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Preliminary Results of an NSF Sponsored Cross Institutional Study for Assessing the Spectrum of International Undergraduate Engineering Educational Experiences and IDI Results of Short-Term Study Abroad (University of Rhode Island)

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The paper consists of two parts; in part I we will present the preliminary results of an NSF sponsored Cross Institutional Study for Assessing the Spectrum of International Undergraduate Engineering Educational Experiences in which University of Rhode Island (URI) participated in spring 2016 along with eleven other engineering schools. Since the cross-institutional evaluation is still on-going, we can only provide a small segment of the cross-institutional results. Part II attempts to explain why those results may have come out the way they did for URI – what kind of international programming inherent in the engineering curriculum at URI may differentiate it from others in the sample? The main set-up and design of international engineering programming at the university will be described as background in front of which the NSF results ought to be examined. Within the context of part II we will furthermore present the outcome of an IDI assessment used for a short-term travel course in January 2017 which also has encouraging results in terms of its impact on student participants. Both URI's long-term and short-term international engineering programs – especially if combined in a student's college career – seem to be effective in changing students' development orientation towards other cultures.

Part I – Results of Cross-Institutional Study for the University of Rhode Island

University of Rhode Island participated in an NSF sponsored cross institutional study for assessing the spectrum of international undergraduate engineering educational experiences. URI was one of eleven schools that participated in the spring of 2016 (two more were added in Fall 2016). The PIs formed a multidisciplinary team from four universities (University of Pittsburgh, Lehigh University, University of Southern California and Clemson University) which investigates how the broad spectrum of international experiences both in and outside of formal curricula impact engineering students' global preparedness. Its four major objectives are delineated into three separate, but interconnected studies (i.e., Delphi, mixed-methods, and cross-institutional) combined with a dissemination system. Below is an excerpt of parts of the analysis of the preliminary URI results of the third study within this work, an in-depth study to analyze engineering students' global preparedness as the result of their academic and non-academic international experiences.

The instrument of the Global Perspective Inventory (GPI)[1] was used to compare GPI scores of engineering freshmen and seniors with and without international experiences. The freshmen cohort was 28 (17 with and 11 without international experience); the senior cohort sampled was 145 (22 without, 8 with pre-college only, 44 with college only and 66 with pre- and college international experience). In this paper we are only providing preliminary analysis of the senior cohort with respect to the effect sizes of their GPI scores[2]. More extensive data are available in the University of Rhode Island report provided by the PIs of this study[3].

