Towards a Global Virtual Community of Female Engineering Students and Professionals: I. Impacts of Grassroots International Partnerships of Student Organizations on U.S. Engineering Undergraduate Cultural Competency

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Introduction

1. Overview
The Society of Women Engineers (SWE) at the University of Michigan has developed a novel program to use established student organizations to build an international community of female engineers and facilitate cross-cultural exchange and global competence among undergraduate engineering students. While this program was primarily developed as a co-curricular program for Liberian undergraduate women, it has the benefit of also serving as a cross-cultural international experience for undergraduate women from the U.S. at the secondary level.

It has been shown [1,2] that a sense of community has a tremendous impact on the success of female engineering students in this country. Many programs in Women in Science and Engineering have established residency programs in order to build a community on campus where female students can feel safe and nurtured by their peers, e.g. University of Wisconsin-Madison, University of Michigan [2,3]. Success was measured by better grades and an overall higher satisfaction with the University. Currently the situation in Liberia is such that there is no critical mass of female students to create such programs and achieve a sense of community [4]. Organizations like SWE have the potential to provide a critical mass of fellow women engineers for female students, and subsequently increase persistence of women in engineering [5,6].

Moreover, global competence is making its way into engineering education as a necessary skill for today’s engineers [7]. International experiences in engineering have been recognized as a primary method of imparting global competence among students, but there is no one international program that can achieve all dimensions of global competence [8]. This poses a need for universities to develop multiple programs in order to provide effective training for their diverse engineering cohort. This work develops one such program using student organization collaborations to build an international community of women engineers and through this community, provide opportunities to develop global competency among undergraduate students.

2. Motivation
The development of this international partnership between two student organizations has developed by building upon observations on the limitations of prior outreach in Liberia and international programs for U.S. engineering students. Educational outreach to Liberian undergraduates began as the University of Michigan was awarded a subcontract to a USAID-funded educational program focused on rebuilding the engineering and agriculture programs at two universities in Liberia [9]. The University of Michigan had a specific focus on developing and implementing programs to encourage and support more students into the engineering and agriculture pipelines, with a specific focus on women. Graduate students from the University of Michigan implemented a month-long co-curricular residential program for 80
Liberian undergraduates split evenly between female/male, agriculture/engineering, and incoming freshmen/sophomore students [10]. The program was carried out from 2011-2013.

The educational outreach program also served as a study abroad setting for undergraduates from the University of Michigan. For two of the three years of this program, an undergraduate group of approximately ten students from the University of Michigan participated in a faculty-led project-based service-learning program to carry out an engineering design project in a nearby community as well as to have a cultural exchange with the Liberian undergraduate participants. While the potential for a rich intercultural exchange between these two groups was high, unfortunately the realization of the exchange was limited primarily due to the separateness of the two student groups (e.g. the University of Michigan undergraduates resided in separate spaces from the Liberian students and participated in separate activities), and due to the difference in academic disciplines between the two groups (i.e. the University of Michigan participants for this specific program were selected from a variety of disciplines from the University of Michigan with a small percentage having a background in engineering, and therefore as a whole a missing shared interest in engineering)[11].

At the same time the educational outreach program in Liberia was implemented, an international service learning program by the Society of Women Engineers student chapter at the University of Michigan—named SWE Overseas—was also developed and implemented in India [12]. Through this program, SWE members from the University of Michigan traveled to Walchandnager, India, to carry out engineering outreach to secondary students at a private school. The purpose of this program was to provide University of X students with engineering outreach experiences beyond the U.S. This program was limited in its ability to provide mutual cultural exchange amongst the University of Michigan students and the Indian counterparts as the cultural exchange primarily occurred between the University of Michigan participants and the secondary teachers at the Indian school rather than undergraduate engineering peers.

