AC 2011-2149: INTERSECTING CULTURAL IMAGES: TRANSFORMATIVE GLOBAL RESEARCH EXPERIENCES FOR UNDERREPRESENTED 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. Born in Taiwan, grew up in Singapore, Chang has traveled to over 30 different countries. Chang has an MS Cross-Cultural Psychology and an Ed. D. degree in Higher Education Leadership and Policy at the Peabody College at Vanderbilt University in 2007.

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E. Daniel Hirleman joined UC Merced as dean of the School of Engineering in 2010. He received the BSME with Highest Distinction, the MSME, and the Ph.D. from Purdue University, following which he joined the Arizona State University faculty in Mech/Aero Engineering. He eventually served in administrative positions culminating in Associate Dean for Research at ASU. In 1999 he returned to Purdue as William E. and Florence E. Perry Head of ME. Hirleman received the Pi Tau Sigma Award for Teaching Excellence and the College of Engineering Award for Significant Accomplishment in Research at ASU. He also received: the International Network for Engineering Education and Research (INEER) Achievement Award in 2006; the Hon. George Brown Award for International Scientific Cooperation from the U.S. Civilian Research & Development Foundation (CRDF) in 2008, and the 2009 Charles Russ Richards Memorial Award from Pi Tau Sigma/ASME. He chaired the International Congress on Optical Particle Sizing, served as Topical Editor for Applied Optics, is a Fellow of ASME, and Chairs the Advisory Board of Engineers for a Sustainable World. His research involves optical sensors for surface characterization, semiconductor manufacturing, particle and flow diagnostics, bio-hazard detection, food safety, as well as global engineering education.

Intersecting Cultural Images: Transformative Global Research Experiences for Female and Ethnic Minority Engineering Students

Abstract

The International Research and Education in Engineering (IREE) program was initiated by the National Science Foundation (ENG/EEC) in 2006 to promote enhancement of global competency of 21st century engineering professionals, development of collaborations with engineering researchers abroad, and providing students with opportunities to experience the life and culture of another country. IREE also seeks to enhance U.S. innovation in both research and education, as well as enable connections between the research programs of NSF's divisions with the education of students. Funded by NSF and administered by Purdue University, the IREE 2010 China program sent 58 U.S. engineering students to China for an intensive 10 to 12 week research experiences in university and industry laboratories. Women and minorities students comprised 51.7 percent of the selected IREE participants. These underrepresented student groups in engineering are widely recognized and researched within the United States. As they participate in their IREE experience, their needs and issues were solicited through one-on-one interviews and focus group discussions. This paper presents select qualitative data and results by delineating the challenges and opportunities faced by female and ethnic-minority engineering students completing research internships in Chinese engineering labs.

Introduction

About IREE

The IREE 2010 China program offered 58 awards to confirmed participants to enable them to conduct engineering research in China. Among the awardees, 27 (or 46%) were women, and 5 (or 9%) were identified as underrepresented minorities. A total of 28 awardees (or 48%) were undergraduate students at the time of application, with the remainder (30, or 52%) being graduate students. Also, 55 grantees (or 95%) were U.S. citizens, 2 (or 3.5%) were U.S. permanent residents, and one (or 1.7%) international student. Awardees represented more than 40 different home universities in the U.S.

The IREE team developed a comprehensive orientation program for all participants, consisting of Mandarin language training, Chinese history and culture, and Engineering Cultures China. A first cohort of 20 awardees participated in a two-week version of the orientation program, held May 10-21, 2010 at Purdue University, and a second group of 19 attended an orientation session in Shanghai, May 17-28, 2010. A third group of 19 awardees completed a 5-week cyber/online orientation from the end of April to end of May. In each orientation group, participants were roughly split between site- and self-placement, and between undergraduates and graduate students. Extensive efforts were made to provide a cyber/online orientation experience that was roughly comparable to the face-to-face orientation.

Beginning in late May or early June, awardees started their research assignments, with a minimum duration of 10 weeks, at more than 20 different institutions across China (universities,

national laboratories, and industry laboratories). The IREE team arranged research placements for 21 participants ("site- placement"), and 37 arranged their own ("self placement"). The most common placement sites were Shanghai Jiao Tong University, Tsinghua University, and Xi'an Jiao Tong University.

