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Global Learning at Home: Understanding Students' Experiences in Global Virtual Team Projects

Siddhant Sanjay Joshi[a], Bruno Staszkiewicz Garcia[b], Niall A. Peach[b], Francisco J. Montalvo[c], and Kirsten A. Davis[a]
Purdue University [a]School of Engineering Education, [b]School of Languages and Cultures, [c]College of Engineering Office of Professional Practice, Corresponding Author's Email: joshi110@purdue.edu

ABSTRACT

CONTEXT

As the engineering workforce becomes more globalized, engineering students must develop the skills needed to work on engineering projects across cultural boundaries. Global virtual team projects are one way to develop these skills without requiring students to travel abroad. This format has the potential to improve access to intercultural learning for engineering students who are not able to study abroad or participate in extracurricular activities. Prior research on global virtual team projects has focused on a limited set of learning outcomes, rather than understanding students' experiences holistically, and has primarily used quantitative survey approaches (e.g., Zaugg et al., 2013).

PURPOSE

The purpose of this study was to gain a holistic perspective of students' experiences in a global virtual team project to explore what and how they learned through the experience.

METHODS

We used a mixed-methods approach to collect data from 65 students participating in global virtual team projects. Students from the United States, Mexico, Ecuador, and Germany formed 7 project teams that worked together for one semester. We collected pre-and post-course individual student reflections describing their goals, challenges, and learning as part of the global virtual teams. We also collected pre/post assessments using the Intercultural Development Inventory (IDI) instrument. Our team iteratively coded the student reflections to identify themes emerging from the reflections. After initial coding, we re-coded each reflection using a holistic coding scheme based on the themes (Saldaña, 2013).

FINDINGS

We identified 7 themes in the students' reflections and found that students shifted their focus from intercultural themes at the start of the semester to team dynamics, professional development, and technical topics by the end of the semester. The pre and post IDI results indicate that students who had received prior intercultural training demonstrated growth in their IDI scores whereas students who did not have prior training experienced a small decline. Further, the students who had received intercultural training were more likely to discuss intercultural knowledge in their reflections compared to the other students.

CONCLUSIONS

Our results suggest that although global virtual teams can provide opportunities for intercultural learning, such learning is more likely to occur when emphasized and supported through intercultural training. However, by taking a holistic view of learning, we highlight a range of other learning outcomes including teamwork and working in a virtual environment.

KEYWORDS

Global virtual teams, qualitative data analysis, intercultural development

Introduction

Research on engineering work has suggested that engineers need to be able to work effectively with diverse groups of people. For example, coordinating the technical work of team members has been identified as a significant part of engineering jobs (Trevelyan, 2007). It is also important that engineers consider the impact of their work on society, requiring an understanding of both social and technical aspects of engineering problems (Bijker, 1997; Trevelyan, 2007). Additionally, engineers from different cultures define problems in different ways, suggesting that engineers should be socially, technically as well as culturally competent to operate in a global engineering industry setting (Downey et al., 2006). Similarly, Ravesteijn et al., (2006) observed that communication competence was needed to secure social consensus for innovation in engineering practice. Given the cross-cultural nature of engineering work, engineering students must have opportunities to develop the skills necessary to be successful in these global environments. The purpose of this project was to gain a holistic perspective of students' experiences in a global virtual team project to understand what and how they learned through the experience.

Literature Review

Although global learning has not historically been emphasized in engineering programs, there has been increasing awareness that these skills are important to include in engineering education (Grandin & Hirleman, 2009). In the U.S. context, there has been growth in the number of engineering students studying abroad (Jesiek, 2018), but this opportunity is not accessible for all students for personal and financial reasons. It is important, therefore, that global skill development be integrated into engineering coursework so that more students can benefit (Downey et al., 2006). Several approaches have been suggested for courses that incorporate global engineering content, including taking a humanities perspective (Downey et al., 2006), using case studies (Rectanus, 2013), incorporating a cultural simulation (Davis et al., 2019), and global virtual team projects (Alves, 2018; Zaugg et al., 2012). This final option has been a popular choice within engineering specifically because so many engineering courses already include team projects, so less adaption is required on the part of instructors.

Prior research on global virtual team projects has suggested that these experiences can contribute to engineering students' development of intercultural skills. For example, one study compared students who had studied abroad with those who participated in a course with global virtual teams, finding that although the study abroad students saw higher gains in intercultural competence, there were some areas where the students in the course scored just as high or better (Ball et al., 2012; Zaugg et al., 2013). Other studies have identified similar outcomes from global virtual team projects, including understanding cultural differences (Miranda et al., 2017), awareness of diversity (Reid & Garson, 2017), and intercultural maturity (Alves, 2018). However, research on global virtual team projects has also identified challenges students face while working on such projects, including personality conflicts, digital literacy issues, prejudices and stereotypes, failure to develop relationships, and lack of cultural awareness (Alves, 2018; Liu et al., 2015; Reid & Garson, 2017; Whitman et al., 2005). As part of their project on global virtual teams, Zaugg et al., (2012) identified several best practices to help overcome these challenges, such as requiring student teams create a code of conduct, helping students develop their communication skills before engaging in virtual teams, and having students reflect upon their experiences.