After the USAID-funded educational outreach program was discontinued, the service-learning program from the University of Michigan was also discontinued. However, some of the graduate students who implemented the educational outreach programs to the Liberian undergraduates were also mentors to many of the founding members of the Liberia Society of Women Engineers student organization that formed in 2013. After seeing the unmet potential of the undergraduate study abroad program from the University of Michigan in Liberia, as well as the minimal mutuality in the cultural exchange with the SWE students in India, graduate students saw a potential for SWE to expand upon its outreach efforts and develop a mutual cultural exchange between female undergraduate engineering peers at a university.

Service learning in engineering and global development has been recognized as a promising means to prepare engineers for a rapidly changing global landscape and to be reflective of their impact on the development of communities worldwide [13]. While these types of programs have been shown to increase student competency in engineering and global development, most of the programs underutilize the potential to deepen this understanding by building cross-cultural peer collaborations. Furthermore, when international service learning programs do have a peer collaboration component, these peer collaborations are usually from a top-down approach in
which the peer collaboration is a part of a program, but not necessarily driven by the students themselves [14]. Additionally, in these programs, students from different universities often operate with some separation (e.g. living in separate residential spaces, different excursions during weekends).

Thus, the graduate students with the University of Michigan saw an opportunity for outreach to continue to Liberian undergraduate women -- especially after the USAID-funded summer program was put on indefinite hiatus -- while also fulfilling the desire by University of Michigan SWE members to have international experiences, and to strengthen these experiences by means of cross-cultural peer collaborations.

3. L-SWE SUCCESS - a novel way to build an international community of women engineers through peer-to-peer collaboration

In August 2015, five undergraduate female engineering students from the U.S. participated in a two-week residential engineering leadership camp, entitled Setting Up Collegiates for Careers in Engineering through Social Support (SUCCESS) alongside 30 Liberian undergraduate female engineering students from three Liberian universities (Stella Maris Polytechnic, University of Liberia, St. Clements University College). The camp was held in Kakata, Liberia, West Africa and carried out by 5 U.S. graduate students.

The camp was structured in a workshop format with an average of three workshops a day. The workshops included academic and professional skills sessions covering topics related to graduate school application process, personal statement writing, leadership development, cross-cultural communication, professional development, and networking skills. The workshops also included three team-based engineering projects that gave participants an opportunity to work on cross-cultural engineering teams. Additionally, a few of the workshops were targeted toward developing and sustaining their local SWE student organization (Liberia Society of Women Engineers, L-SWE). Underlying all of these workshops was the desire to provide all students involved with cross-cultural leadership experiences. Finally, to assist with the planning of the camp and to encourage cross-cultural team building, committees were formed between the L-SWE leadership team and the University of Michigan members to plan and carry out different aspects of the camp, namely, logistics, health and safety, activities, conflict resolution, and reflection. Further details on the programmatic aspects of this camp can be read in paper titled “Towards a global virtual community of female engineering students and professionals: II. Impacts of leadership camp on Liberian undergraduate women studying engineering”, also presented at the ASEE 2016 Conference [15].

4. Building a global engineering community

Apart from being a one-of-a-kind experience, the camp had specific goals in regards to the global engineering community. The primary goal of the camp was to engage undergraduate students from both countries in cross-cultural peer-to-peer collaborations. We believe this grassroots approach will build a close knit international community of women engineers. Further, this camp was an opportunity for the members of SWE and L-SWE to build their international networking skills. The X-SWE members had an unprecedented mentoring and networking opportunity with undergraduate Liberian female peers, along with an enriching cultural exchange. The L-SWE
members were able to work alongside and learn from an internationally-recognized SWE collegiate section, and were subsequently exposed to a strong global community of women engineers and role models.