In mid-September of the same year, 56 IREE participants who completed their summer experience in China attended a two-day re-entry meeting in Chicago, Illinois. The purpose of this re-entry meeting was to (1) provide opportunities for participants to evaluate and reflect on their IREE experiences, (2) allow professional and social network opportunities among the participants, and (3) assess the challenges and opportunities faced by the program participants. At the IREE re-entry meeting, individual hour-long interviews and two-hour thematic focus groups were conducted with 56 participants.

For the scope of this paper, we present and discuss select focus group and interview data related to three different themes: (1) gender differences, (2) second generation Chinese immigrants, and (3) African and Hispanic Americans. Preliminary data analysis reveals some of the unique issues faced by each student population, as well as some of the cultural images encountered inside and outside of various cultural boundaries.

Underrepresented Populations in Engineering Education

America is becoming an increasingly diverse nation. Many minority groups and women have been underrepresented in the engineering education path and workforce. It is projected that more engineering challenges will affect this broader population, and thus these individuals are needed within engineering.[1] The demand today for employees who speak foreign languages and are internationally savvy is also greater than ever. However, relatively few minorities enroll in college international programs, and few choose careers that involve global work.[2]

There is large and growing literature examining women's and minorities experience with the engineering education process. Beddoes, Borrego, and Jesiek[3] performed a literature review of gender in engineering education research papers and found the most often researched topic focuses on recruitment and retention of female engineers. Perrucii pointed out the career paths of women in engineering tends to be heavily influenced by life events, such as marriage and child-bearing.[4] Huang et al.'s National Center for Education Statistics report[5] supports an overall notion that much of the racial/ethnic and gender differences in the entry to science and engineering programs in postsecondary education can be explained by examining family environment, family support, student behavior, and school factors across race/ethnicity and gender.

Much of this literature focuses on underrepresentation in engineering and how it impacts the profession, yet very little research has more specifically focused on how these themes *global* engineering. Chichester and Akomolafe state that the underrepresentation of minorities in the nation's foreign policy circles deprives the country of a range of perspectives, input and human resources to draw upon in meeting today's international challenges.[6]

Women and ethnic minority students clearly face unique challenges in engineering education. Within the context of global engineering programs, the results of this paper show that they also face challenges when participating in learning experiences abroad. In many cases, underrepresented students feel that stereotypes and above-mentioned issues are amplified by cross-cultural differences. On the other hand, encountering various cultural norms and challenges can also provide students with opportunities for self-discovery and identification.

Methods

The methods used in this paper align with qualitative methodology that is often employed in social sciences and behavioral studies. Data gathered are from transcripts from interviews and focus groups conducted with the IREE 2010 participants. These one-on-one interviews and focus groups of female and ethnic-minority students were conducted after their IREE experience. All interactions were recorded, transcribed and analyzed to seek out commonalities in responses. The commonalities were then compared to the general data set to determine themes that categorizes students' experiences. Excerpts and quotes from transcripts are presented in this paper to illustrate findings about the abovementioned student populations. All appropriate human subjects procedures were approved and followed under Purdue IRB protocol #1004009220.

In comparison with the larger numbers of women and Asian American participants, we acknowledge that the results and observation from this program represents a small sample of the African and Hispanic student body ($n < 10$). Other extraneous variables may also influence participant responses, including differences in maturity levels and personalities. Nevertheless, these research results, aligned with the literature, provide interesting insights that prompt further research and programmatic evaluations for global engineering education. The preliminary results presented here should be viewed as pilot studies that can help fuel a larger discussion about – and research on –best practices in global engineering programs.

Non-U.S. Citizens/ Residents

One other group of students that was not included in this paper's discussion is international students. While many engineering schools focus on study and work abroad opportunities to be the pathway to achieve global competency, many overlook the opportunity to leverage the international students population on home campus. In 2007/08, engineering continued to be one of the most popular fields of study for international students, chosen by approximately 96,000 (17%) of all the international students in the U.S.[7] In order to increase the number of U.S domestic students gaining global experience and competency, engineering education leaders must think beyond using traditional study abroad programs as the only pathway to educate engineering graduates.

