



## **An Evaluation of the Mexican culture on students hands on research experiences**

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# An Evaluation of the Mexican Culture on Students Research Experiences

## Abstract

The performance of a student undergoing research or pursuing education in a culture different from his/her home country will not be same as that of the students working in their home country. This transcript describes how an NSF funded international research experiences in Mexico impacted the Industrial Engineering (IE) students who participated in this project. The students worked with companies that had operations in Queretaro, Mexico, over the summer, including several multi-national firms. The students were required to take Spanish, a research methods course at Monterrey Tech, Queretaro, and perform research as part of their program. The impacts of learning, communicating and presenting final results in Spanish are evaluated. This research describes the results two cohorts of students and their experiences over the last couple of years.

## Keywords:

Research experiences, Mexican culture, Industrial Engineering students, impacts

## 1. Introduction

The global economy demands that engineers be able to successfully negotiate and understand different cultures. The culture to which we have been exposing students, the Hispanic/Latino culture, is aimed to maintain its importance with regard to U.S. interests throughout the 21<sup>st</sup> century. As mentioned by Thomas Friedman in *The World is Flat*, international understanding is pivotal to the nation's development and future expansion of the U.S. economy<sup>1</sup>. Sixty-three percent of the 150 executives polled chose Spanish as the most valuable second language<sup>2</sup>. According to the *Chronicle of Higher Education*, Hispanics currently comprise 13.7 percent of the nation's total population, and this segment of the population is growing at unprecedented rates. If current trends continue, by 2020 Hispanics will account for 17 percent of the U.S. population<sup>3</sup>.

Consequently, a significant segment of the American workforce either speaks Spanish as a first language or will speak Spanish as a first language. Management practices suitable for the current American workforce are not necessarily suitable for a Hispanic workforce – not only because of the language barrier, but also because of cultural differences in environments where managers have been slow to update their management styles<sup>4</sup>.

Unfortunately, the problem is exacerbated by the claim that the federal government is not doing enough to address the nation's "globalization Achilles' heel" that is Americans' lack of foreign language skills and global awareness<sup>5</sup>. The IRES project in Mexico is designed to counter that claim. This IRES is built upon the relationship and logistics developed by Dr. Erick Jones from his current international research grant in Mexico. The lessons learned in that project provide the groundwork necessary to facilitate this type of undergraduate research in another country.

Tecnológico de Monterrey is an excellent university for the type of collaboration proposed in this program given its prominence as a producer of engineers in its country, its interest in conducting research related to inventory control in logistics and transportation using RFID technologies, and the UT Arlington COE and the PI's relationship with international researchers.

## **2. Background**

The World Economic Forum report on “The Outlook on World Global Logistics and Supply Chain Industry 2012” describes the shortage of key knowledge workers that will need to address global logistics problems such as de-carbonizing the supply chain, improving the efficiency of port operations, and the shortage of qualified supply chain logistics management and logisticians with key understanding of modern technologies. The impact of this lack of understanding is having a global impact on exports costing most countries 30% increased costs and reduced the opportunity for countries to export more goods.

The connection to this reduced production and the loss of manufacturing opportunity is described as an opportunity for improvement. The driving factor for understanding global impacts of logistics and when organizational supply chain network systems is that they are not globally competitive due to focusing only on domestic supply chains. Not only do sub-optimal overall system performance result but missed opportunities for governments to improve the GDP with more manufacturing and exporting activities.

Research that leads to better decisions through the use of technologies that provide real-time data become more effective, profitable, and provide important value. Real-time data visibility allows efficient coordination of operations supply chain and logistics systems through technologies like radio frequency identification (RFID) tracking and improve overall system effectiveness. With accurate data, supply chain analysis become even more effective and profitable.

