

Exploring the International Experiences of U.S. Domestic Engineering Graduate Students

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Abstract

The engineering field is increasingly required to produce graduates able to perform successfully in a global environment. Different venues of study abroad experiences have proven to be effective to enhance global competencies among undergraduate engineering students. However, the effectiveness of this type of experience for graduate students has not yet been adequately explored. Furthermore, the few existing studies are focused on the experiences of international students in U.S. graduate programs. Therefore, there is a critical need to explore how studying and conducting research abroad impacts U.S. domestic engineering graduate students, and how these experiences help them to develop skills to perform in a global environment. This study focuses on three research questions related to the experience of U.S. domestic graduate students who conducted research-related activities abroad:

- 1) How do students prepare for their international experience?
- 2) How would they describe their experiences?
- 3) How relevant are their experiences to their personal and professional social networks?

This pilot study uses a qualitative approach in analyzing interviews of domestic graduate students enrolled in U.S. engineering programs who traveled abroad for research-related experiences. The thematic analysis of students' answers identified the main strategies that students used to prepare for their experiences abroad, as well as positive and negative aspects associated with their travel experiences, and their perceived long-term impacts. Students with the longest stay in duration did not feel prepared in the absence of a working plan to get the best of their international experience. Students' exposure to other cultures was helpful in increasing their awareness about the differences in working styles between countries. All of the students showed interest in developing respectful and healthy cross-cultural professional relationships. The insights obtained from this research have potential implications for the improvement of the experiences abroad for U.S. domestic graduate students in the field of engineering, especially in helping them to better prepare to maximize their experiences and generate more effective professional relationships.

Introduction

Graduate school is an important stage of professional preparation for those aiming to generate expertise in a particular area of study. It is also a time during which graduate students are paying a cost opportunity by delaying their integration to the workforce in the preference for the development of their expertise. Therefore, it would be desirable that the experiences of graduate

students would also be oriented towards gains in not only in their scientific preparation, but also in the acquisition of the professional skills that they will need in the engineering labor force.

The case of graduate students in engineering is particular from the point of view of their gains and losses during their preparation. Some programs promote a high technical preparation while leaving aside the professional skills that the students should also acquire during their training¹⁻³. In spite of students' career plans and whether they would be working in academy or industry, they will need preparation for the generation of functional working relationships. The globalized world that we live in today poses a particular challenge for this type of non-technical preparation. By the time of graduation, graduate students will be required to work effectively doing research or performing in industry within an internationalized framework. Therefore, their skills to thrive through this globalized environment will be important for their future professional success.

Extensive research has been devoted to the exploration of international experiences of undergraduate engineering students⁴⁻⁶ and how these affect the global competencies of engineering graduates⁷. However, research is limited in the international experiences of engineering graduate students, especially in how these experiences contribute to enhance their global competencies. Furthermore, differences exist in the experiences between domestic U.S. students and international students in the U.S.⁸. International students in the U.S. tend to have already been exposed to contrasts from their own culture in the academic, professional and cultural aspects; while domestic U.S. students may not necessarily have experienced the challenges of language limitations and cultural shock related to relocation in a foreign country⁹.

This work starts to uncover the stories of domestic U.S. graduate students in engineering programs, and how their experiences when going abroad have helped them develop better skills for working in a globalized environment.

Background

In its vision "The Engineer of 2020," the National Academy of Engineering (NAE) has stated that engineering activities should be framed under a speeding technological change, a global interconnection of resources, and an increasingly diverse and multidisciplinary population of individuals involved in or affected by engineering developments¹⁰. This vision reflects the need of the engineering field to embrace global competencies framed under strong ethical considerations. The ability to perform in a global environment has also been considered one of the expected outcomes in the training of engineers of any ABET certified program.¹¹ Many efforts have been devoted to the enhancement of these global skills among engineering undergraduates. Downey et al. (2006) have summarized the strategies used by universities to promote global competency skills among undergraduate engineering students into five classes: a) International enrollment, b) International projects, c) International work placement, d) International field trips and e) Integrated class experiences, all of which have shown having an impact on improving the global competencies of students to some extent.¹² However, there is limited exploration on how to enhance global competencies among graduate students, as well as the identification of the most effective and appropriate strategies for increasing these competencies.

Furthermore, the analysis of the experiences of graduate students has been mainly focused on international students in the U.S.^{8,13} For example, in the qualitative analysis performed by Jian (2010), Chinese engineering graduate students were interviewed in order to identify the intercultural learning process during their time attending U.S. graduate schools. The results showed that even though the students were exposed to a high diversity of cultures and people, they did not recognize any changes in their mindset in terms of their “values and beliefs, prejudices and stereotypes.” The students reported that language barriers and cultural differences were their main challenges to engage in inter-cultural interactions. They also reported detraction from looking for opportunities to interact with individuals outside of their comfort zone because of the presence of a strong peer-network of other Chinese students. In the academic aspect, students also reported being challenged to adapt to the independent learning style commonly used in the U.S., and struggling with the lack of instructions or guidance¹³. Other studies have explored the experiences of Indian engineering graduate students in the U.S. in terms of their acculturation¹⁴ and shifts in cultural expectations¹⁵. However, academic implications of these phenomena are not further explored.