The large number of international student population in the U.S. must be viewed and leveraged as an asset to facilitate global experience for engineering majors. Yet, many scholarship and assistance programs supported by government agencies prohibit programs from awarding funds to non-U.S. citizens or residents. Future studies of underrepresentation in engineering education should include this student population.

Challenges For Global Experiences

Gender Differences

Most IREE participants found their hosts very hospitable, especially in provisions such as arranging meals, transportation and shelter. Yet many of the students did come across challenges in the laboratory. Feelings of being an outsider often arose as well as complications in the research plan. It was found that the reactions to these events varied between men and women.

Many women interviewed expressed their frustration at laboratory obstacles and their assertiveness in their response while approaching such impediments. While describing the feelings of isolation in the laboratory environment one woman said:

> When I first came in they (lab mates) were all very timid like. At times I was not sure if they were being hostile or timid or reserved, I mean, it gets confusing, so I said … "We are going to be staying for ten weeks together. So I think the best thing is for you to fall in love with me 'cus, I will be your nightmare."

She goes on to explain her action by adding:

> It is up to me to [make] myself happy in no man's land. If I don't, I will be frustrated all the way through, so it was really important that I understand them their way of life, how to relate to them. You know, I guess I did a very good job at that. I showed him (another participant in the focus group) my birthday cake that they got me on my birthday, barely a month that I got to [the University].

A man in the same focus group had a similar experience of isolation from people in his laboratory, but took a less direct approach to befriending other laboratory members:

> I went to the lab the first day, and I think the first three days no one in the lab would talk to me. I was really alone, just said "hello" and they said hello back, and that was it. I think because the first few people [were] kinda reserved and shy and my Chinese wasn't that good, so umm, I started with a few Chinese phrases, but then, I didn't know what to say next. Ah, but after a few days, you know, we went to lunch together or dinner together and people kinda realized a little bit, especially umm, we went hiking for one weekend and so we got to know each other more and then actually at the end, I made good friends with some people from my lab, and now we are still talking.

Another woman explains problems that arose in her research and her reaction to it as follows:

> For the first two weeks and a half, we [a graduate student and her] were working on something… then, we had … [a] general meeting where my assigned graduate student got to present her research. The data that she had collected … [was] not as expected… so [the professor] … switched her project. That means that my project had been switched too, … [the professor] basically wanted me to learn

> c++. … I [was] really frustrated with research, so I [told] them "I cannot do that, … this is not practical, your expectations are very high, your deadlines are just ridiculous."

While explaining her response she stated:

> You need to be a bit aggressive with them, because they are a little bit, they're over shy, … I had to, like, define my project. I had, I had very little time by the end to do it.

One of the main factors of the gender differences in the example above is the personality characteristic of the participants. The women and men express themselves in the way most comfortable. However, a general observation from the focus group is that American women expected their views and opinions to be heard and presumed that their assertiveness is allowed and appreciated.

Another preliminary finding reveals that female IREE students are often questioned and challenged by Chinese social norms such as marriage and child-bearing, while their views on research may not carry equal weight in their host laboratories, especially as compared to their male counterparts. On IREE female participant recalled:

> I guess a few more men than women but all the people I talked to said the same things, that it's really hard for a woman to find a job in China in environmental engineering because they would rather hire a man because the assumption is that the woman's going to start a family anyway and they won't be able to travel as much and they won't be able to do as much manual labor. But I think part of it is almost like a self-fulfilling prophesy, because I also noticed in the lab where I had no problem lifting up water jugs and things like that, all of the women would say, "Oh, why don't you just have a man do it? This is--that's man's work, not women--not for women."

One final and most obvious challenge for female participants is that their physical appearances are drastically different from women in the host culture. This is a challenge to all global programs for potential safety concerns that are not faced by male participants. There are many study abroad pre-departure orientation materials address the issues of women traveling abroad. One must acknowledge that the American's cultural bias portrait female as capable and independent, whereas many other countries often perceive American women to be *loose* or *easy*. This opinion is created/reinforced by American television shows and films.[8] As one IREE female participant reported:

> Actually, as far as like going to bars and clubs, …one of my friends that already… studied abroad in China and she's like, "Oh, as a white girl, the guys will go--the guys will all go crazy for you, so watch out." And so--yeah, with my red hair, it happens.

