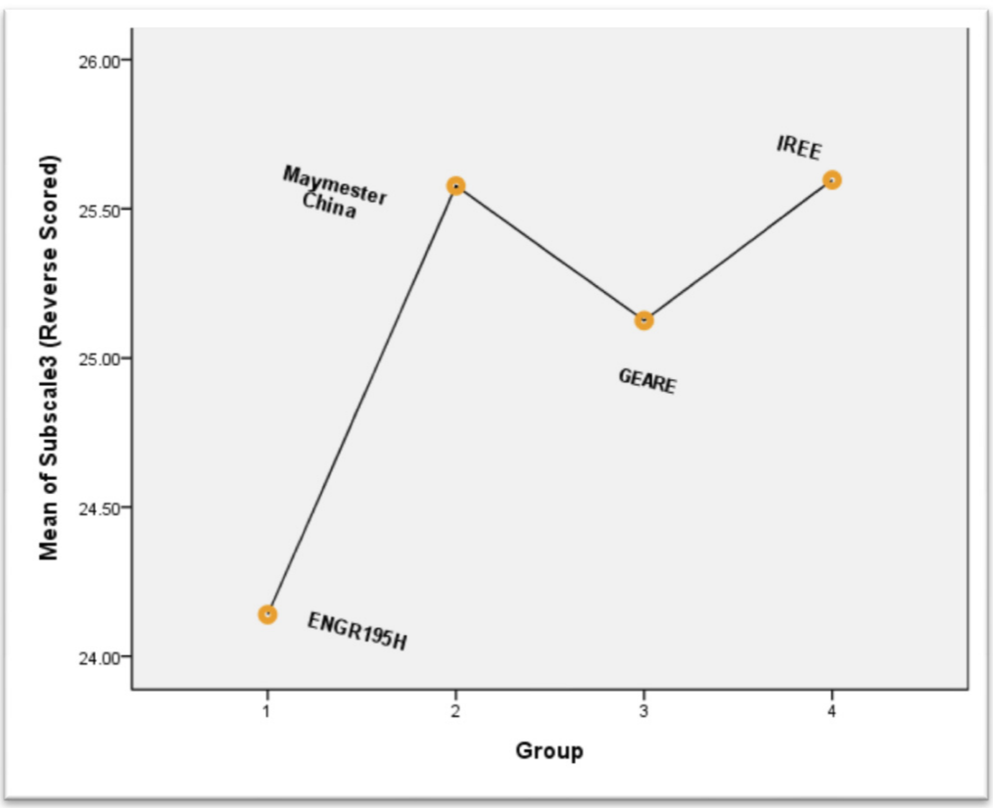


Finally, students in the three international programs also demonstrated a higher level of *comfort with differences* than the first year engineering students (Mean = 24.14, reverse scored). Among the three international programs, the students' level of comfort with differences increases from GEARE (Mean = 25.13) to Maymester China (Mean = 25.58) and IREE (Mean = 25.60). Table 5 and Figure 4 present the results.

Table 5. Descriptive statistics for MGUDS-S Subscale 3 (Comfort with Differences)

Group	N	Mean	Std. Deviation	Minimum	Maximum
ENGR195H	50	24.1400	3.80660	14.00	30.00
Maymester China	26	25.5769	3.21463	18.00	30.00
GEARE	16	25.1250	2.41868	20.00	30.00
IREE	57	25.5965	3.03468	15.00	30.00
Total	149	25.0537	3.32636	14.00 (min)	30.00 (max)

Figure 4. Group Comparisons of MGUDS-S Subscale 3 (Comfort with Differences)



These results parallel previous research findings by showing that students opting into global programs indicate a more advanced cultural orientation, suggesting that a self-selection factor is likely at work. Moreover, our study expands previous findings by examining the relationships between different dimensions of cultural orientation and the specific features of global engineering programs. It uncovered meaningful relationships between student's cultural sensitivity and their decision to participate in different types of global programs. More specifically, different aspects and levels of cultural orientation in term of general cultural outlook, diversity of contact, and relativistic appreciation, and comfort with differences may affect an engineering student's participation choice of global program with respect to its programmatic features and/or intensity, as well as its degree of cultural immersion and duration. These results are useful for global engineering programs to recruit and orient students, tailor orientation and other program activities, and monitor participants during their experiences.

Hypotheses Testing for MGUDS-S Multiple Group Comparisons

To address the second research question, this study proposed and tested four sets of hypotheses, as described above, with respect to the total MGUDS-S score and the three MGUDS-S subscales. Multiple comparisons of group means using t-tests were performed for hypotheses testing. For each set of hypotheses, three one-tailed, planned contrasts were performed to compare results for each group of global program students (Maymester, GEARE, and IREE) with the baseline first-year student population (ENGR195H). Table 6 presents a summary of the test results.

