INTERNATIONAL VIRTUAL EXCHANGE EXPERIENCE FOR CIVIL ENGINEERING STUDENTS

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Abstract

This study was conducted to assess the value of an international virtual exchange (IVE) experience between Clemson University, Bucknell University, and An-Najah National University. The focus of this study was a five-week collaborative project where civil engineering students enrolled in pavement design or environmental engineering courses at the three universities were tasked to develop innovative solutions to a pavement related problem.

Based on the course enrollments at each institution (35 US and 51 Palestinian), there were two treatment groups: IVE and non-IVE. There were nine bi-national IVE teams, five US non-IVE teams from Clemson and seven Palestinian non-IVE teams from An-Najah. The evaluation in this study focused on team dynamics, global competencies, and perceived value of the experience.

The influence of the experience on teamwork for IVE and non-IVE teams was evaluated using the Individual and Team Performance (ITP) Metrics Peer Feedback and Team Dynamics survey (ITPMetrics.com). The global competencies of the students in IVE and non-IVE teams were assessed quantitatively and qualitatively using a post-program survey based on the Stevens Initiative and RTI International's *Common Survey Items* as well as survey items developed for this IVE to measure whether the program promotes gender equity. This survey included post-project and retrospective questions. Finally, the perceived value of the project experience for all students was evaluated using a mixed methods assessment based on the "value-creation framework" of Wenger-Trayner et al. that included four cycles: (1) immediate value, (2) potential value, (3) applied value, and (4) realized value.

Results showed that the IVE teams exhibited greater improvement in team dynamics measures over the project duration compared to the non-IVE teams. The students on IVE teams also showed greater gains in all aspects of the global competencies assessment than their non-IVE peers. Finally, all students expressed that they found value in the experience. However, there were no differences in perceived value between the IVE and non-IVE teams. The differences came from students from different countries as the Palestinian students perceived greater value in the experience than their US peers regardless of whether they were on an IVE team or not.

Introduction

It is critical that engineers not only have technical expertise, but also be able to work on diverse teams, effectively communicate with broad audiences, have a global perspective, and consider the implications of their solutions on users and society as a whole. The importance of these essential skills has been highlighted by the engineering profession including ABET, the accrediting body for engineering programs [1]; the Grand Challenges Scholars Program (GCSP), endorsed by the National Academy of Engineering [2]; and the American Society of Civil Engineers (ASCE) Civil Engineering Body of Knowledge [3], to name a few.

Cross-border collaboration is becoming more common in industry as a result of increased globalization, thus signifying the importance of intercultural competence as an essential skill of today's engineers, in addition to technical skills. To address and develop the intercultural competence of engineering students, universities offer and promote different types of programs to help students develop these skills [4]. International exchange programs or international internships are standard among these programs, while international virtual exchange (IVE) are another option that have gained popularity with advances in collaboration tools and technologies [5].

Objectives and Scope

The primary objective of this study was to evaluate the influence of participation in an IVE project-based learning experience on team dynamics, development of global competencies, and perceived value to the students. The objective was achieved by developing and implementing a project-based learning experience that a portion of students completed as an international virtual exchange (IVE) experience as members of a bi-national team while others were on teams comprised of students from a single institution. A series of surveys were employed to assess team dynamics, development of global competencies, and student perception of value of the experience.

There were two research questions we set out to address in this study.
1. Are teamwork and global competencies strengthened through the IVE project-based learning (PBL) experience compared to the non-IVE PBL experience?
2. To what extent does the IVE experience enhance the perceived value of the assigned project for the participants?

Project Overview

The basis of this study was a multi-week project that challenged student teams to develop an innovative solution to a pavement related problem. The primary goals of this project were focused on helping the students develop effective teamwork and communication skills, implement the design thinking process, recognize the broader impacts of pavements on our society, and develop global competencies. The project was implemented as an IVE project in the fall semester of 2022.

The Principal Investigators first collaborated on this project in Fall of 2021. Based on that first experience, they incorporated some modifications in Fall 2022 that was assessed in this study.

The two most significant changes implemented in this offering were (a) the addition of cross-cultural dialogue sessions for IVE teams prior to the start of the project and (b) dedication of class time for teams to work together synchronously.