Second Generation Chinese Immigrants

It is probably easy to assume the Asian American participants with Chinese heritages face less cultural challenges than their non-Asian peers when going to China for research collaboration or study. However, our research found several unique challenges for this specific population. One major challenge came from the "Chinese common knowledge" expectation they received from Chinese people. Another main challenge stems deeply and powerfully from inside themselves: the rediscovery of their self-identity.

In our study, several Asian American participants agree that Chinese people's *expectation* that they are "Chinese" because of their appearance create unexpected cultural challenges or discomforts that the other ethnic groups often do not face. One participant describes one of her uncomfortable experiences:

> I went to Tai Shan (a famous mountain in eastern China). One of the guys there, he decided to give me a tour. He was a middle school dropout, he hasn't got much school, and he was telling me all the Chinese history, and everything that have happen on this mountain. He was asking me if I know this name, this name, and this name, and I don't know anything of it. He thought I was 'completed retarded'. He was like… I look Chinese but I didn't know any of the Chinese history!

Other Asian American students reported similar challenges about the expectations from Chinese people they encountered in daily life. These unmet expectations came from their 'seeming lack of knowledge' in areas ranging from Chinese history, customs, traditions, and festivals to modern Chinese lingo not taught in language textbooks.

Interestingly and perhaps ironically, the experiences of working in China also triggered self-identity disruption and rediscovery among several Asian American students. They found that some Chinese people consider them 'aliens' because of their behaviors, language ability or even styles of dress. One participant described in her own words how this IREE experience challenged her to re-think her own identity:

> In my entire life, I grow up by myself. I grow up in the south (of U.S.). I was the only Chinese person for miles, and you know, people, like every single day, asked me: "Where were you from? Where were you from?" Then I always have to say, I am from China, I am Chinese. So I answered that question for years, and every single time they asked me my origin and I say I am from China, I am Chinese. So the second I got to China, somebody look at me, and asked "where are you from?" It was so heartbreaking. And I couldn't say China, because nobody will believe me! So I didn't know what to say after that. So I also felt like, you know, in the limbo in between the two things. After that, I sort of feel like I was not as Chinese, as I have been telling everyone.

She continues, with obvious emotion:

> I think for me, I finally completely understood Asian American. I guess, I used to tell everyone I am Chinese, and then, while I was in China, I got used to tell everyone that I am American, because after a while, just nobody will believe me. So when I came back

> to the U.S., and I met other Chinese people that have been living in U.S. for a long time, I am like, we are Asian American! *This is exactly who I am*.

The drastic impacts of finally going back to cultural roots for Asian Americans with Chinese heritage were shared by several IREE participants. Another student described her experience this way:

> I remember one day, it was a meeting or something, and people refer to us as the "Three American Kids". I just…I feel a little weird of that, I mean, I was in China and I look Chinese, but people were saying we were American. And sometimes people in my lab would tell me that, every now and then they still think I do act differently from them. I totally agree…I have a lot of friends they are either born here (in U.S.), or they came here when they were little, maybe around two or three, and they wouldn't know whether they should say they are Chinese or American. And I think Asian American probably is the best identity they should adapt to.

Another participant with heritage half Chinese and half Caucasian described how she felt after going to China:

> I am kind of in the place in the middle: because I am not you guys, and I am not them. I am just like falling in the middle, and I connect the culture, because it has been ingrained with me. You can't pull apart what's Chinese and what's American. It is just how you grow up, so a lot of values I understand them. *I am in a strange place, but not a bad one.*

Although conventional knowledge suggests Asian American engineering students would adapt to a Chinese working environment faster than other non-Asians, they also face some very unique, sometimes unexpected challenges that are drastically different from the other ethnic groups. In the Lessons Learned and Best Practice sections below, we present recommendations aimed at helping programs and participants overcome these and other kinds of challenges.