Even though the analysis of international students in the U.S. is not extensive, the study of the experiences of domestic students abroad is even more limited or, to the best of the authors’ knowledge today, non-existent.

Some venues can be useful to start gathering information about the experiences of domestic students abroad. The National Science Foundation supports programs of multinational collaboration between graduate programs in engineering. One of the objectives of such programs is to promote collaboration in education and research among their partners. For this, the programs mobilized their graduate students within the involved universities, in this way they could take advantage of their availability and diversity of human factors and infrastructure. Some experiences of the graduate students in these programs are research stays in a partner university, or presentations in international conferences. The experiences of these students can help to start exploring: what is the experience like for domestic U.S. students to go abroad to perform research-related activities? And more specifically, can these experience help foster long-term international partnerships or strengthen existing collaborations?

In order to address these inquiries we consider the following research questions:

- 1) How do students prepare for their international experience?
- 2) How would they describe their experience?
- 3) How relevant are their experiences to their personal and professional social network?

Methods

In this work, the first exploration to the considered questions is possible due to the access of graduate students participating in an NSF funded project. The project is led by a large, research-intensive, Midwestern university in collaboration with universities from different countries in Asia and Europe.

Participants

Four graduate students were interviewed for this study; three men and one woman—all in engineering. All of them had different destinations for their experiences. Their length of stay

ranged from one to three weeks. Three of the students attended an international conference and the fourth student experienced a research stay in the host university. All of them were funded by the NSF project considered. We use pseudonyms to protect the identity of the participants while reporting results.

Interview procedure

The interview protocol included requesting information for their previous experiences abroad in order to set a baseline for the level of novelty of going abroad. Direct questions related to our research objectives were also stated such as: What did you do to prepare for travel to [name] country? Describe your research abroad experience, or how would you describe the relationships you have established with your international collaborators?

They were also asked about the most enjoyable parts of their trip and what they think would have made their experiences better. Other information requested were: How the experience contributed to their long-term goals, and which experiences they considered relevant for their future development of international collaborations in their respective research areas. While a structured interview protocol was used, the interviewer allowed for room to probe further upon emergent themes.

After the interviews were executed, recorded and transcribed, the analysis was performed through open and structural coding¹⁶, which was found appropriate for the exploratory nature of this work.

Results

Interview Results

We build this section around our research questions. For each question, different codes were considered, for example the different types of preparation that the students underwent were considered separately in the academic and non-academic components (customs, language, tourism).

1) How do students prepare for their international experience?

For those attending conferences, they mentioned preparation for their conference materials, such as posters or conference presentations. The students also showed an interest on respecting the local culture and customs, Casey, who was traveling to an Asian country, mentioned performing research online to find “*things to avoid doing just to avoid offending anyone there.*”

There was an interest on learning the local language before arriving, although it just showed for students with: a) the longest stay or, b) a particular interest in the country of destination. Students traveling only for conferences did not show a concern of learning the language of the host country because of: 1) its difficulty and 2) was not relevant for their purposes. All students reported some level of online research to the touristic things to do in the host country during their visit; the time spent on this research was proportional to their length of stay.

2) How would they describe their experience?

In this section we first report on the differences the students perceived during their stay in the host country. For these experiences, they did not express positive nor negative feelings. The level of reflection in these differences shown by the students can help them assess their own graduate experience compared to those students in the host country and simultaneously reflect on the weight of their cultures into their work styles. The identification of these differences can help establishing more efficient and successful research partnerships or work relationships in their future careers. Later, we summarize the positive experiences reported by the students, it is envisioned that these experiences could help to set expected outcomes to the plan the foreign forays for other students. Finally, we also report their negative experiences, so we can make recommendations to avoid the recurrence of similar episodes for future students traveling abroad.

Perceived differences

A noticeable cultural difference the students reported was that of the social structures, and the relevance of hierarchies. For example, Casey reported “*the culture is very, very polite and you’re very respectful of anyone who; a) is older than you, or b) has a position above you. So, it was really important like even just speaking to someone that you were very conscious of that and respectful.*” acknowledging that this may be different from the American style where students can often refer to professors by their first name if that is the way they introduce themselves.