Cross-cultural Dialogue Sessions
These sessions were developed based on the feedback, observations, and lessons learned from the 2021 iteration of the project with curriculum support from Soliya. Over two meetings, the IVE students participated in four contact hours of cross-cultural dialogue activities led by United Nations (UN) certified cross-cultural dialogue facilitators from Soliya. The overarching goal of these modules was to prepare students to constructively engage with difference throughout the collaborative project-based learning component of the IVE experience. Several student-centered pedagogical techniques were utilized in the design of these modules inspired by the framework for cross-cultural dialogue. These included learning through reflection, free flow dialogue, small group and interactive learning spaces, and the creation of a "brave space" conducive to constructive and meaningful dialogue.

Dedicated Class Time
One 75-minute class period per week was allocated for project work during the project duration. This made it easier for both IVE and non-IVE teams to coordinate their schedules. At the beginning of each of these sessions, the instructors led a brief overview of a stage of the Design Thinking process to give the students more direction and focus on one stage of the process each week leading to their final solution. Following the instructor led session on Design Thinking, the teams worked in Zoom breakout rooms and the faculty mentors provided feedback each week. This class period was scheduled for 3:35-4:50 pm EDT on Wednesdays and was attended by the IVE and US non-IVE teams. The seven-hour time difference made it difficult for the An-Najah non-IVE teams to attend.

There were 35 US students (33 from Clemson and two from Bucknell) and 51 Palestinian students from An-Najah. The students were divided into IVE and non-IVE teams. The IVE teams consisted of two US and two Palestinian students and the non-IVE teams were comprised of three to five students from either Clemson or An-Najah. There were nine IVE teams, five US non-IVE teams from Clemson, and seven Palestinian non-IVE teams from An-Najah.

Assessment Methodology

To more completely understand the influence of this project experience on students participating on both IVE and non-IVE teams, the research team implemented specific survey instruments for each of the following areas of interest: teamwork, global competency, and perceived value.

Teamwork

To assess the students' individual team performance and overall team dynamics, the Individual and Team Performance (ITP) Metrics Peer Feedback and Team Dynamics survey was administered at the mid-point of the project and after project completion (ITPMetrics.com). This

online survey measures a team member's individual effectiveness in five dimensions based on peer feedback [6, 7]:

Commitment: Commitment to the team's work
Communication: Communicating and interacting with teammates
Capabilities: Strong foundation of knowledge, skills, and abilities
Standards: Emphasizing high standards and expecting quality
Focus: Keeping the team on track

Team dynamics were measured through this survey using the team CARE model developed by O'Neill et al. [8]. The team CARE model assesses team health in four categories:

Communicate: Cooperative environment, role clarity, and strategy formulation and planning
Adapt: Team monitoring and backup, goal progression, and coordination
Relate: Contribution equity, healthy fact-driven conflict, lack of personal conflict, and trust
Educate: Constructive controversy, exploitative learning, and exploratory learning

The survey also quantifies overall team satisfaction.

Global Competency

Attainment of global competencies was measured using a survey administered to all students (IVE and non-IVE) after project completion. The survey was based on the Stevens Initiative and RTI International's *Common Survey Items* with additional questions related to innovation and problem solving as well as equity and inclusion [9, 10]. The post-project survey using retrospective questions is recommended over a pre-project survey as students tend to rate themselves relatively higher in pre-program surveys than they would after reflection following the program [11]. The survey statements are included in Appendix A.

Perceived Value

The perceived value of the student experience was measured using the framework for value creation by Wenger-Trayner et al. [12]. The first four cycles of this framework have been used to measure the value of IVE programs. These cycles include:

Cycle 1 – Immediate Value: Focuses on the opportunities for social engagement and interactions
Cycle 2 – Potential Value: Focuses on how interactions in Cycle 1 can create 'knowledge capital' or 'insights, connections, or resources'
Cycle 3 – Applied Value: Focuses on how the knowledge capital can be applied or leveraged
Cycle 4 – Realized Value: Focuses on how application or leverage of the knowledge capital contributes to personal or organizational goals

The value survey (see Appendix B) was administered to students following the completion of the project.