African American and Hispanic American

When compared with Caucasian and Asian American groups, this year's IREE-China program received relatively less applications from African American and Hispanic American students. As a result, the numbers of awardees from these two ethnic groups represented only 9% of the participant population. This may reflect an existing challenge to bring these two ethnic groups to international educational activities based in China or similar Asian countries. Even though we have a small sample size, thus making the results less generalizable, it is important to document the experience of this group and see how their ethnicity affected their international experiences. In fact, there are some findings from the Hispanic and African American students that are unique when compared to other ethnic groups . These findings can help us: 1) explain what factors contribute to these students' decision to study abroad, and 2) develop effective strategies to recruit more African and Hispanic students to future IREE programs.

In contrast to many Asian American and even Caucasian participants, African American IREE participants reported that they received less support from family members due to stereotypes and

a lack of familiarity with China. One African American student described his grandmother's response about him going to China:

> My grandma didn't want me to go … well, my grandmother, she is just kinda old fashion, I think it also goes with a bit of a stigma most people, you know about in the states have about China, especially the older people. A lot of people still think China is a third world country, and there is like ... Umm ... she'd probably prefer me just stay inside the United States, she is kinda old fashion about going anywhere else, anywhere outside the US.

Similarly, another participant with Hispanic heritage also expressed her family's initial negative response of her going to China for research. As she explained:

> [M]y family does travel but basically just between the US and Mexico, different parts of Mexico for vacations and stuff like that, so I'm the only one that has actually traveled outside the US and Mexico and umm, umm, my mom was … she didn't want me to go, but you know, I wanted to go, so she's kinda like supported me (at the end).

These stereotypes and lack of familiarity with the host country obviously pose a significant challenge to recruiting African and Hispanic participants for research or education activities in certain countries and regions abroad, including China. However, the situation is often very different if one of the family members possesses more multi-culture experience and knowledge. Another participant with Hispanic heritage described her own experience:

> My father he works in China for about a quarter of each year and so, he was always pushing me to go to China and then I saw this opportunity so I jumped on it and he actually came to visit me while I was in Xi'an, which was great because he was working at a nearby city and ahh, I know we always talk about how it's difficult to go back home and to try to communicate your experiences and to, to people who really don't understand what the trip was like, but in my case my dad understands; my mother has been to China; my brother has been and so I don't have that problem at all … definitely a ... a big influence.

Such patterns of response may also be linked to socio-economic status in minority families.[9] Close kinship and family structure also plays a factor in African American students studying abroad. One participant described:

> My mother, you know, that close knit family structure, like we did, we didn't do much traveling as my family, 'cus, I think my family, everybody is just kinda homebodies, like my, grandmother, basically, all my fathers brothers, probably, everybody stays at least an eight hours radius of where my grandmother, you know, where they all grew up at and so, nobody goes, nobody really strays too far.

Yet on the flipside of this apparent challenge for minority students lays opportunity. International experiences (working, research or education) can greatly enrich one's knowledge. The benefits can also extend to participants' family members as the participants help eliminate stereotypes and misconception. IREE participants brought their own experiences back to their families and

communities. In the section that follows we discuss opportunities for these underrepresented populations to attain global engineering experiences.

Opportunities For Global Experience

Women

There are many unique benefits associated with women participating in global engineering experiences. For example, the contrast of gender roles between home (America) and host country (China) culture provides insights to the female participants about engineering profession that otherwise would have gone unnoticed by male participants. One common theme that female IREE participants point out is the differences between a "man's job" and a "woman's job."

> We had a mix of – I guess a few more men than women but all the people I talked to said the same things, that it's really hard for a woman to find a job in China in environmental engineering because they would rather hire a man because the assumption is that the woman's going to start a family anyway and they won't be able to travel as much and they won't be able to do as much manual labor. But I think part of it is almost like a self-fulfilling prophesy, because I also noticed in the lab where I had no problem lifting up water jugs and things like that, all of the women would say, "Oh, why don't you just have a man do it? This is – that's man's work, not women – not for women."