The desired outcomes for X-SWE members were:

- Cultural immersion with fellow Liberian students
- Broader international understanding of engineering leadership and education
- Networking with an international group of female engineers
- Development of leadership, professional, and academic skills
- Enhanced understanding of engineering education in other countries and continents

Preliminary results from discussions with the X-SWE members who participated in the first year of this program demonstrate that a student organization collaboration model is a successful and novel method to increase the persistence of women in engineering globally and to promote cross cultural engineering and leadership experiences among undergraduate engineering students. This paper evaluates this model using the Psychological Sense of Community framework developed by Sarason et al. [15, 16] and the Global Competency framework developed by Parkinson et al. [17].

The two research questions for this work are:

1. Can international student organization collaborations foster long term relationships that can lead to an international community of female engineers?
2. Are student organization collaborations effective in achieving cross cultural exchange thereby preparing engineering undergraduates for a global workplace?

Methods

With Psychological Sense of Community (PSOC) and Global Competency as the basis of our conceptual framework, we carried out a qualitative research study to answer our research questions. A qualitative approach offered a holistic view of the experiences of the participants at the camp that enabled the researchers to compile common themes from the rich descriptions of perspective provided by the of all interviewees.

The data was acquired through pre-trip reflection surveys and post-travel semi-structured interviews for the 5 U.S. undergraduate students. We focus to thick description of participant experiences to allow readers to make decisions regarding transferability[18] rather than drawing generalizations due to the small number of participants. The pre-trip reflection survey explored pre-travel global competency. The reflection survey specifically investigated expectations in regards to interactions with the Liberian students and Liberian culture (Appendix 1). The post-travel semi-structured interviews focused on participant reflections from the trip.

Participants engaged in semi-structured interviews using with open-ended questions and prompts. Interviews lasted for about 1 hour and were audiotaped. Complete confidentiality of all of the data collected from the interviews was assured. The launch of the interview began with the protocol established by the IRB to obtain informed consent. Once participants provided informed consent, the participants were asked share any general thoughts on the camp and describe their experiences since the camp. There were essentially two sets of questions that directly explored
the four elements of the psychological sense of community: membership boundaries, mutual influence, needs fulfillment and shared emotional connections. The first set of questions elicited information about their social, academic and professional interactions during the camp. The participants were further probed to compare and contrast their experiences at the camp with other cross-cultural experiences. The second set of questions explored peer collaboration and professional connections established during the camp (Appendix 2).

Results

1. Global competency

In their 2009 paper, Parkinson et al. describe 13 dimensions or attributes of global competence for engineers [17,19]. Through a survey of engineering educators and industry representatives, they decided that the five most important dimensions of global competence are that engineering graduates: can appreciate other cultures; are proficient working in or directing a team of ethnic and cultural diversity; are able to communicate across cultures; have had a chance to practice engineering in a global context, whether through an international internship, a service-learning opportunity, a virtual global engineering project or some other form of experience; and can effectively deal with ethical issues arising from cultural or national differences. We present evidence of the efficacy of the peer-to-peer collaboration model at achieving these competencies.

The most important aspect of global competency for engineers as ranked by the Parkinson survey was that engineering graduates can appreciate other cultures. In the university setting this is often achieved by language and culture classes or through other exchanges [8]. One of the ways the program achieved it was by housing all participant in a single dormitory where 12 people slept in each room. One of the U.S. participants commented:

“If I had to think of anything that was more collaborative or cross-cultural, I think it was that. Because I know that they ended up trying to be a little quieter for us because they are used to being really loud in the middle of the night and working on projects and talking. So they tried to be a little quieter for us and we tried to understand that they came from a different culture.”

Another way this was achieved was through the camp workshops. During the first few days, the participants carried out a generative interview with one another to prepare for writing a personal statement.

“I really really enjoyed when we did one-on-one interviews and just talking with them because I feel like that gave me a lot of insight into what it is like to be a female engineering student in Liberia, which is not something I had ever even thought about before this trip. I hadn’t even really thought about what it was like to be a female engineer anywhere else in the world so I think that was really really great. It gave me a lot of perspective and made me think about things I hadn’t thought about before.”