Table 1: GPI Scores for University of Rhode Island Seniors -- Effect Sizes

	No Intl Exp vs. Pre-College Exp			No Intl Exp vs. College Intl Exp			No Intl Exp vs. Both Pre-College and College Intl Exp		
	Cog (effect) n_1, n_2	**Intra** (effect) n_1, n_2	**Inter** (effect) n_1, n_2	**Cog** (effect) n_1, n_2	**Intra** (effect) n_1, n_2	**Inter** (effect) n_1, n_2	**Cog** (effect) n_1, n_2	**Intra** (effect) n_1, n_2	**Inter** (effect) n_1, n_2
Personal Tourism	.003 (no effect) *6, 22*	.74 (medium) *6, 22*	.18 (no effect /small) *6, 22*	.98 (large) *10, 22*	.70 (medium) *10, 22*	.44 (small) *10, 22*	.99 (large) *57, 22*	.99 (large) *57, 22*	.87 (large) *57, 22*
Second Language Course	.36 (small) *2, 22*	.89 (large) *2, 22*	.72 (medium) *2, 22*	1.02 (large) *20, 22*	.70 (medium) *20, 22*	.64 (medium) *20, 22*	.89 (large) *52, 22*	1.02 (large) *52, 22*	.82 (large) *52, 22*
U.S. based research project that examines a global issue	-	-	-	- *1, 22*	- *1, 22*	- *1, 22*	.91 (large) *5, 22*	.95 (large) *5, 22*	.32 (small) *5, 22*
Non-engineering focused service learning program	-	-	-	- *0, 22*	- *0, 22*	- *0, 22*	.52 (medium) *8, 22*	1.35 (large) *8, 22*	1.28 (large) *8, 22*
University housing with international focus	-	-	-	1.43 (large) *7, 22*	.59 (medium) *7, 22*	.04 (no effect) *7, 22*	1.02 (large) *17, 22*	1.08 (large) *17, 22*	.82 (large) *17, 22*
Engineering focused service learning program (e.g. Engineers Without Borders)	-	-	-	.14 (no effect) *2, 22*	-.37 (small) *2, 22*	.62 (medium) *2, 22*	1.01 (large) *6, 22*	.70 (medium) *6, 22*	1.12 (large) *6, 22*
Study Abroad	-	-	-	1.60 (large) *14, 22*	.60 (medium) *14, 22*	.88 (large) *14, 22*	1.24 (large) *27, 22*	1.00 (large) *27, 22*	1.02 (large) *27, 22*
Engineering course with a global focus (e.g. J-term international travel course, summer courses through Chinese Language Flagship Program)	-	-	-	.68 (medium) *6, 22*	.53 (medium) *6, 22*	.16 (no effect /small) *6, 22*	1.45 (large) *18, 22*	1.20 (large) *18, 22*	1.00 (large) *18, 22*
Non-engineering course with a global focus	-	-	-	.27 (small) *5, 22*	.37 (small) *5, 22*	.42 (medium) *5, 22*	1.21 (large) *23, 22*	1.09 (large) *23, 22*	.98 (large) *23, 22*
U.S. engineering course with an international project	-	-	-	- *1, 22*	- *1, 22*	- *1, 22*	1.24 (large) *4, 22*	.75 (medium) *4, 22*	.71 (medium) *4, 22*
Other	-	-	-	- *1, 22*	- *1, 22*	- *1, 22*	.95 (large) *5, 22*	.75 (medium) *5, 22*	1.09 (large) *5, 22*
Internship/co-op/technical research project conducted internationally	-	-	-	1.29 (large) *11, 22*	.74 (medium) *11, 22*	.86 (large) *11, 22*	1.36 (large) *22, 22*	.93 (large) *22, 22*	.88 (large) *22, 22*
Dual degree program with an international university (e.g. Direct Exchange)	-	-	-	1.19 (large) *3, 22*	.64 (medium) *3, 22*	.45 (medium) *3, 22*	1.78 (large) *7, 22*	1.45 (large) *7, 22*	1.43 (large) *7, 22*
International Engineering Program (IEP)	-	-	-	1.02 (large) *36, 22*	.85 (large) *36, 22*	.59 (medium) *36, 22*	1.12 (large) *42, 22*	.91 (large) *42, 22*	.87 (large) *42, 22*

The analysis of data and individual report, summarized by the PI institutions through the chart above, reveals that University of Rhode Island has some of the highest Global Perspective Inventory (GPI) scores across all 11 schools for senior students who only had international experiences during college and for seniors who have had experience both before and during college. For seniors who only had international experiences in college, they rank 1st in the cognitive domain, 3rd in the intrapersonal domain, and 3rd in the interpersonal domain. Moreover, URI seniors who have had international experiences before and during college, they rank 3rd in the cognitive domain, 2nd in the intrapersonal domain, and 2nd in the interpersonal domain.

When comparing the GPI scores at URI who have never had an international experience to those students who only had experiences in college, we can see that there is a large effect of the international experiences that students are having during their college years. Across all three GPI dimensions, the effect sizes (measured by Cohen's D) are all large (above 0.80) and are consistently higher than the other schools in the study. The effect sizes for the XX students in this category are also the most consistent across all GPI dimensions. In other words, while some schools might have had larger effect sizes in certain GPI dimensions, URI is the only school in the sample that have statistically large effect sizes across *all* dimensions of the GPI when comparing seniors with no experience to seniors with experience before and during college. This results seems to speak to the efficacy of the international programs and opportunities that URI offers its engineering student population. Further work will be done soon to examine the effect of the different types of experiences offered at URI as it relates to students' global perspectives.