Examples of such initiatives that have been investigated by Dr. Erick Jones through funding from NASA EPSCOR, Department of Transportation, and Nebraska Department of Economic development, along with numerous industry projects as an NSF Industry University site director include (but are not limited to):

- Engineering manufacturing techniques that may lower the overall cost of implementing active RFID tags in the supply chain
- New methods for applying and utilizing automatic identification systems in materials handling systems within the supply chain
- Engineering economic models for substantiating the historical academic supply chain optimization techniques for locating facilities, warehouses, manufacturing plants, and retail outlets that minimize cost or maximize profit
- Use of emerging information technologies to facilitate sharing critical information among supply chain partners
- Methods for modeling the overall economics of internal and external supply chain and logistics systems by characterizing the impacts of organizational strategic decisions on overall system performance

Dr. Jones currently supports 6 undergraduates who have been engaged in the previous international projects and in his research labs. The host institutions of University of Texas at Arlington (UTA) and the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) have excellently facilitated and managed the **6 previous projects with 5 corporations** in Querétaro (QRO), Mexico, and have a framework to continue student research that will ensure the success of this IRES program. This framework includes lab access, classroom facilities, and procurement of field and lab equipment. Over the past two years, the researchers have solved the challenges of transporting the research equipment internationally.

### 2.1. *Related researches*

Dr. Jones has experience administering several prior NSF-funded projects with undergraduate research components. Prior to joining the UTA faculty, he managed an REU supplement awards at UNL that supported 2 female undergraduates to perform research in RFID and logistics. They presented posters at Industry-University Centers Conferences. He has also administered an RET supplement that supported 1 female mathematics teacher in Nebraska. Also while at UNL, he acquired IRES Award No. #1128150 (2011-13), “International: IRES in Mexico RFID in Logistics”, which he continues to administer now at UTA. This project has funded 2 cohorts of 6 students each to date (10 undergraduates, 2 undergraduates) to conduct research on RFID applications. Of these, 50% of undergraduates were from underrepresented groups (1 African American male, 1 African American female, 1 Caucasian female, 1 Hispanic Female and 1 Hispanic male). There have been a total of 5 engineering research reports developed for partnering companies and 1 conference proceeding thus far.

This project is on-going. In addition to broadening minority participation in STEM research and the aforementioned publications and presentations, the results of the international awards include development of foundational relationships, investigation of international integration of research topics, and coordination of activities to allow the development of additional proposals. Further results allowed for the developing the research resources and support mechanisms that allow for successful international research for the IRES team, and extends to the REU project team.

### 3. **Research objectives**

The IRES program strived to achieve the following **objectives**:

- **Objective 1:** Increase the awareness and improve student research capabilities in various applications of RFID technologies and/or engineering logistics
- **Objective 2:** Increase understanding of the cultural impacts of language barriers for international collaborations
- **Objective 3:** Demonstrate successful dissemination of STEM research to the K-12 audience; and
- **Objective 4:** Improve student (K-12 and undergraduate, US and international) exposure to and interest in pursuing graduate degrees in STEM fields.

In program year 2012, we proposed an 8 week summer research program that was grounded by an intensive 6 week international experience comprised of a series of research and development

activities for the undergraduate students. A combination of orientation, research training, graduate school development, cultural and language training and social activities had been planned to engage students in the context of an international research experience, thereby preparing them for a future in global cooperation. The final two weeks of the program included completion of work in a U.S. research lab and preparation for an academic-year activity in which results were disseminated in a K-12 environment.

The **assessment question** for the program that we were interested in is “*How does the International Research Experience for Students in Mexico Program influence the overall student learning experience in preparing future engineers who are culturally prepared to confront global science and engineering challenges?*” In order to answer this question, six sub-questions (Assessment sub-question #A, Assessment sub-question #B, Assessment sub-question #C, Assessment sub-question #D, Assessment sub-question #E, and Assessment sub-question #F) were developed and will guide the data-collection, analysis and reporting. The sub-questions along with assessment methods and brief explanations were shown in the following discussions.

**Assessment sub-question #A:** “*To what extent does being immersed in a different culture influence a student’s ability to conduct culturally competent undergraduate engineering research?*” **Assessment methods for sub-question #A:** (1) pre-survey and post survey of students’ level of intercultural communication, sensitivity and expectations; (2) focus group with students at the end of their summer experience; (3) reflective journals and weekly meetings with faculty. In assessment method #1, to better capture the information, students were given the *Intercultural Development Inventory* developed by Milton Bennett of the Intercultural Communications Institute, and a customized survey designed by the external evaluator. In assessment methods #2 and #3, students provided greater insight into their experience and how they perceived their ability to work effectively in a global society as engineers. In addition, this information provided an opportunity for day-to-day observation and weekly input regarding students’ experience in the program.