The second dimension of global competency was proficiency working in or directing a team of ethnic and cultural diversity. During the camp, the participants were split into engineering teams
where they worked on three different design projects. All of the X-SWE members had sentiments similar to the following:

“One thing I found in the Liberian group when we were working together, everybody was very excited about the project itself and I didn’t really feel like any one person took charge. It was almost like everybody took charge. In a way it was challenging because we didn’t have as much direction but I think it was also sort of refreshing because everybody was very excited, everybody wanted their ideas to be heard.”

The third dimension of global competency is the ability to communicate across cultures. The official language of Liberia is English, but many speak a nonstandard version that they refer to as “Colloqua” (or colloquial). This slang along with the differences in educational backgrounds led to many learning experiences among the community.

“I think that was a good experience to have because I got to experience that and understand that when somebody says something to me they may not mean it the way I might perceive it. “

“I think sometimes it was a little bit difficult to communicate what we were trying to communicate with them because of the cultural barriers.”

“One of the things that I appreciated a lot… was their openness. Like they were very open always to tell me pretty much anything in their life. Like I said, it made me uncomfortable sometimes because they also expected me to tell them everything about my life “

The fourth dimension of global competency is the chance to practice engineering in a global context, whether through an international internship, a service-learning opportunity, a virtual global engineering project or some other form of experience. While the entire camp could be described as a chance to practice engineering in a global context, we specifically had three engineering projects with one open ended project that concentrated on team building. These projects were beneficial to the students as one student comments:

“For instance, when we were doing soldering, it was my first experience doing it along with a lot of the Liberian students so I felt like that was a really cool opportunity because none of us had done it. Even though we were coming from such different backgrounds. That was a point where I really felt connected with the Liberian students because you know all of us were working on this engineering project together.”

The fifth dimension of global competency is about effectively dealing with ethical issues arising from cultural or national differences. Although no major ethical issues that we know of arose during the camp, this dimension was still achieved as described by one of the students:

“I was led to realize that it is okay to be frustrated by things, but then you also you need to be able to reflect on them and figure out why.”
While the Global Competency framework was able to demonstrate the general influence of this international program on the University of Michigan undergraduate participants, it is limited in its ability to demonstrate the specific influence of this international community of female engineers, which has been shown to be particularly influential for women in engineering [6]. Thus, the true efficacy of the student organization partnership in achieving global competency is shown through the PSOC analysis and the building of a community.

2. Analysis from PSOC and its effects on global competency
Researchers McMillan and Chavis center their definition of sense of community on four interacting elements: membership, influence, need fulfillment and shared emotional connection [19, 20]. From the semi-structured interviews, we found that all four of these elements were developed at the camp. Below are examples from the U.S. undergraduate participants.

**membership**
“There were a few of the Liberian students who were over 10 years older than I am and they were still pursuing an engineering degree and some of them had children. I found that just very inspiring personally that they had that drive to pursue their goals…. It made me proud to be a part of that international community where there are these women that are working so hard to achieve what they want to.”

**influence**
“I’ve kept in contact with a lot of the Liberian students and they’ve asked me for help, they’ve asked me for advice, I’ve asked them for advice and them for help.”

**need fulfillment**
“I really liked that we had committees that were US students and Liberian students. On every committee, there were multiple people from both communities. That showed me, as a person coming into it, that this was an organization and a cause that had thought about this before. It wasn’t just ‘Oh, we are going to go to Liberia and help these female engineering students without asking them about what they want or what they need.’”

**shared emotional connection**
“I have always been interested in sort of the broader community of women engineers and I really enjoyed it because, for instance, one of the students was telling me how when she was in school she had male classmates who were really discouraging of her for doing well in math and, in the US, I had the same experience in high school. So I felt like that was a special moment to be able to share with her. When she is on a different continent and having the same struggles at age sixteen as I had.”