Can we indeed conclude from these results that the efficacy of the international programs and opportunities that University of Rhode Island offers its engineering student population is very high? The authors of the NSF cross-institutional study found that there are a myriad of factors (both programmatic and demographic) that could lead to high global perspectives. The group's qualitative findings showed that high scorers exhibited the ability to work through social risk taking situations constructively, had increased independence as a result of the experience, and engaged in cross-cultural teamwork. Long-term study abroad and language preparation also contributed to higher GPI scores. Furthermore, the highest scoring students were drawn to programs that had a good reputation. The section below outlines that URI's International Engineering Program promotes exactly these aspects.

What sort of programming in particular might have led to the strong scores? How might the different types of experiences offered at University of Rhode Island relate to students' global perspectives? While further deep analysis of the collected data still has to been done, it is reasonable to assume that it was the curricular design of the program the majority of the seniors surveyed from University of Rhode Island were enrolled in - its five-year dual Bachelor International Engineering Program – mattered in terms of its impact on student performance in the GPI.

The International Engineering Program at URI was conceived in 1987. The program was originally designed as a dual degree program for German and Engineering majors; students received bachelor's degrees in the language as well as in their engineering discipline. Key components of the program from the beginning were specialized language courses[4],[5],[6] that included instruction in technical German and a six-month professional internship with an engineering company in one of the German-speaking countries. In 1995 an optional semester of study at our partner university in Germany, the Technische Universität Braunschweig (TUBS) was added; a second partner, the

Technische Universität Darmstadt (TUD), came on board in 2016. The German undergraduate exchange was eventually expanded to include graduate programs in which students simultaneously earn advanced degrees in engineering from URI and TUBS at either the master's or the doctoral level[7]. Inspired by the immediate success of the German program, the university added similar dual degree programs in Engineering with Spanish, French, Chinese, and most recently Italian, which also proved successful[8]. A Japanese track is currently in preparation. 27% of engineering undergraduates at URI pursue the IEP.

In addition to the year-long senior year abroad URI has been championing short-term educational experiences for the January term. Aside from the annual J-terms to Germany which are sponsored by the German Academic Exchange Service (DAAD) and the Max Kade Foundation, the IEP was also able to offer a J-term to Chile after securing a grant from Obama's 100,000 Strong in the Americas Initiative through the Partnership in the Americas Foundation, and a J-term to France. A short-term summer program to Colombia funded by a second 100,000 Strong grant will be conducted in 2017. Integrating a short- with a long-term portfolio is especially effective in study abroad design and programming[9].

The fact that the majority of senior students surveyed from URI not only double majored in the language of the country in which they studied abroad, but also used that language in an applied way during the internship part in their various engineering disciplines; that they, secondly, combined a semester of study abroad during which they enrolled in language, culture and engineering courses at the IEP's partner institutions with a semester of work abroad, often prepared through research projects at university institutes; and that they, thirdly, were guided by University of Rhode Island faculty/IEP directors through the spring/summer "internship course" which allowed them to critically reflect on the experience while they were in it by writing reports, producing videos or engaging in interactive peer-to-peer assignments in the target language -- all of these components of curricular design and faculty intervention during the students' year abroad make out the background and most likely key to the success behind the seniors' high intercultural gains and later on also career success[10].

An additional key element that may have played a role in the students' high GPI scores is the sequence of a voluntary faculty-led short-term trip abroad prefacing their year-long independent sojourn. The short-term tour plays a significant role in engineering student retention[11].

Part II - Curriculum Design and Development of Intercultural Competence in a Short-Term Language and Culture Course with Study Abroad Component in Germany

IDI assessment results of *Germany Today: Science-Technology & Culture* with integrated on-campus preparatory module and short-term January study tour reveal further encouraging trends: it yielded gains in intercultural development orientation. The curriculum design involved several interventions[12] before and during course – the preparatory three-day course in which students were instructed in the target language despite the various language levels; they had a chance to go on the subsequent tour to Germany in a virtual way before going in person and thus could familiarize themselves with what to expect and get excited about their personal passions (e.g. going to the Porsche plant in Leipzig, the Maxi Gorki theater in Berlin, the universities in Braunschweig or Darmstadt where they would study abroad in their senior year etc.). And lastly, they could also bond ahead of time with the faculty leading the tour and fellow students strengthening their advising and peer-to-peer relationships. While the curriculum design described below may not serve as a fool proof of why the outcome of the IDI assessment was particularly positive, it can,

however, provide a good template for an "invention strategy" in the sense of Paige and Vande Berg (see IDI part below), that is for a successful structured engagement with the new culture before, during and after the trip.