Few studies of these earlier studies have explored students' experiences while they are participating in global virtual teams to understand how opportunities for both learning and conflict may arise in this environment. Prior studies have used surveys, questionnaires, interviews, and reflections to understand the development of competencies in students but without much emphasis on student perspectives (Alves, 2018; Ball et al., 2012; Duus & Cooray, 2014; Liu et al., 2015; Miranda et al., 2017; Whitman et al., 2005). In contrast, our

study aimed to uncover student perceptions of their experiences in global virtual teams in a holistic manner by analyzing student reflections at the start and end of the semester.

Background

The Global Engineering Alliance for Research and Education (GEARE) is a comprehensive study and work abroad program from the College of Engineering at Purdue University available to students in all engineering disciplines. The multi-year program involves intercultural training sessions, domestic professional experiences (industry or research internships), and international experiences including one semester of study abroad and a work experience in the same country. The program also requires a global design project (GDP) that may be conducted at an international location or remotely. In response to the COVID-19 pandemic, all GDPs have been conducted remotely in collaboration with GEARE partner universities. In the GDPs, students work in a multidisciplinary team of students from both Purdue and a global partner university to tackle real-world problems related to engineering, transportation, energy, and sustainability in a global context.

Starting in Fall 2021, intercultural learning sessions were incorporated into the GDP course at three points during the semester (early, middle, and end). Before these sessions, students submitted individual reflections (discussed in the Methods section). During the intercultural learning sessions, one of the instructors led group discussions building on the reflection topics and asking students to respond to each other's ideas. The topics of these discussions included reflection on the students' experiences with their project teams, looking specifically at their teamwork, intercultural awareness, and any mediation needed to work together. The goal of these sessions was to provide a space in which we guided the students to consider more critically how they worked together and their own goals for the projects.

Methods

Participants

In Spring 2021, 69 students participated in the GDP course from four countries: Ecuador, Germany, Mexico, and United States. All students had a background in engineering, although their specialties differed. All the students from the United States had completed a prior semester-long intercultural competency introduction course, and during Spring 2021 were also taking the GEARE program's second semester-long intercultural seminar. The students from the other countries did not have previous intercultural training. This project was approved by the Purdue University Institutional Review Board, and 65 of 69 students (94.2%) in the GDP course agreed to participate in this study.

Data Collection

We collected both quantitative and qualitative data for this project. The quantitative part consisted of a pre-and post-test of the Intercultural Development Inventory (IDI; Hammer et al., 2003). Students took the IDI assessment at the beginning and end of the course. The IDI assesses intercultural competency, locating individuals on the intercultural continuum (ranging from denial to adaptation). Additionally, we collected students' reflections on cross-cultural teamwork at the start and end of the semester. We provided a prompt for each reflection in both English and Spanish, and participants were encouraged to respond in the language in which they felt most comfortable. The prompt for the end of semester reflection is shown below:

- *Tell the story about one specific experience on the team project that has been significant for your learning. This could be something that went well, was challenging, or helped you develop a different perspective. Explain what happened, how you responded, and what you learned from the experience (e.g., knowledge, skills, behaviours, perspectives).*

- *In addition to the learning mentioned as a part of the first question, what other knowledge, skills, behaviours or perspectives have you learned related to working on a team project, working on a cross-cultural team, and/or working in a virtual environment?*
- *What areas for growth can you identify that you want to continue working on in your:*
    - *Next group project?*
    - *Next cross-cultural experience?*
- *Lastly, think about your team as a whole. What did the team do well? What areas for improvement might you identify if the team was going to work on another project together? (which is typical in many work settings)*

The start of semester prompt was similar but asked about students' prior intercultural experiences, prior team projects, and expectations for the semester. Most students wrote between 1-2 pages for each reflection.

Data Analysis

We analysed the students' reflections in two stages. We first thematically coded a subset of reflections to identify common themes. Our research team of five authors reviewed the same subset of reflections through several iterations of analysis and group discussion to develop the final set of themes. In the second stage of analysis, the research team used holistic coding to score each reflection based on these themes (Saldaña, 2013). We began by coding a subset of reflections as a group to ensure a consistent coding approach. Two researchers then scored each reflection and met to discuss and reach an agreement. Our scoring approach assessed the depth with which a reflection discussed each theme, where a 0 indicated no mention of a theme, a 1 indicated a surface-level mention, and a 2 indicated a detailed description or a story related to a theme. This scoring process was applied to both the pre- and post-course reflections, which were pooled separately.