Building on the four elements of a sense of community, specifically having an all-female program led to a greater shared emotional connection and perception of influence. One participant spoke about her interaction with her Liberian peers:
“There is certainly a more openness and more willingness to share with a female counterpart than a male counterpart but then that taken even one step further with the Liberian students. I think a lot from their culture and their expectations of what it is like to interact with others, but then also the camp setting and everything in general really fostered that relationship building.”

The results from these interviews with the University of Michigan undergraduate SWE members are preliminary, and further results will be gathered in subsequent iterations of this international program. However, it is promising to see how the psychological sense of community can be achieved and strengthened through international and mutually-beneficial peer-to-peer networks.

Limitations and Future Work
1. Limitations
The current work suffers from a few key logistical and epistemological limitations. The first shortcoming is that this work is a pilot study using a relatively small sample set. The conclusion made here show that this program has great potential but is still highly preliminary. To make up for this preliminary nature, we have drawn on qualitative experiences of the participants to create our narrative.

The next limitation of our framework is that the current funding for this camp experience relies heavily on one-time grant applications. We funded the camp by combining over 10 different sources. For this project to continue, corporate sponsorship or a larger research grant needs to be obtained. We are uncertain how corporate donations will influence the camp programming and what type of effect it will have on the camp structure.

Finally, our application of Global Competencies was not perfect. In this pilot camp we did not discuss cross-cultural competency with the Liberian students as much as we had with the US students. The US students underwent over 20 hours of cultural research and cross-cultural communication preparation before departing for the trip. By comparison, the Liberian students underwent no prior training and had less than 3 hours of explicit cross-cultural communication work later in the camp. This was a large source of frustration for one of our participants.

“Another thing that I didn’t discover about myself, but there was a frustration for me that I felt like I was being really cognizant of this cultural difference, being tolerant of the differences, and really trying to understand in my frustration stemmed from a cultural difference or if it was something else that I needed to deal with. But, I didn’t feel like the Liberian students were always necessarily doing that. I felt that the US students for the most part were cognizant of that and recognizing that in themselves, but.. I felt that as a US student, I was willing to bend and compromise on those frustrations and differences and I didn’t always feel that the Liberian were willing to do that. And I am not sure if that was because they weren’t or if I wasn’t seeing it or if they were presenting it in a way that wasn’t making it obvious to me. But, that was definitely something that I have experienced that frustrated me.

…
I’ve also thought too, I don’t know if it is fair to expect them to do that because we are the ones who are traveling there, we are the guests. We are the people who are putting themselves into their community. Maybe it is not their responsibility to do that and I am not sure how I feel about that. “

2. Future Work
In order to address the current limitations of this project, we intend to expand this limited data set into a broad longitudinal study including perspectives from the domestic undergraduate students, domestic graduate students, and Liberian students. We intend to follow up with the domestic undergraduate participants on an annual basis and distribute short-answer surveys. We will also conduct semi-structured interviews based on the short-answer responses. The goal is to discover the long term impact this type of project has on undergraduate participants and to see if it truly grows into a sustainable virtual community.

Expanding on the domestic longitudinal data set, we intend to begin a combination of semi-structured interviews and short-answer surveys with the graduate student and Liberian participants. These data sets will also grow into a multi-year project with follow-ups with past and current project participants.

Conclusions

1. Best Practices
When planning this camp, we were cognizant of power imbalances that often occur when undergraduate students from the U.S. travel abroad to low-resourced countries [21]. Our goal was to create a camp that was built around the needs of the Liberian students, founded on peer-to-peer relationships, and resulted in a psychological sense of belonging in the greater global engineering community. We believe that we were successful in this goal with few best practices for similar programs.

The largest concern was how to create a ‘flat’ structure at the camp where every participant felt ownership over the camp and a sense of belonging. To decrease the traditional US-Liberian power dynamics, we appointed the graduate students as the actual camp facilitators. The US undergraduate students were treated the exact same as the Liberian students in all activities. They slept in the same communal dormitory and had access to the same resources as the Liberians students. Examples include medical resources, entertainment, and snacks. By designating the graduate students as ‘near-peer’ leaders, deeper friendships were able to form between the undergraduate students resulting in greater global competency development.