The female participants also gained insights about other traditional cultural norms for Chinese women:

> Well, a lot of [Chinese] female students didn't really want to be engineers. Their parents told them to and so they did for undergrad. And then their parents told them to go to grad school. And if they don't find husbands by the time they graduate, they will move back to their parent's house. It's very much a like, "Oh, we are--" because they were like appalled that I was single. "Oh, but you are 24? When will you get married?" Like that was kind of like the--and they're not going to pursue--like they don't--A, they don't have any interest in what they're studying. Like I didn't talk to one out of all of them that was at all interested. And they're not getting PhDs. Their parents won't let them get PhDs even if they wanted to because then they would be too old to get married.

Such observations and comparison between gender norms can help participants reaffirm their career aspirations and professional goals. As one participant explained:

> Even some of the other people that I talked to, they were so amazed at like I had a reason for going into environmental engineering and I chose it because--I told them, you know, "I think water, world water issues, it's a huge problem. It's going to be the next big problem and I want to help solve it and I want to find ways to be able to give people in developing countries access to clean drinking water." And they said, "Wow. We don't know why we're environmental engineering. We don't know why we chose that."

Second Generation Chinese Immigrants

We are also interested in the advantages that come with including second-generation Chinese (Asian American) students in global educational experiences in China. First, they are optimally positioned to serve as bridges between the American and Chinese research communities. Second, they are able to engage their fellow IREE participants in social settings, as well as helping their peers to overcome major language and cultural barriers.

In some laboratory where English is not the most comfortable language, Asian American students found themselves serving a role as the *go-to people for communication*. Such a role helped them develop closer working relationships with their Chinese hosts, and eliminate barriers in research activities for both themselves and their non-Asian peers. Some Asian American students also found it is easier for them to obtain needed instruction or access to equipment because of their strength in Chinese language and understanding of culture.

In an education or research lab where there is no mandatory requirement for communication between members from different cultures, the advantage of being able to speaking the same language can be dramatic. One IREE participant described his communication experiences working in a research lab in China:

> … the people in my lab already have a lot of trouble communicating with me even [though] I already spoke some Chinese. I feel like they will expect a lot of that in terms of communication. I mean, they speak some English, but whenever they could, they will speak Chinese. So I think they really try not to use any English at all. With me, they really want to speak Chinese. So if it has been placed with someone who couldn't speak any (Chinese) at all, they probably wouldn't have expected too much in terms of communication and research.

There are also opportunities for students to benefit from their IREE experience in some personal but very important areas. One of the significant areas they reported personal growth is in their relationship with parents and family. Family members of Asian Americans generally favor students "returning to their cultural roots." This provides stronger motivation for them to participate in international research and education activities in Asia. One IREE participant confirmed her strong personal motivation, and also reported the IREE experience in China helped her create a closer relationship with her family than anything she ever experienced in the States before. She describes it this way:

> When I went to China, and I told my parents, my Dad was really excited because I went through kindergarten, elementary, middle, high school, and college … everything was in U.S. I had to explain everything to my Dad who went to college in China. I spend hours telling him what an AP test is … So there is always a giant gap between what me and my Dad understood as the education system. So when I told them I am going to Tsinghua (University), they were so excited. They were like, the family is coming with you! We all will drop you off [in] Beijing, and go see the rest of family. So they all came, and finally me and my Dad have some sort of connection as what school is like in China, and we can finally talk about it. And it doesn't just bring me closer to my culture, I feel like it bring me closer to my family. I finally have something to relate to… with my Dad!

A consensus shared by the IREE Asian American participants is that their experience in China helped them develop a stronger bond with their first generation immigrant parents, obtained a better understanding of where their family came from, and ultimately provided a fulfilling experience exploring their family roots and cultural heritage.

Lessons Learned from IREE 2010

Our discussion provides a basis to inform program administrators and funding agencies to better relate to the needs of female and ethnic minority student populations in global engineering programs. Moreover, the results of this study will provide insights to federal funding agencies about optimal strategies for determining student eligibilities. The paper concludes with three major best practice recommendations and lessons learned, many of which are relevant for faculty and staff involved with engaging underrepresented engineering students in global educational experiences.