Limitations

One limitation of this project is the format of the course, where students were divided across seven projects with different engineering goals and professors. Thus, students had more variation in experiences than in a typical course. A second limitation is that the post-course reflection was assigned at the end of the semester when students also faced significant amounts of work, such as exams. This may have resulted in less time and thought spent on the reflections. Finally, all students faced different situations related to the COVID-19 pandemic, which impacted their ability to engage with this project and the related reflections.

Results

IDI Results

A total of 47 students completed both a pre-course IDI and a post- course IDI. The results from the tests showed that the entire group grew an average of 4 points (see Table 1).

Table 1: Results from the Pre- and Post-Course IDI Surveys

	Pre-Course IDI	Post-Course IDI	Change
IC Training	92.00	101.73	9.73
No IC Training	83.58	81.90	-1.68
All Students	87.71	91.34	3.61

The students who had received intercultural training (IC training) in a prior semester as part of the GEARE program ("IC training" group in Table 1) had higher average scores in the pre-

course assessment and saw more significant growth between the pre- and post-test. Two separate paired *t*-tests were conducted to compare the effect of GDP on the groups with and without the IC training. The results show a significant increase between the pre-course and post-course IDI surveys for the group with IC training ($p < 0.01$) but no statistically significant difference for the group without IC training. We also compared the scores of the two groups using *t*-tests and identified no significant difference in pre-course scores, but the IC training group's scores were significantly higher in the post-course survey ($p < 0.01$).

Reflection Results

In the first stage of our analysis, we used thematic coding to identify common themes in the student journals and identified seven themes using this approach. These themes along with their definitions and example quotations from student reflections are shown in Table 2. This process addressed the first goal of our project, which was to gain a holistic perspective of what and how students learned through global virtual team projects. The themes we identified revealed that such projects provide a range of learning opportunities for students across technical, professional, and intercultural topics.

Table 2: Themes Identified in Student Reflections

Themes	Definition	Sample Quotes
Technical	The reflection mentions technical goals, developing a product, or creating a deliverable.	*"I remember in a specific moment when I was working with [instructor] on relating the lift distribution analysis of the 3-D elevator to the proper sizing of the glider elevator based on our selected NACA 0024 profile, and [instructor] had ideas that I had not considered when I felt stumped like I hit a wall."*
Team Dynamics	The reflection provides specific examples of challenges, benefits, or processes that teams face.	*"I personally believe that the previous issue was a failure on the part of [teammate] and I to properly make sure everyone in the team felt included, which I think is one of the unique issues that can arise with remote work."*
Professional Development	The reflection describes specific skills, knowledge, or growth the student gained or would like to gain (including language skills, but not technical or intercultural skills).	*"This was challenging because I felt unprepared, since we didn't really have a 'backup plan.' Although the whole experience was pretty stressful, it taught me a few valuable lessons about how to assign different responsibilities and to prepare properly for a group presentation."*

Social	The reflection mentions wanting to connect with or get to know teammates in a personal sense.	*"I wish I would have spent more time getting to know my team members personally, and asked more questions about what their university experience is like, what classes they take, etc. I do think this is harder virtually, because it's not very common to make small talk in a Zoom class."*
Intercultural Knowledge	The reflection mentions specific cultural differences (i.e., ***facts*** about cultures).	*"I remember our team met for one of our weekly meetings and we ended up having a very insightful conversation about the various social movements (specifically regarding women) in each of our countries."*
Intercultural Mindset	The reflection mentions respect, openness, or cultural awareness (i.e., positive ***attitudes*** towards other cultures).	*"Some method should be implemented to make sure that everyone is understanding what needs to get done and feels free to express their thoughts without feeling insecure. I do not know the best way to go about doing this, but I think starting with patience and trying to listen is a good way to start."*
Intercultural Behavior	The reflection mentions adapting, being flexible, adjusting to others' preferences, or wanting to learn new approaches from other cultures (i.e., past or future ***actions***).	*"Communication-wise, it's the first time I've worked this closely with someone from another country, with a different cultural background. It was definitely a learning experience trying to be careful how I word things, and trying to avoid using too much slang in my texts. There was also the different type of English that both of us had to adapt to."*

In the second stage of our analysis, we scored each reflection on a scale of 0-2 for each of the seven themes identified above. We used heat map visualizations to compare the scoring results between the pre- and post-course reflections (Tables 3 and 4). These tables show the percentage of reflections that received each score for each theme, where 0 indicated no mention of a theme, 1 indicated a surface-level mention, and 2 indicated a detailed description or a story. This process addressed the second goal of our project, which was to explore how students' experiences shifted over the course of the semester.