**Assessment sub-question #B:** “*To what extent does conducting research in a different culture influence students’ ability to work in teams with others who are culturally different as well as develop lifelong learning and project management skills from a global perspective?*” **Assessment methods for sub-question #B:** (1) on-site observations while students were working with others from Mexico; (2) focus group with students at the end of their summer experience. In assessment method #1, we developed observation criteria to compare student perceptions with actual behaviors regarding research in engineering that also demonstrated sensitivity to a worldview. In assessment methods #2, students provided greater insight into their cultural experience and how they perceived their ability to commit to seeking out information and relationships from other cultures.

**Assessment sub-question #C:** “*To what extent does being immersed in a different culture influence a student’s ability to conduct culturally competent undergraduate engineering research?*” **Assessment methods for sub-question #C:** (1) reflective journals and weekly meetings with faculty mentors. In assessment method #1, the information provided observation research methods regarding teaming and project management skills of students while working in

a different culture. In addition, this question-oriented process helped students self identify the complex realities of learning and appreciating people of different cultures.

**Assessment sub-question #D:** *“To what extent does Spanish language acquisition influence research effectiveness when working with others from a Spanish speaking culture?”* **Assessment**

**methods for sub-question #D:** (1) interviews with faculty who participated in the summer research program; (2) focus group with students at the end of their summer experience. In assessment method #1, the information identified effective teaching pedagogy that might be more conducive to helping students work more effectively in a culturally different environment while conducting engineering research. In assessment methods #2, students provided greater insight into their experiences, how they perceived their ability to work effectively in a global society as engineers, and how acquiring another language influenced their research effectiveness with others from Spanish-speaking countries. In addition, this question-oriented process helped students self identify the complex realities of learning and appreciating people of different cultures.

**Assessment sub-question #E:** *“To what extent does conducting research in a different country influence students’ ability to confront global science and engineering challenges?”* **Assessment**

**methods for sub-question #E:** (1) reflective Journals and weekly meetings with faculty mentors; (2) pre-survey and post survey of students; (3) focus group with students at the end of their summer experience. In assessment method #1, #2, and #3, information gathered from these assessment methods provided greater insight into students’ attitude, behaviors, and expectations regarding their work with others from a different culture. In addition, observations and journal entries provided day-to-day experiences that inform whether or not students “progressed” in their ability to deal with global and engineering challenges.

**Assessment sub-question #F:** *“How to increase student interest in grad school and to increase student abilities with respect to those tools that makes them competitive in a research environment: research acumen, technical communication and responsible research conduct ?”*

**Assessment methods for sub-question #F:** (1) reflective journals and weekly meetings with faculty mentors; (2) pre-survey and post survey of students; (3) focus group with students at the end of their summer experience. In assessment method #1, #2, and #3, students provided greater insight into how this experience has impacted their decision to pursue graduate degrees.

#### **4. Methodology**

The students were divided into two teams; each team had a faculty mentor from ITESM-QRO. One team conducted a research project with Kellogg’s distribution facility in Querétaro and the other team with InterDeli a Mexican owned food production plant. The students worked collaboratively with employees from the companies, their ITESM-QRO mentor and Dr. Jones. Using the research methods and skills learned in the classroom, the students identified parts of the processes that could be improved and then conducted a research study to analyze how RFID could be used to improve the process.

To measure the impact of the program on the questions mentioned previously in section 3, both qualitative and quantitative data were collected. The quantitative data consisted of pre- and post-surveys, with responses on a 7-point Likert-scale, from 1 - ‘strongly disagree’ to 7 - ‘strongly

agree' with a neutral point of 4 - 'neither agree nor disagree'. The survey consisted of 43 items covering five categories: 1) Engineering Skills, 2) Language and Culture Skills, 3) Awareness of Global Issues and Cultural Differences, 4) Future Plans, and 5) Cultural Intelligence. Each of these categories maps to one or more of the assessment questions.