The 2017 j-term course *Germany Today: Science, Technology & Culture*[13] at the University of Rhode Island took place from January 3-20. Before the group traveled to Germany, all twenty participating undergraduate students had to complete a mandatory three-day preparation course on campus. The group consisted of 20 undergraduates of all class years with about one third of freshmen and sophomores, and another third of juniors who will go on their year of studying and interning abroad this coming Fall. Furthermore, two graduate students who had already spent their senior year abroad in Germany, completed the dual Bachelor degree in an engineering discipline and German, and are now enrolled in the dual master program between URI and TUBS, were chosen to accompany the group as chaperones. The vast majority of the group had never traveled to Germany or overseas before and had never been directly exposed to the target language and the German culture in the country itself. Only three students had been to Germany.

The three-day preparation course was considered crucial for a number of reasons: Since the participants came from various engineering/business disciplines at URI and are from different class years, they hardly knew each other or not at all. The preparation course was designed to help them get to know each other and bond before departure, prepare "their" trip in a cooperative way by exploring the destinations virtually and through research and content-based learning, find out about each other's motivation and objectives and practice their common second language together. An additional goal was to raise their intercultural awareness and competence and to critically examine any biases they might harbor. In preparation for the trip, a website including a blog was designed which students were asked to fill with content of their own before, during and after the trip. The course syllabus informed students that they had to complete three main assignments consisting of five specific parts:

Each student had to write two individual personal blog posts, one before the trip with their personal profile and a short introduction, and, the second as a short final conclusion statement about their findings at the end of the travel tour. The goal for these two postings was that they should be informative and suitable for sharing with other students who have never been to Germany and/or are planning to visit Germany in the near future, in other words they serve as a resource and at the same time as marketing tool for the next generations to come. The second assignment was to complete a video in Germany as a team working on a topic related to the places we were visiting. Students had to sign up for a topic that interests them most. For each team a "team leader" was appointed – a more advanced German student. All students were provided with information sheets, useful web links and other materials before and during the preparation course and with resources and guidelines on how to approach making the video for their particular topic. They were advised to collect data, information and material and take them to Germany on their laptops or tablets. Including interviews with people in Germany was one of the prerequisites for completing the videos which were uploaded on the website after the trip. The third assignment consisted of two topic-related blog posts written together with a partner that included a minimum of three daily observations on one of our travel days. These (subjective and personal) observations were supposed to address cultural differences and practices and observations that surprised the students about life in Germany. They could be in the area of food, public transportation, social interactions, language (dialects), customs, daily life, public places etc. This entry was supposed to be creative

and fun, but on the other hand also reflect common stereotypes – introduced beforehand in class – in a critical way, as well as pique the other students' curiosity. The second blog entry had to be written together with a partner about a company or institution we visited and should focus on any cultural differences and observations students found interesting in the German working environment: dress code, personal interaction, work place layout/culture, staff/employees, company culture, etc. Students informed themselves already during the preparatory course and gave a short presentation about their chosen company or institution.

In addition to the comprehensive project-based pre-departure research, data collection and presentation geared at familiarizing the group with the different destinations and places they were going to visit, a number of task-oriented learning activities were also incorporated into the three-day preparation course. First of all, students were encouraged to discuss about intercultural commonalities and differences they might expect, what they consider to be typical American or typical German, how they think Germans might perceive Americans etc. Then, students were divided into task forces each of them exploring different topics and questions such as the immigration procedure, going shopping, asking for and finding one's way, using public transportation and buying a ticket, their own time management when traveling to the different places and arriving there on time, food and drink, historical sites related to German history and culture, art, museums to visit, theater and literature, different dialects spoken in the regions we were visiting, and also handling difficult situations that could occur, and how that all compares to what they know from their own culture.