Students were also able to identify some differences in terms of the work structures in the host countries. Considering the autonomy of graduate students when working, one student reported on how she perceived that, compared to students in the host country, she was more independent and free to try new endeavors without her advisor’s supervision. She also perceived that they work longer than she do. Another difference reported was about the accessibility of professors, citing that the U.S. style allows to impromptu conversations with their advisors about their projects, while students in the host country have to make an appointment to discuss their questions.

Another point was made about the level of security in the infrastructure visited, Robin, who visited a research institute, reported that when compared to the U.S. “*The security is much higher. It’s like if you went to a national lab...*” he compared this versus the usual access he has in the labs of his university, which usually do not require any type of badge.

Positive experiences

Students reported positive experiences about their academic growth, especially due to the conferences they attended. Something similar was reported for the usefulness of the poster sessions, where students were able to receive useful feedback from other people in the area. This reflects how the relevance of the exposure was resulting in positive consequences for the students.

About the cultural experiences the students had, they cited that their exposure to a different culture was something they enjoyed. They also reported that there were not a lot of barriers in the communication with their peers neither in the conferences or in the laboratories they were

visiting due to the fluency in English of the students in the host country. About the infrastructure of the visiting country, students noticed positive differences for example, that the host country had a considerably better public transportation system than the U.S.

All the students reported visiting the main attractions of their destinations, as they perceived it as a *“once-in-a-lifetime opportunity.”* Especially for those attending conferences, the touristic experience was shared with local graduate students. They also reported that it was valuable getting to know these students better and understand their work styles and life styles differences. Jamie, who was interested in developing higher skills in the language of the host country, reported spending extra time with tourism activities before the academic events sharing with locals to improve their speaking skills. In addition, Casey reported having a good perception of the locals for their attitude towards tourists, stating, *“everyone’s very friendly and very helpful. Like we had people stopping us on the street to see if we needed help getting somewhere ‘cause they could tell that we were tourists.”*

Negative experiences

Students attending conferences were not able to identify negative themes in their academic experiences. However, Robin, who had the longest stay in the host country, reported a lack of preparation for his trip in terms of not having a clear objective and/or program for the stay. The student reported that his lab mates in the hosting institution were busy working on ongoing projects and there were almost no opportunities for him to generate something valuable towards their research collaboration. He reported: *“they didn’t have time to kind of start working on a new project and they also didn’t have time. . . there was no real specific project for me to be working on. So, a lot of what I did was I read a lot of papers there, kind of they recommended...there was no real project that I was working on specifically with them.”*

In terms of the location, some students reported differences that they did not feel comfortable about. For example, Taylor reported that the place he traveled to was dirtier and more populated than expected. He attributed his higher expectations to the media. In terms of tourism, the only slightly negative experience was held by Robin, which reported some level of frustration from the inability to navigate the city as desired for tourism due to the limitations in his communication skills.

3) How relevant are their experiences to their personal and professional social network?

The students reported creation of professional connections mainly with professors, which they saw as potentially helpful for their future professional plans, such as for recommendations or potential future work. For example, Casey mentioned *“while we were there one of the professors mentioned that he may have a post-doc position coming up. And since I’ll be graduating soon I may look into that.”*

They did not report the creation of any new non-professional connections. Moreover, sometimes when they tried to keep in touch with graduate students in the host country, they did not get any replies or further contact. Robin, when questioned if he stayed in touch with the students that he met there, mentioned, *“I actually tried to but they didn’t email me back ever. So, I guess, yes and no; I tried but they didn’t.”*

When questioned about how influential was the experience for their future plans of going abroad, the majority of students reported an existing proclivity towards going abroad for either study, research or work, while only one reported not having a real desire for traveling in his career. Those with previous inclinations to go abroad reported that their intentions did not necessarily change due to the experience, or they reported that it was just slightly enhanced by it. Nevertheless, the one without previous desires to travel reported a positive effect if the future opportunities would be related to research (“*I’m still not huge open into traveling but I’m definitely open to traveling for Ph.D. research type of things.*”)

The Miville-Guzman Universality-Diversity Scale Short Form (MGUDS-S)

Before their experiences abroad, the four students took the Miville-Guzman Universality-Diversity Scale Short Form (MGUDS-S) survey. The MGUDS-S measure the Universal-Diverse Orientation (UDO) construct, which “describes an attitude of awareness and acceptance of both the similarities and differences among people”¹⁷. This version of the tool has 15 items and has been validated extensively to measure UDO in a reliable way¹⁸. The MGUDS-S has been previously used in engineering students to measure UDO as a surrogate of global competency of students^{7,19,20}. Therefore, it was considered in this study to measure the student’s baseline levels of global competency before going abroad. The consistencies or differences between their scores and their reported perceptions are analyzed in this section.

The MGUDS-S has three main factors that help identify specific traits;

- (1) ***Diversity of contact***: student interest in participating in diverse internationally focused activities of social and cultural nature;
- (2) ***Relativistic Appreciation***: reflects the appreciation level of similarities and differences in people.
- (3) ***Comfort with differences***: reflects the comfort level with individuals from diverse backgrounds ¹⁸.