Engineering Skills maps to assessment questions A and B; the questions in this section focus of both the technical and professional skills of an engineer and how these skills are used within a cultural context. The Language and Cultural Skills category maps to assessment question B and D; in this section the questions focus on working and communicating with people from a different culture in the context of engineering. The Awareness of Global Issues and Cultural Differences category maps to assessment question E and the questions focus on students' awareness of global issues in engineering and understanding of the differences between the USA and Mexico in technology, economics and socio-politics. The fourth category, Future Plans, maps to assessment question F and asks the students about their future plans in regards to career. The last category, Cultural Intelligence, is an instrument measures four competencies of cultural intelligence, namely cognitive, meta-cognitive, behavioral and motivational. Each competency included multiple survey items: the cognitive competency was measured with six items, the meta-cognitive with four, the behavioral with five and the motivation with five. This survey was completed by the students on the first day of classes (a few days after arrival in México and after the on-site orientation) and then again on the last day of classes (a few days before departure to the USA).

There are three pieces of qualitative data collected during the summer program; 1) a pre and post short response question, 2) student journals, and 3) end of program semi-structured interviews. The short response question asked students what they expected to gain from the program and then to reflect on if the expectation was met and why or why not. The student journals were initiated by Dr. Jones and were a means for the students to reflect on their experiences daily, while allowing Dr. Jones some insight on how the students were doing. The interviews were conducted on the last day of classes, they were semi-structured and approximately 45 minutes each. The interview questions focused on five areas: 1) Engineering Skills, 2) Language and Culture Skills, 3) Cultural Competency in Research, 4) Future Plans, and 5) Role of Faculty.

For the quantitative data, means were calculated for the pre and post responses and the gain in the means. For the Cultural Intelligence category, means were calculated using all items in each particular competency. Due to the small sample size t-test were not calculated. The student journals were reviewed for themes and to identify topics to probe during the interviews. The interviews were audio recorded and field notes were recorded during the interview. Dr. Adams read the field notes and listened to each interview to identify major themes in each category and to identify themes across participants. Results from this analysis are in the following sections.

#### ***4.1. Facilities and equipment used in research***

Facilities and equipment were available in two locations, at the RAID Labs of UT Arlington (USA) and Tecnológico de Monterrey (Mexico).

#### 4.2.1. U.S. host institution resources (UTA)

UTA has recently established itself as a competitive university in regard to research and future innovation in the state of Texas. The University of Texas at Arlington's College of Engineering (COE) provides one of the most comprehensive engineering programs in North Texas and the nation, with 8 baccalaureate programs, 13 masters and 9 doctorates programs as well. Also is the fourth largest engineering college in Texas, with about 3,900 students.

The Radio Frequency Identification and Automatic Identification Deployment (RAID) Laboratories mission which is, “*Providing integrated solutions in logistics and other data driven environments through automatic data capture, real world prototypes, and analysis*” is led by the PI, Dr. Erick C. Jones who has performed innovative research and received over \$3.5 million dollars in funding from multiple agencies including NASA EPSCOR, Department of Transportation, and numerous industrial companies. This research has led to 1 industry handbook, 2 textbooks on RFID, and over 60 published manuscripts. With respect to undergraduate students, over 10 students have been funded for research projects of whom 6 continued to graduate school and received a masters or better; 4 students published conference and/or peer reviewed papers. Currently, 6 undergraduates work in the RAID labs.

#### 4.2.2. Mexican host institution (ITESM)

Tecnológico de Monterrey was founded in 1943, and is one of the best universities in Mexico. The Tecnológico de Monterrey has more than 126,000 registered students and almost 8,000 faculty members on its 33 Campuses. The Tecnológico de Monterrey has been accredited by the Southern Association of Colleges and Schools (SACS). The mission of Tecnológico de Monterrey is to: form persons with integrity, ethical standards and a humanistic outlook, who are internationally competitive in their professional fields and will, at the same time, be good citizens committed to the economic, political, social, and cultural development of their community and to the sustainable use of natural resources. Given these missions, Tecnológico de Monterrey and its community are committed to contributing to the educational, social, economic, and political improvement of Mexico.

The Querétaro Campus is a medium-size campus with almost 5,000 students. Nearly 55 percent of the student body comes from outside the city. The Queretaro Campus offers 16 undergraduate programs, 14 master's level degrees and one doctoral level degree. The campus has been recognized as the best option to pursue studies in Central Mexico and offers the best university facilities in the region. These include classrooms equipped with multimedia technology, 60 specialized laboratories, a new gymnasium/auditorium, a new residence hall, the largest library in the state of Querétaro, new specialized buildings for the media center and industrial design, and a wireless internet connection for the entire campus. The size and composition of the student body at Campus Queretaro contributes to a warm and supportive study environment that is multicultural as well. In addition, the International Programs Office on Campus offers services specially designed for exchange students. These services include an orientation program before the term starts, immigration services, housing, academic counseling, health insurance, field trips, and special events.