Cross-cultural Training

Cross-cultural training is an increasingly important topic both in the workplace and on the campus alike, and is especially relevant for international education initiatives. The critical components for cross-cultural training include: general and country-specific cultural awareness; areas studies (history, geography, politics, economics); frameworks for understanding and valuing cultural differences; business and social customs in the host country; international transition and stress management; practical approaches to culture shock management and lifestyle adjustment; and repatriation as a pre-departure issue.[10] As noted interculturalist Margaret Pusch[11] explains,

> cross-cultural training is designed to address those issues that arise when people of different cultural origins must work, study, or play together at more than a superficial level". The cross-cultural experience is complex partly because people are generally unaware of their cultural identity and its impact on human relations. However, people do have the capacity to change their "behavior and attitudes and grow in knowledge and skills

Cross-cultural information should be included in the pre-departure, reflection, and re-entry components of study abroad programming. Pusch stresses the importance of design principles to ensure that the cross-cultural training "provides a conceptual framework for understanding differences among culture groups in general and comprehending how those concepts might be used in face-to-face interactions with people from other cultures"[11]. The cross-cultural training design should meet participant and program objectives, utilize adult learning styles in a balanced manner, and "integrate the cognitive, affective, and skill learning" taking place. As such, cross-cultural training, which focuses on the country to be visited as well as the personal learning that occurs when one is outside of his or her own comfort zone, is an important component of study abroad programming that should be included in pre-departure orientation as well as utilized as a reflection tool during and after the experience.

From the global engineering education perspective, it is crucial that a cross-cultural training program should include elements that address gender roles, racial/ ethnic issues, and self-identity studies and survey. Participants would be better prepared when such issues arise when they are abroad. As educators of engineering students, we measure success by how participants encounter, define, and solve the technical problems within their research laboratories. We must realize that underrepresented student populations should be encouraged to reflect on how cross-cultural differences, such as gender roles and skin colors, may impact their experience in study or work seetings. Such reflections should be continuous and be viewed as life-long learning opportunities.

Customize Foreign Language Training

For the short-term intense language program, the IREE participants suggested greater focus on reading and speaking skills, instead of writing Chinese. In their observation, the writing tasks they need to perform in China were mostly technical and can be done in English. Therefore the short term language training program should focus on essential daily activities, such as reading the street signs and restaurant menus, asking directions, and ordering food. Also more emphasis can be placed on the campus environment as most IREE participants live within or near Chinese college campus. Some of the participants suggested having a minimum requirement of one year of proper foreign language classes for future IREE applicants.

For the sake of uniformity, it is not uncommon for global programs to offer a one-size-fits-all curriculum. In the case of IREE 2010 program, students varied in their Chinese language fluencies. The language training portion of the orientation was designed for students who has no prior knowledge of Chinese language and therefore was overly basic for some students. This especially applied to Asian Americans awardees who often possess Chinese as their second native language.

Naturally, students who have more advanced language skill were disengaged at the language training classes. It is recommended that global programs customize foreign language training, if offered to students, according to language competencies. If this is not possible, program administrators should at least be creative to engage these students by designated them as teaching assistants and facilitators of small group discussions. The results of the Asian American focus group indicated that these students enjoyed being "useful" to the class.

Funding for Second Generation Immigrants

Following the discussion of the previous section, it is necessary for program administrators and funding agencies to examine the need for recruiting second-generation immigrants to study or intern back in their country of cultural origin. On one hand, these students' language abilities and skills can serve as advantages to the host culture program. On the other hand, finite funds are available to maximize student learning. One may argue that is it more beneficial to send students who have minimal exposure of the host culture rather than students who already possess prior knowledge. The program administrators of the IREE 2010 program saw benefits to include these students in the program. During one interview, an Asian American student noted that:

> IREE should definitely still recruit Asian Americans, just because I think when you place that next to non-Asian Americans, I think Asian Americans definitely have more personal motivation to go, and that automatically make them get more out of it. I came away also becoming closer to my family because I have that background. If your family is not Asian at all, you are going to learn a lot, but you just walk away, and you put it in…[someone else: "a shoebox?"), right, and it's just like another crazy experiment you had. While as an Asian American, you walk away with so much more. It's like closer to family. It was the most Asian experience I ever had and I can relate more with my parents now than I ever did before.