The responses to the MGUDS-S items are recorded in a Likert-like scale (1=Strongly Disagree, 6=Strongly Agree). There are five items per factor, for a total possible score per factor ranging from 5 to 30 points, and they are summed up to a total MGUDS-S score. In this work, the MGUDS-S was administered to the students before their international experience; these scores are analyzed in order to identify any relationships between their reported perceptions and the score components.

Consistencies between interviews and MGUDS-S scores

The summary of the MGUDS-S scores is shown in Table 1. The mean MGUDS-S score for the four students in this study was 69.75. Only one student scored a total lower than the mean.

Table 1. MGUDS-S scores of the four students by different scales.

Student	MGUDS-S Scores				Sample of Student Comments
	Diversity of Contact	Relativistic Appreciation	Comfort with Differences	Total	
Casey	23	26	23	72	<i>“I did some online research on...[list] ... and things to avoid doing just to avoid offending anyone there.”</i>

					<i>"everyone's very friendly and very helpful. Like we had people stopping us on the street to see if we needed help getting somewhere 'cause they could tell that we were tourists."</i>
Jamie	27	25	23	75	<i>"[I liked] seeing so many people who think a lot like I do. A lot of the people there, they were interested in learning another language; they were interested in [topic]."</i>
Robin	17	20	20	57	<i>"The security is much higher. It's like if you went to a national lab..." "they didn't have time to kind of start working on a new project and they also didn't have time. . . there was no real specific project for me to be working on..."</i>
Taylor	24	26	25	75	<i>"... attending those lectures was very useful, we got to kind of fill in the blanks that we had." "I expected something more modern and cleaner... we saw that it was overpopulated"</i>

Some results can be tied together between the MGUDS-S scores and the analysis of the interviews, and propose some further research questions. First, the student with the lowest score in the total MGUDS-S was actually the one expressing the highest amount of negative experiences. At the same time, those expressing a bigger proportion of good experiences were those with higher scores. However, the student with the lowest MGUDS-S score was actually the one with the longest stay in the visiting country; therefore, the question arises if the negative experiences are more prone to be reported because of the longer stay. The student also reported a high number of previous trips, so it would worth to explore the quality of these previous experiences, as well as the reasons for these trips. This result contradicts research that tends to relate the number of trips made outside of the country of citizenship positively to the level of global competency²¹.

Supporting this contradiction, the student with no previous history of trips abroad showed one of the highest MGUDS-S scores. This sheds light in the possibility of developing global competency without participating in the traditional interventions, such as study-abroad; but through exposure to other cultures even in their normal local setting, through classes or other extracurricular activities. In addition, through the analysis of potential changes, it would be possible to generate a more detailed analysis of the influence of different demographic factors such as gender, ethnicity or age in their levels of global competency.

Discussion and Future Work

The results represent some opportunity areas to improve the experiences of domestic graduate students outside of the U.S.. First, their preparation is currently self-led in many aspects (academic and non-academic). For students traveling for conferences, this did not present any major issues, but for the student with the longer stay, the mismatch between the student's expectations and his research abroad experience highlight a potential area for improvement. A more developed research plan or expectations that are more consistent with what could be accomplished given a particular length of stay may have helped maximize the travel abroad experience for the student and may also be of greater benefit to the host institution.

Second, the identified differences represent a valuable learning experience for the students. Especially for their future professional plans, many of them expressed an interest in fostering some sort of international professional experiences. Similarly, they will keep working with people from many different places and the development of certain level awareness of their cultural differences would be a valuable social-asset to have as professionals. Finally, we found evidence for the students being proactive towards the generation of professional relationships that would relate to their professional plans. Although none of them reported a formalization of these relationships for future work.

This could be a potential area that faculty, program administrators, and stakeholders for the development of strategies to generate more effective and rewarding travel abroad experiences for domestic U.S. graduate students. One of the limitations of this work is that we had a small sample where most of the students were abroad for conference purposes, it would be desirable to capture the variety of the experiences of more students going abroad for longer periods of time, and under different projects. Further, it would help contribute to the literature to compare the experiences of international students who traveled to the U.S. to enroll in engineering doctoral programs. In addition, the MGUDS-S scores considered were measured before their international experience. Therefore, it would be interesting to obtain a second measurement of their MGUDS-S score after the interview and sometime later to assess their changes in their global competency levels and identify specific influential factors. One of the most relevant recommendations from this work is that, it would be desirable for domestic students going abroad to have a stated objective for their research stay. Since many of the graduate students of today will be the researchers of tomorrow, it is important to start paying attention to the support they are getting on building skills to create and foster successful international partnership.

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