## 5. Results and key findings

Shown in Table 1 below is a summary of the demographic data for this cohort. Note that demographic information is not provided for each individual separately as it might make participants identifiable. To further protect identity, participants are simply referred to as Student 1, Student 2, etc. This is particularly important because this cohort is so small and worked so closely with Dr. Jones. Even though the cohort is small, only containing five students, it is quite a diverse group. One student was excluded from the quantitative data analysis, because they did not complete a pre-survey, so all of the following data is for an N of 4.

The cohort was racially diverse, with one student indicating their race as ‘black or African-American,’ one as ‘white,’ one as ‘Hispanic,’ and one student selected not to respond. In the aspect of ethnicity, the cohort was divided between ‘Hispanic or Latino’ and ‘not Hispanic or Latino’ with two students in each. Likewise the first language of the students was divided between ‘English’ and ‘Spanish’ with two students in each category. The cohort was balanced in gender with two ‘female’ and two ‘male’ students. The academic standing of the students was less diverse, with three students recently completing their sophomore year in college and one student currently in a graduate program. Of these 4 students, all of them are enrolled in the department of Industrial and Manufacturing Engineering at University of Texas, Arlington. What this data does not show is that one of the sophomore level students has already earned a B.S. in another field of engineering.

Table 1: Participant demographic information

Demographic	Count*	Demographic	Count*
Race:		Gender:	
Black/African American	1	Female	2
White	1	Male	2
Hispanic	1	Academic Standing:	
No response	1	Sophomore	3
Ethnicity:		Graduate	1
Hispanic or Latino	2	Program of study:	
Not Hispanic or Latino	2	Industrial Engineering	4
First Language:			
English	2		
Spanish	2		

\* One student has been excluded from the statistics

The student that was excluded from the data did not complete a pre-survey and additionally they are an outlier to the data set. This student had completed their sophomore year in the nursing program at University of Texas, Arlington. The experience of this student is very unique and valuable; their perspective will be discussed in the interview summaries section.

*Quantitative Pre- and Post- Survey*

A. Engineering Research Skills

This section of the survey contained nine items which focused on students’ beliefs in their engineering, research, and professional skills and their perceived ability to exercise these skills in a culturally diverse environment. This cohort saw gains in all measures of their perceived engineering research skills. The greatest gains came in areas where the students started out the weakest. All student responses on the post-test indicated that the students agreed with the statement. The areas of highest outcome are the students believe that *they can conduct engineering research using common engineering tools* and that *they are able to identify problems for further investigation and research*. Even in areas that the students had high pre-test marks, the students still showed gains.

There were two items that showed the greatest gain in the mean. The first is *determining appropriate data collection methods for engineering research*, which showed a gain in the mean of over 2 points. The second is the *understanding of cultural influences on research* which showed a 2.25 point gain in the mean. These results indicated that the practical experience in the field increased students’ confidence in their ability to choose methods for data collection and research.

Table 2: Engineering research skills

“I am able to ...	Pre-survey			Post-survey			Gain in Mean Gain in Mean
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	
8. conduct engineering research using common engineering methods.”	4	5.00	2.16	4	6.75	.500	<b>1.75</b>
9. identify problems for further investigation and research.”	4	5.50	1.73	4	6.75	.500	<b>1.25</b>
10. determine appropriate data collection methods for engineering research.”	4	4.25	1.71	3	6.33	1.15	<b>2.08</b>
11. analyze and interpret data for engineering research.”	4	5.50	.577	4	6.25	.500	<b>0.75</b>
12. orally communicate the results of research projects.”	4	6.00	.816	4	6.50	.577	<b>0.50</b>
13. write a research paper for publication.”	4	4.50	2.08	4	5.75	.500	<b>1.25</b>
14. “I understand the cultural influences on research.”	4	4.25	.957	4	6.50	.577	<b>2.25</b>
15. determine cultural influences that might impact a research project.”	4	4.75	.500	4	6.50	.577	<b>1.75</b>
16. conduct research within an inter-cultural environment.”	4	5.50	.577	4	6.50	.577	<b>1.00</b>