Table 6. Group Comparisons of MGUDS-S Total and Subscale Scores

MGUDS-S Scale	Contrast	Value of Contrast	t	Sig.(2-tailed)	Decision
Total	IREE vs. ENGR195H	7.5849	5.241	.000	Significant
	GEARE vs. ENGR195H	6.6825	3.115	.002	Significant
	Maymester vs. ENGR195H	4.0367	2.177	.031	Significant
Subscale 1	IREE vs. ENGR195H	4.3474	5.919	.000	Significant
	GEARE vs. ENGR195H	4.7125	4.903	.000	Significant
	Maymester vs. ENGR195H	2.3583	2.127	.039	Significant
Subscale 2	IREE vs. ENGR195H	1.7811	2.939	.004	Significant
Subscale 3	IREE vs. ENGR195H	1.4565	2.283	.024	Significant

As these results demonstrate, group comparisons of Total MGUDS-S score concluded with three statistically significant results in support of H1, H2 and H3. In summary, the students entering all three international programs demonstrated higher average levels of cultural orientation towards diversity as compared to the baseline population of first-year engineering students. An evaluation of MGUDS-S Subscales across the four groups also revealed statistically significant results that support H4, H5, H6, H7, and H10. All three groups of global program students demonstrated broader *Diversity of Contact* than the baseline population of first year engineering students (H4, H5, and H6). The IREE students also indicated a higher level of *Relativistic Appreciation* and *Comfort with Differences* as compared to the first-year engineering students (H7 and H10).

5. Discussion and Conclusion

This research explored strategies for systematically measuring aspects of global competency among different engineering student populations. The study results have several theoretical and practical implications. First, as described in the literature review, previous efforts to use other instruments such as IDI to detect differences in intercultural development among engineering students participating in global educational experiences have not been very effective. However, the current study does detect statistically significant differences in cultural orientation between a baseline population and engineering students entering different types of global programs. And while differences in average scores are not dramatic – amounting to a swing of about 7.5 points between the lowest and highest scoring groups – we are encouraged by the consistency of results across all three subscales. This implies that MGUDS-S survey may be an appropriately sensitive assessment tool for understanding cultural development and competency of students, and thus more effective for evaluating the effectiveness of global study programs. The instrument also has the advantage of being freely available and relatively short.

Yet how do we account for these differences in scores among the subject populations? We tentatively propose two explanations. First, self-selection factors are likely at work. As we note above, the MGUDS-S scores from our first-year engineering group are largely consistent with results obtained from other general undergraduate student populations. Hence, higher scores among students opting into global programs suggest that these individuals are predisposed to participate in global experiences due to their more advanced cultural outlook. These results are consistent with similar patterns observed in IDI data.[12,13] Second, we note that prior global experiences also probably correlate with higher MGUDS-S scores. We especially expect this for the IREE group, where more than half the population reported a prior study, intern, or research abroad of two or more months duration. We are continuing to investigate such correlations.

These findings and observations also have important implications for faculty and staff who are developing or running global engineering programs. First and foremost, we suggest that the average engineering student is not likely to sign up for an immersive, long-term global experience without first having orienting experiences that help develop their cultural awareness and orientation. This could include relevant activities "at home," such as coursework or extracurricular experiences, or short-term travel programs. Second, instructors and program administrators should be mindful of the different levels of cultural awareness and appreciation that exist among participants in global educational experiences, and use this knowledge to tune orientation and program activities accordingly. To support development of global competency, students should be provided with a variety of reflective learning opportunities that allow them to engage, understand, and appreciate cultural differences.

Our study also points to numerous opportunities for further research, some of which we are pursuing in our own work. In particular, we are now examining whether there are statistically significant increases in MGUDS-S scores collected from our IREE cohort before *and after* their research experience abroad. Additionally, we are developing a Readiness Assessment survey to measure the sense of preparedness felt by students about to go abroad, and we are examining correlation of results from this instrument with MGUDS-S scores.

Ultimately, our goal is to develop, apply, and disseminate integrated assessment models for global engineering programs that bring together measures of readiness assessment, general multi/cross-cultural competency, and global engineering competency. Making connections across these different measures provides opportunities to understand specific aspects of global preparedness and competency, as well as their interplay with one another. This type of integrated assessment model would be especially useful for faculty and staff responsible for administering and overseeing global educational programs, especially by allowing them to systematically evaluate the effectiveness of their programs, and purposefully and tactfully support and assess key learning outcomes and competencies. The present study represents a significant step towards developing and testing such a model.

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