Very specifically, different encounters and possible scenarios were role played. For example, students had to find out what store is behind which logo and then talk to the sales assistant, ask to buy something, find out about the price and pay with (real) Euro currency (vs. using their US credit card). For a visit in a typical German restaurant in one of the oldest historical districts of Berlin, students had to find out about the history part first and then study the menu in their group discussing what the different types of food and drinks are and then role play their orders and related questions they might have to the service personnel. Another example that addressed students' insecure before departure was traveling alone (or in a small group) on public transport. After researching where and how to buy an individual ticket and with the help of a suitable (offline) app on their cell phone they figured out which way to travel. Asking for and finding the right way students practiced with the real places we were going to visit, and they could also find alternative routes they personally preferred. In preparation of the theater visit, students studied text excerpts from the novel presented on stage, about the German writer and the theater history.

For all these activities students were given key phrases and by intensively practicing the language along with acquiring more knowledge about the intercultural aspects of the trip they gained more self-confidence and were highly motivated and ready for departure. The intensive preparation before and accompanying reflective activities during the trip yielded encouraging results.

We used the Intercultural Development Inventory (IDI) (Hammer, Bennett, and Wiseman)[14] to evaluate changes in students' orientation toward interacting with people from different cultures. The IDI is a cross-nationally validated instrument that indicates respondents' predominant orientation when interacting with people from different cultures on the Intercultural Development Continuum (IDC)[15]. The continuum distinguished 5 predominant orientations: denial, polarization,

minimization, cultural acceptance, and cultural adaptation. Overall results for respondents' Developmental Orientation (DO) are measured on a 90-point scale with a standard deviation of 15 and a midpoint of 100. The primary purpose of this project was to access the value and feasibility of using the IDI to assess student learning on various international education programs, particularly short-term study tours. Out of the 20 students that participated in the short-term study tour in Germany, 13 (65% of participants) completed the IDI before and after their return. This sample of students is not large enough to make any meaningful generalizations or to describe the overall experience of students on the program. Instead, the results allow us to explore some interesting problems from the literature and pose questions for more rigorous study.

Paige and Vande Berg[16] report in their meta-analysis of studies using the IDI to examine the effects of study abroad on intercultural development that in programs without evidence-based intervention strategies, average gains fell within the standard error of measurement (SEM) for the DO, which is 3.66[17]. For example, Paige and Vande Berg describe results from the Georgetown Consortium Study from 2004-2007 which found that the mean IDI gain for students in 60 programs without intervention strategies was 1.32 points. Their research also found that the shorter the duration the smaller the gain with students in programs that were 13-18 weeks showing an average gain of 3.4 points.

In this context, the average gain on developmental orientation (DO) for students in the Germany J-Term Program (0.91 points) is consistent with the overall research. The more interesting results come from disaggregating the results. Of the 13 students, five made statistically significant (greater than the SEM) gains in their DO, while another five decreased significantly relative to the SEM. One student gained 18 points on their DO, while another student declined by 12 points. As an example, the IDI results indicate that the student who gained 18 points moved from a predominant orientation of polarization to one of minimization on the Intercultural Development Continuum (IDC). For those five that increased, the average gain in DO was 9.7 points compared to -7.7 points for those that declined.

This wide distribution of results actually indicates that for 10 of the 13 students, the study tour with in-built intervention strategies which prepared the students linguistically and culturally before leaving, actively engaged them with the language and culture during the tour, and offered tools to reflect upon the experience after the tour, likely played a significant role in changing how they thought about and oriented themselves to cultural difference. Declines should not be interpreted as incorrect or failed learning, but are more likely indicative of students getting more realistic experiences of cultural difference that have caused them to rethink their ideas. The sub-scales of the instrument provide good indications on how students who experienced a significant change in their DO were affected by the study tour. There are eight 5-point subscales including defensive, reversal, cultural acceptance and cultural adaptation. Defensive and reversal describe two kinds of polarization – seeing cultures in terms of us and them.