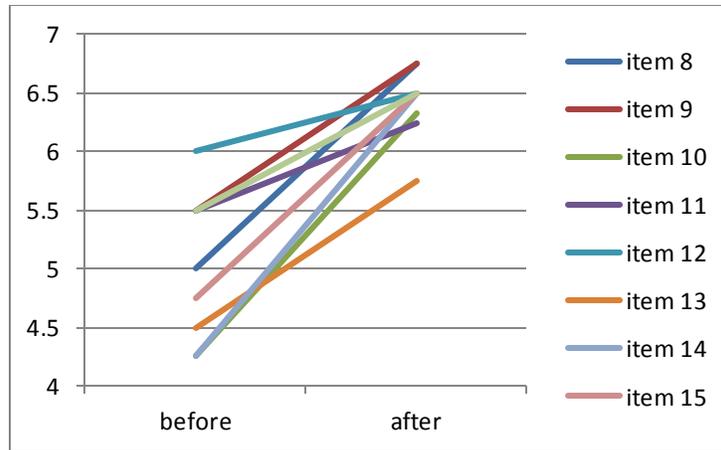


Figure 1: Post program gains for engineering skills (note 4 is the neutral point on the 7-point Likert scale)

## B. Language and Culture

The Language and Culture section of the survey contained five items. The language questions focused on students' confidence in their use of the second language and their ability to communicate with other members of an international research team. The cultural questions asked for students' comfort in working on inter-cultural teams. During the data analysis a concern arose in how the students who indicated Spanish as a first language perceived the questions regarding *confidence with second language*. For this reason on items "I'm confident of my second language skills" and "My current second language skills improve my ability to conduct research on an international team" we will only look at the two students who indicated English as their first language; these two students show a gain in the mean of 3.5 and 2.5, respectively. For the other three items which focus on students comfort and ability to work and communicate on international and culturally diverse team, the students indicated a gain in the mean for each and all post-survey means greater than 6.

Table 3: Language and culture skills

	Pre-survey			Post-survey			Gain in Mean
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	
17. "I am confident in my second language (Spanish or English) skills."	4	4.00	2.94	4	5.75	.957	<b>1.75</b>
18. "I am able to communicate with members of an international research team."	4	5.75	.957	4	6.25	.957	<b>0.50</b>
19. "I am able to conduct research on an international team."	4	5.00	1.41	4	6.25	.500	<b>1.25</b>
20. "My current second language (English or Spanish) skills improve my ability to conduct research on an international team."	4	4.50	2.38	4	6.25	.500	<b>1.75</b>
21. "I am comfortable conducting research with people from a different culture."	4	5.50	.577	4	6.50	.577	<b>1.00</b>

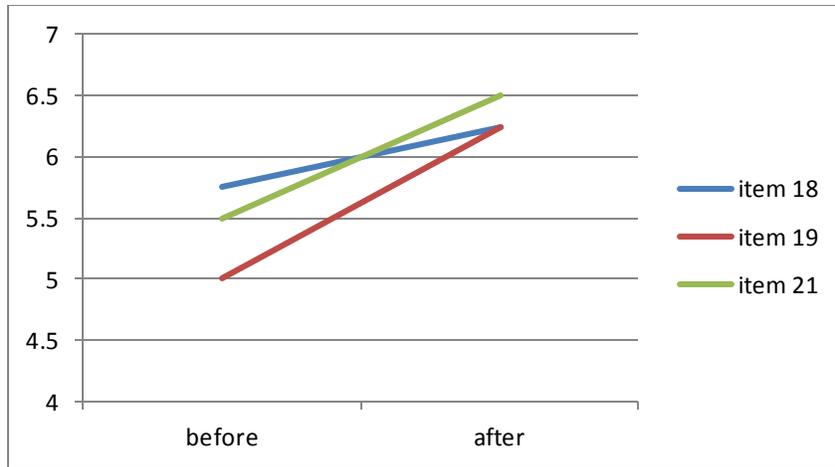


Figure 2: Post program gains for language and culture skills (note 4 is the neutral point on the 7-point Likert scale)

### C. Awareness of Global Issues and Cultural Differences

The global issues and cultural differences portion of the survey contained four questions about the students' perceptions of their awareness of global science and engineering issues and understanding of technology, economic and socio-political issues between the USA and México. For all items in this section students indicated agreement on the post-survey, additionally all items showed a gain in the mean. The largest gain in the mean was in the *understanding of the socio-political differences between the two countries*; it is interesting to note that it was this item that had the lowest mean in this section on the pre-survey.