These heat maps summarize our main observations in comparing the pre- and post-course reflections. The biggest shift was that at the start of the semester, students were more likely to discuss the intercultural themes than at the end (especially *Intercultural Mindset*). Instead, the post-course reflections focused primarily on topics related to the *Technical*, *Team*

Dynamics, and especially *Professional Development* themes. Some students seemed to be aware that this shift had occurred, mentioning that they wished they had spent more time learning about the cultures of their teammates and getting to know them as individuals.

Table 3: Pre-course reflection heat map

Score	Themes						
	Tech	Team Dyn	Prof Dev	Social	Int. Know.	Int. Mind.	Int. Beh.
0	42.86	7.14	14.29	67.86	30.36	17.86	69.64
1	33.93	30.36	53.57	28.57	39.29	66.07	19.64
2	23.21	62.50	32.14	3.57	30.36	16.07	10.71

Table 4: Post-course reflection heat map

Score	Themes						
	Tech	Team Dyn	Prof Dev	Social	Int. Know.	Int. Mind.	Int. Beh.
0	41.07	5.36	16.07	55.36	35.71	42.86	62.50
1	21.43	10.71	33.93	39.29	41.07	39.29	30.36
2	37.50	83.93	50.00	5.36	23.21	17.86	7.14

We also compared these results between the IC training and no IC training groups (from Table 1) but did not see many notable differences in their responses on the reflections. The students with prior IC training were more likely to discuss *Intercultural Knowledge* in both the pre-and post-course reflections, which may be the result of their prior training. Their focus on *Intercultural Knowledge* development may have supported their improved scores on the IDI. The no IC training group was slightly more likely to discuss *Professional Development* in the pre-course reflections, mainly focusing on improving language skills through the course. The overall trends between pre- and post-course were similar between the two groups.

Discussion & Implications

In this study, we used a mixed-methods approach to explore students' experiences and outcomes during a global virtual team project course. In analyzing the pre- and post-course IDI scores, we found that the students in the course had improved their IDI scores on average, but that students who had prior intercultural courses and training saw more notable growth than those who did not. We gained a more holistic view of student learning by analyzing students' reflections at the start and end of the semester, identifying seven main themes that students discussed in their experiences of the course: technical topics, team dynamics, professional development, social interactions, intercultural knowledge, intercultural mindset, and intercultural behavior. Over the semester, there was a shift in the reflections towards the technical, team dynamics, and professional development topics, resulting in less emphasis on the three intercultural themes in the post-course reflections.

Taken together, our results suggest that although global virtual teams can provide opportunities for intercultural learning, such learning is more likely to occur when emphasized and supported through intercultural training. The IDI results we report here align with similar findings from the study abroad literature, where students who have more pre-travel support and ongoing cultural mentoring during their time abroad experience greater increases in IDI scores (Engle & Engle, 2012; Vande Berg et al., 2009). Although we sought to incorporate intercultural learning in the course via the intercultural learning sessions, these remained a much smaller component of the course than the engineering projects. The students' reflections revealed that they tended to focus on the technical and team learning outcomes of the course, despite their interest (expressed in both pre-and post-course reflections) in the

intercultural learning component. Students have been found to adapt their learning approaches and priorities based on their perceptions of an assigned task (Marton & Säljö, 1976), which may have influenced students' increasing focus on the technical projects over the semester (as the projects comprised the majority of their final grade).

Although the reflections had less emphasis on intercultural learning than we had hoped, the students thoughtfully reflected on several other important learning outcomes. In particular, students described *Team Dynamics* that they dealt with through the semester and how they handled these situations. This finding aligns with prior work on global virtual teams, which has suggested that there are unique teamwork skills required in virtual environments that can make such projects more complex to manage than those where students are co-located (Liu et al., 2015). Students also emphasized other *Professional Development* outcomes, including topics such as public speaking, project management, and time management. Students reflected that these skills were necessary to work effectively in a virtual environment, and anticipated that this would be a part of their future work experiences. Similar findings have been reported for marketing students in global virtual team projects (Duus & Cooray, 2014).

In the era of COVID-19, there has been a rush to develop global virtual team projects as traditional travel-based opportunities for intercultural learning have been unavailable. Although this approach may be useful for improving access to intercultural learning for engineering students, our findings indicate that simply placing students in a global virtual team environment may not result in intercultural learning. We suggest that if intercultural learning is a desired learning outcome for a global virtual team project course, it is important to emphasize this part of the course equally with the other course content. For example, it may help to include more intercultural training than we did in this study and emphasize intercultural learning more in course assessments. Although the students in our study were interested in getting to know their teammates and learning about their cultures, this does not happen organically in global virtual teams, so instructors will need to build opportunities for such connections and learning to occur. Lastly, based on our experience in this project, we recommend the use of reflections as both an instructional and assessment approach, as they allowed us to gain a more holistic perspective on students' learning outcomes.

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