As the previous sections of the paper outline, there were many unexpected benefits for the Asian American participants, and they also enriched and enhanced the diversity of the program. These participants also often possess citizenship or permanent residence in the United States. As a result, their legal status made them eligible for federal funding and thus no discrimination should be made when making funding decisions. Weighing the advantages and disadvantages, it is recommendable for future global program administrators and educators to consider allowing second-generation immigrants to participate in programs.

Women and Safety

Scientific and engineering research is not gender-specific. However, gender-specific differences can be found in global traveling and inter-cultural communications. During the 2007 and 2008 IREE programs, a handful of female IREE grantees expressed concerns about safety in the conference discussion. [12] Though their comments are informal in nature, they warrant serious attention by program administrators. According to the Institute of International Education, females are more prone to personal security issues than males while traveling. Female students inevitably will have to fend off unwanted attention more than their male counterparts. As discussed above, female IREE grantees may receive different treatment and social courtesy in China than male grantees.

As gender-dependent treatment is prevalent in some cultures more than others, the differences in experiences between female and male grantees are inevitable. This by no means suggests that female grantees are at a disadvantaged position to conduct IREE research. With proper orientation and preparation, grantees can be made aware of the nature of cross-cultural collaboration and approach their research from an objective and cross-culturally sensitive perspective. This way they will receive (and contribute to) all of the benefits of international experience and enhance the quality of the research, while at the same time receiving an education in cross-cultural collaboration that will be crucial to their future success as engineers and scientists. It is recommended that global programs focus greater attention on gender issues during all program phases, from application and orientation to the experience itself and re-entry.

Best Practices for Global Engineering Programs

The IREE program administrators and research team have learned much from the IREE 2010 program. Women and ethnic minority engineering students do face unique sets of challenges and opportunities when traveling abroad. A good program will not only be successful in daily

logistics, but will also help students to succeed by delineating expectations and guidelines. Proper program design and special attention is required to engage women and ethnic-minority engineering students. Based on the lessons learned, this paper lists the following best practices for recruiting such students to global engineering programs and enhancing their success:

1. Encourage cross-cultural sensitivity – students should be patient and take the time to explain cultural differences to international collaborators, and accept existing cultural differences in international research and educational communities.

2. Be prepared for gender differences – Gender roles vary from culture to culture. In fact, it is often one of the most descriptive differences between cultures. Both female and male students should be made aware of such differences, and be open-minded and willing to learn about different cultures and people. Student should learn that gender roles might be vastly different from what they are used to at their home culture; therefore such difference may impact the engineering work environment and practices. Instead of rejecting different cultural practices, students should be taught appropriate skills for negotiating and cultural difference, and integrate these into their engineering decisions and research practices.

3. Leverage strong family support – It is observed that African Americans and Hispanic American students tend to have closer family ties and kinships. Instead of view such ties as hurdles to recruit students into global programs, program administrators should explore ways to leverage and openly communicate with students' family members prior and during students' sojourn.

4. Heritage retrieval for second generation Americans – Students who are descendants of first generation immigrants have unique bi-cultural backgrounds. Depending on their family upbringing and parenting practices, these students often vary in the degree to which they embrace their native heritages and language. To these students, studying abroad in their cultures of origin has positive impacts on their heritage retrieval and social identities. They should be viewed as assets to global programs, especially in helping their American peers in overcoming language barriers and understanding cultural differences. It is also a good practice to allow all students, including special cultural heritage populations, to have ample time to reflect on and formulate their sense of identify, both prior, during and after their sojourn.

Conclusion

Global competency is essential for U.S. engineers who now compete in an international market for engineering profession. Projects are distributed across sites and effective collaboration requires professionals who can work productively with colleagues who are very different from them.[13] This paper provides insights and ways to mobilize the often-overlooked population in engineering toward attaining global competencies. Their needs and challenges are special. With proper leverage and strategic programming, these students will excel in global engineering programs around the world.

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