Table 2: Mean Change in IDI Results by Students Who Declined and Increased

Indicator	All	DO Decline	DO Increase
Number of Students	13	5	5
Mean Initial Developmental Orientation (DO)	79.11	78.69	82.78
Mean Change in Developmental Orientation (DO)	0.91	-7.74	9.73
Mean Change in Denial Subscale	0.15	-0.09	0.37
Mean Change in Defensive Subscale	-0.10	-0.50	0.27
Mean Change in Reversal Subscale	-0.04	-0.31	0.38
Mean Change in Minimization Subscale	0.05	0.00	-0.04
Mean Change in Acceptance Subscale	-0.12	-0.64	0.28
Mean Change in Adaptation Subscale	0.27	0.29	0.24

Students who declined became more polarized in their view of cultural difference, particularly increasing the defensive form associated with ethnocentrism. Not surprisingly, these students saw large decline on the cultural acceptance scale which measures understanding of cultural difference. In contrast, students who made significant increases in their intercultural DO reduced their polarized feelings about cultural differences and increased their cultural acceptance as measured by the respective scales. This suggests that investigating what activities can help address polarizing experiences on short-term study tours is an important avenue for future research. The five students that had significant declines in their DO after returning had an average initial DO of 78.7 compared to 82.8 for students that saw significant increases in their DO. The students who had no significant change in their DO after the study tour, had an average initial DO of 73.7. This suggests that increasing interventions focused on increasing students DO prior to departure might increase their likelihood of significant personal growth and intercultural development.

The adaptation scale of the IDI measures one's recognition about the need to change one's thinking and behavior to interact effectively with people in different cultural contexts. Ten of the 13 students reported gains on this scale and the gains were independent of their change in overall DO. The average gain on the adaptation subscale was 0.27 for all students with four students gaining more than 0.50 on this subscale. This raises an interesting question to explore in future research. Did the study tour give students meaningful opportunities to become more familiar with the subtle cultural differences in thinking and behaving that are best learned through direct experience? How did short-term faculty-led international experiences in college weigh in the overall GPI results of the senior sample of the NSF assessment?

One general takeaway from the NSF reports is that not all global programming is created equal. This finding is seconded by the comparison between long- and short term URI programs and the

students' performance on instruments measuring their global perspective development. Further investigation into the relative impact of international experiences is definitely needed to better understand why specific programs are effective and how.

WORK CITED

[1] Instrument website: http://www.gpi.hs.iastate.edu/. The Global Perspective Inventory (GPI) is a web-based assessment of individual experiences and development of a global perspective. The emphasis placed on cognitive, intrapersonal, and interpersonal dimensions provides a holistic approach to assessing learning and development. The three dimensions each as two subscales.

[2] Data and analysis of the URI report results provided by Scott Streiner, University of Pittsburgh. To see more detailed results please refer to Benson, L., Besterfield-Sacre, M., Matherly, C., Shuman, L., Ragusa, G., Streiner, S., "Assessing the Spectrum of International Undergraduate Engineering Educational Experiences: A Cross Institutional Survey" Conference Proceedings of the ASEE Annual Conference, June 25-28, 2017, Columbus, OH; ID #20308.

[3] Besterfield Sacre, M., Matherly C., Ragusa, G., Benson, L., University of Rhode Island Report: Cross-Institutional Study on Assessing the Spectrum of International Undergraduate Engineering Educational Experiences, print provided July 22, 2016. Results of the Cross-institutional Study presented at a workshop on May 23rd, 2017 at Lehigh University: *"The work consists of three studies. The first study was an extensive Delphi survey with subject matter experts. The second study consisted of a quantitative and qualitative analysis of students at our four institutions. From Study Two, the team improved and finalized the student background instrument. The research team used this instrument in conjunction with the Global Perspective Inventory (GPI) to launch Study Three with the purpose of further testing and exploring the hypotheses and findings from the second study. For Study Three, implemented in spring 2016 and the focus of this report, we invited a larger representative sample of engineering schools to participate in an in-depth study to analyze engineering students' global preparedness as the result of their academic and non-academic international experiences*" (Report, p. 2).

[4] For information on German for special purposes courses see Grandin, J.M. and Kirchner, D., "German and Engineering – ein interdisziplinäres Programm an der University of Rhode Island, in *Wirtschaftsdeutsch International: Zeitschrift für sprachliche und interkulturelle Wirtschaftskommunikation*, WDi 1/1999, pp. 109-119.

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[8] Berka, S., Groll, E. (2011-13): "Bridging the Languages with Engineering - In Honor of John Grandin," *Online Journal for Global Engineering Education*: Vol. 6: Iss. 1.

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