The second best practice is that the camp logistics were a team effort between X-SWE and L-SWE. Although the US students planned the majority of the camp curriculum, the Liberian students had weekly input into what type of development they desired (e.g. a very popular request was engineering design activities). For the actual camp logistics, we had five committees covering topics of Social Activities, Logistics, Safety, Orientation, and Conflict resolution. Each committee had students from University of Michigan, University of Liberia, and Stella Maris Polytechnic. Every camp participant was given the opportunity to join a committee if they
wanted to and half of them (~17) did. Not only was this absolutely necessary for the on-the-ground logistics, it instilled a sense of community in the participants before the camp even began and led to the adoption of digital tools for communication. Most committees planned their tasks via Facebook messenger with some use of email and WhatsApp.

In summary, the best practices that we observed from the execution of this camp as as follows:

1. Intentional planning to reduce power dynamics and keep focus on peer-to-peer relationships. This includes:
   a. Inclusion of graduate students as mentors
   b. Equal access to common resources
   c. Mixed communal housing
2. International collaboration in planning camp logistics

2. Summary
From this study, we assert that the grassroots approach to creating an international partnership of student organizations is successful in achieving the important global competencies for engineering students. This approach gave more control to the tailor the program to drive the participants to achieve the desired effect of cultural competency. As evidenced by the PSOC framework, having an all female (SWE) camp introduced reasons for identification within the community and fostered a sense of belonging that made cultural differences less drastic, and fostered the motivation and connection. In addition, by priming the U.S. students for peer collaboration and establishing a flat camp structure where all of the students worked together to organize the camp, participants were able to more readily enter into and continue this international community.

References


Appendix 1

Pre-trip reflection survey

Interactions with Liberian Students
1. What are some similarities and differences you expect between you and the Liberian counterparts
2. Describe the sort of interactions you expect to have with the Liberian counterparts
   a. During the student organization development
   b. During the academic, professional and leadership development
   c. During the engineering activities
   d. During leisure time
3. How will these interactions be similar and/or differ from typical interactions you have had with UM counterparts in comparable scenarios?
4. How do you expect the Liberian counterparts to participate during the camp?
   a. During the student organization development
   b. During the academic, professional and leadership development
   c. During the engineering activities
   d. During leisure time
5. What do you expect the attitudes of Liberian counterparts to be toward you personally?

Cultural expectations
1. What do you think the Liberian culture will be like?
2. What are some of your previous cultural experiences that may influence your experiences in Liberia?
3. What are you really looking forward to?
   a. Interactions with Liberian students
   b. Interactions with fellow UM students
   c. Liberian culture
4. What are you most concerned about the trip
   a. Health and safety
   b. Interactions with Liberian students
   c. Interactions with fellow UM students
   d. Liberian culture
5. Personal goals: How would you define success for your travel
   a. Quantify them
   b. Prioritize your goals
6. What do you expect to get out of this trip
   a. Personally
   b. Professionally
Appendix 2

Post trip semi-structured interview questions

1. Interactions: How were they different/similar to those
   a. with peers in the U.S.
   b. with other cross-cultural experiences you have had
      i. Social interactions
      ii. Academic/professional interactions
      iii. Cultural interactions

2. Thoughts on the camp
   a. Effectiveness
      i. peer collaboration,
      ii. sense of international community
      iii. mentor/mentee prospects/ ease
   b. Were all trip goals achieved?
   c. What would you want to see done differently this year

3. How would you use the connections you made in future/ career

4. Impacts of the trip on your academic, professional and social lives from September 2015:-
   specific examples

5. How did you handle any disagreements you may have had

6. What did you discover about yourself?