Table 4: Awareness of Global Issues in Engineering

	Pre-survey			Post-survey			Gain in Mean
	N	Mean	Std. Dev	N	Mean	Std. Dev.	
22. I am aware of the contemporary issues in science and engineering.	4	5.50	.577	4	5.75	.500	<b>0.25</b>
23. I understand the technology differences between the U.S. and Mexico.	4	5.00	1.41	4	6.00	.816	<b>1.00</b>
24. I understand the economic differences between the U.S. and Mexico.	4	5.75	.500	4	6.25	.500	<b>0.50</b>
25. I understand the socio-political differences between the U.S. and Mexico.	4	4.75	2.63	4	6.25	.500	<b>1.50</b>

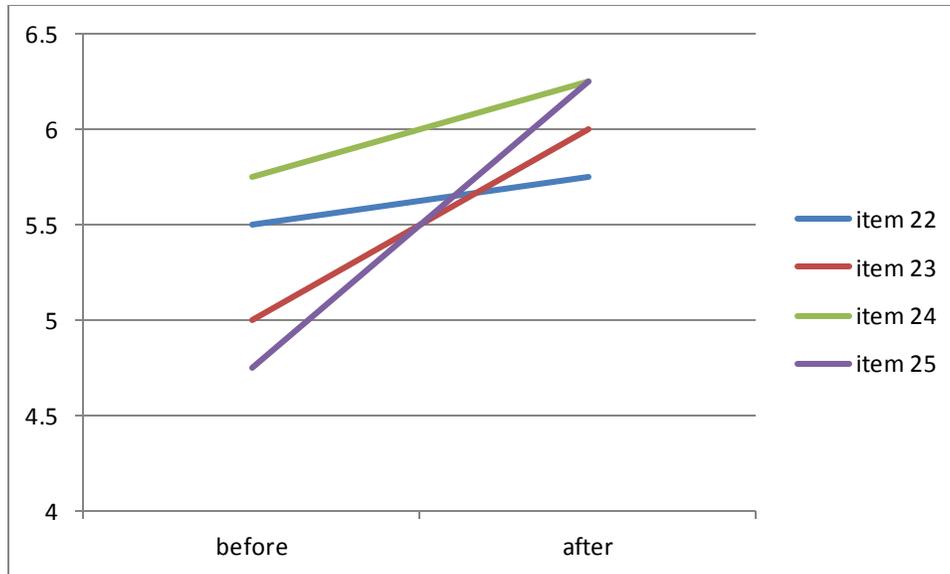


Figure 3: Post program gains for awareness of global issues in engineering (note 4 is the neutral point on the 7-point Likert scale)

### Qualitative Data

#### A. Personal Expectations and Outcomes

As part of the pre and post-survey students were asked to write a short response, in a few sentences, about their expectations of the program, additionally for the post-response to reflect on if the expectations were met and how. The pre-responses were quite short and surface level; in one instance the student did not write in complete sentences. For the post-response the student increased the length and depth of their responses. In the pre-response all students indicated a *desire to gain experience or skills in a “real world” or practical setting.*

For the pre-response, only two students mentioned *global or cultural expectations*, these two students are also the students who indicated English as their first language. One student, perhaps the most reflective of the cohort, touches on parts of their identity; the student mentions *becoming confident* and being able to *integrate their self in the culture* of the Mexican company.

#### B. Research Ability in Cultural Context

One area of focus for the student exit interviews was on their research skills and their abilities to recognize the impacts of culture on research. Students were able to list many engineering tools that they learned through the program; the lists included six-sigma for research, continuous improvement, Pareto analysis, fishbone diagrams, flow charts, Hawthorne effect and many more. When asked about their understanding of these tools, the four engineering students expressed confidence in their understanding and mentioned that their understanding was reinforced through the research papers and the research projects.

The nursing students indicated that she had some understanding of how "...six-sigma can be applied to the healthcare industry" and is confident in her understanding of flow charts and

fishbone analysis. Her understanding is attributed to the use of these tools for the research project. Students were asked about their confidence in using these tools and all stated that they had confidence in their abilities with the tools they used in the projects; additionally the engineering students stated that continued experiences would improve their abilities. The nursing student sees flowcharting as a tool that can be used for her schooling, but is unsure of her ability to use it as a research tool.

When the students were asked about their understanding of the influence culture has on engineering research several themes appeared: schedules, economics, regulations, available resources, and communication styles among others. The students all noted that within the Mexican culture there was a very relaxed perspective on time and schedule and as a result the students had to learn to be flexible, anyways prepared, and patient. The nursing student was able to relate a very specific example of how the culture could impact the decisions one makes about solutions.

As a result of this international research experience the students in general feel prepared to enter cultural research environments in the future. However, the two students with Spanish as a first-language were somewhat less confident in their preparedness to enter a culture that was not Spanish speaking. One theme that appeared across the student interviews is observation; most of the students mentioned the observation skills that they used in their research are also important to understanding a culture.

#### C. Teamwork Skills in Cultural Context

During the interviews the students were asked to reflect on their abilities to work in teams with others who are culturally different as well as their life-long learning and project management skills. The students had many experiences with the Mexican culture and Mexican people, many of these experiences occurred with their host families or within social settings; however the students were able to transfer these experiences to their research and professional work. The experiences included: locals expressing encouragement and patience while the students attempt to communicate in Spanish, discussions with host families about the Mexican presidential election and politics, using public transportation, and conversations about Mexican work-life balance.

#### D. Faculty Strategies in a Cultural Context

The students expressed varied views about the roles of the professors in helping them understand the influence of culture on research. Overall the students saw all of the professors and even Dr. Jones' assistant Diego Brizuela as supporting their experiences, research, and learning.

#### E. Spanish Language Skills

The students expressed different experiences with the Spanish language acquisition. Two participants have Spanish as their first-language and their experiences with language in the program are similar; they both focused on the fine details the language and learning colloquial

use of Spanish in Mexico. They also found that it was beneficial to help the other students to learn Spanish and reinforce their own understanding.

#### F. Confronting Global Science and Engineering Challenges

All of the engineering students were able to identify some areas where their new research skills could be applied to help solve problems of global importance. Two students mentioned that the basic methods (e.g. research and the scientific method) they learned could be applied anywhere. Two students mentioned how engineering is needed to help solve problems of basic human needs such as clean water and sanitation and how technologies can help provide these solutions. The nursing student does not see herself doing engineering type work but is better able to see more applications and possible solutions when engineering tools are used such as RFID.

#### G. Student Interest in and Preparedness for Graduate School

From the surveys it was unclear what paths the students desired after finishing their current degrees. However, in the interviews all of the students had clear ideas and plans of what they will do after graduation. There is one graduate student who is still unsure if they will pursue a PhD after their master's degree, but was able to decide on a specialization of manufacturing for their current degree. The three undergraduate engineers all plan on pursuing a master's degree in industrial engineering. The influence that the program had on their degree plan was in solidifying their choice and building confidence in their preparedness and giving guidance on how to apply to graduate school.

### 6. Conclusion and recommendations

During the exit interviews the students shared some recommendations for improvement of the program. These include:

1. More pre-trip preparation; particularly for non-engineering students. Pre-trip preparation should include clear expectations and roles for non-engineering students.
2. There should be more clarity as to when the students have “free-time” and when the students should participate in program activities.
3. Students would like a more accelerated Spanish course. Some of the students started at a beginners level, however their language skills advanced at a rate higher than average because of the influence of living with a host family. In addition, they indicated the desire to have more “Spanish for industry” training.

In general students greatly enjoyed their experiences. This program proved to positively impact the students in all aspects that were intended. Some changes are recommended for the wording of a few survey items. In addition, it is recommended that the interview protocol be shortened and a few questions re-worded. The survey and interview protocols that were used are attached and the suggested changes are included with the protocols. Lastly, it is suggested that more reflective practices be implemented with the daily journals. Reflective practices would guide students away from simply recollecting their experiences towards making meaning of their experiences. Reflective thinking is often a practice that should be taught, and then given opportunities to practice and then receive feedback.

## 7. Contact information

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