Results & Discussion

Teamwork

The Peer Feedback results summarized in Figure 1 show that students participating on IVE teams demonstrated significant growth in Communication, Capabilities, and Commitment over the duration of the project. The changes in the areas of Standards and Focus, while positive, were not statistically significant. The non-IVE students did not demonstrate significant growth in any of the areas. In fact, the US non-IVE students showed significant declines in the areas of Standards, Focus, and Commitment over the course of the project.
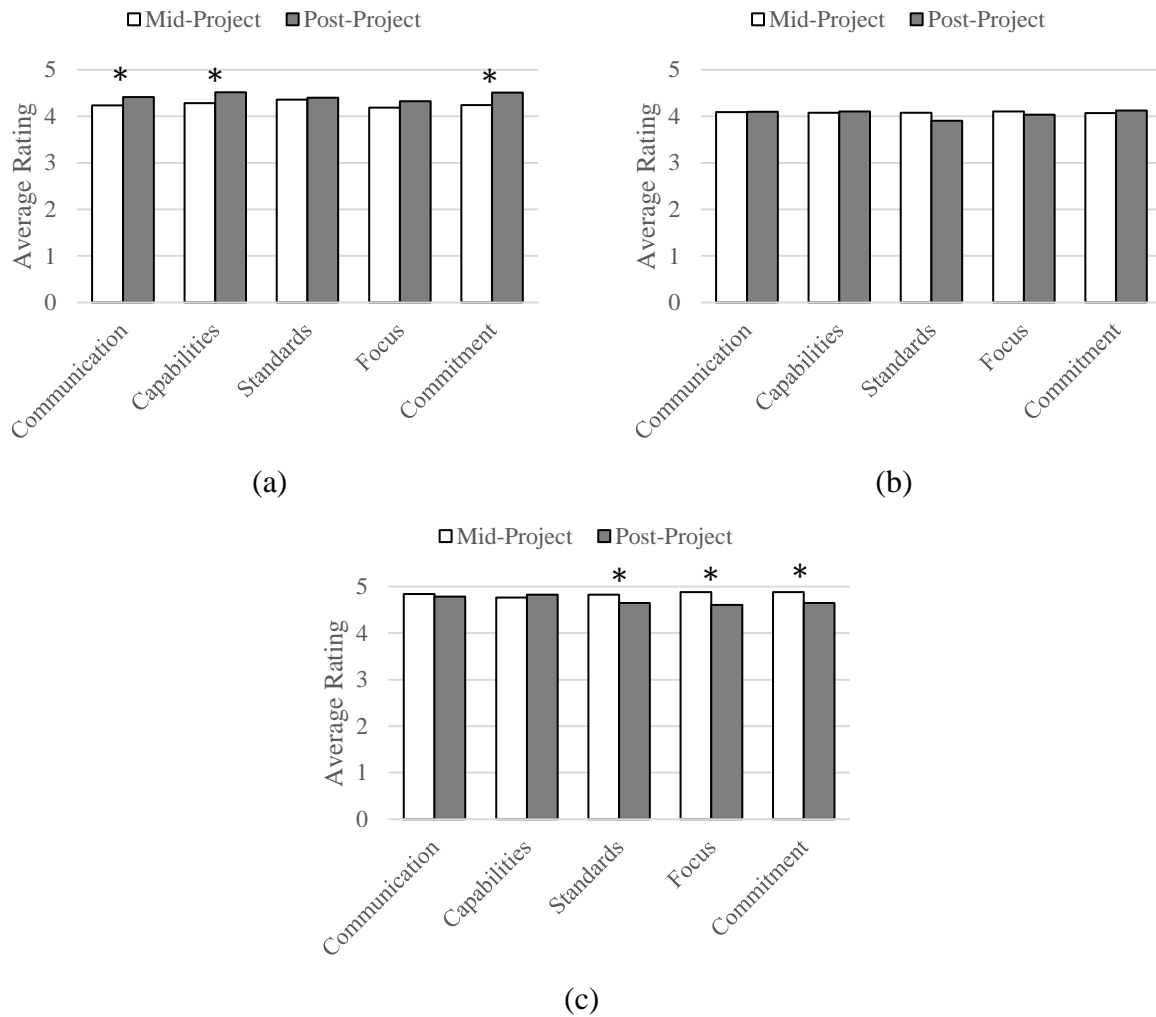

(a)

(b)

(c)

Figure 1. Peer evaluation results for (a) IVE teams, (b) Palestinian non-IVE teams, and (c) US non-IVE teams. *indicates statistically significant differences between the mid- and post-project survey results (α = 0.05).*

As shown in Figure 2, the IVE teams exhibited significant growth in team dynamics over the duration of the project, specifically in the areas of Communicate, Adapt, and Relate. The overall

team satisfaction also significantly improved. The non-IVE teams did not exhibit any significant changes in team dynamics over the course of the project. As with the individual performance, the US non-IVE teams generally showed slight declines in multiple categories over the duration of the project.
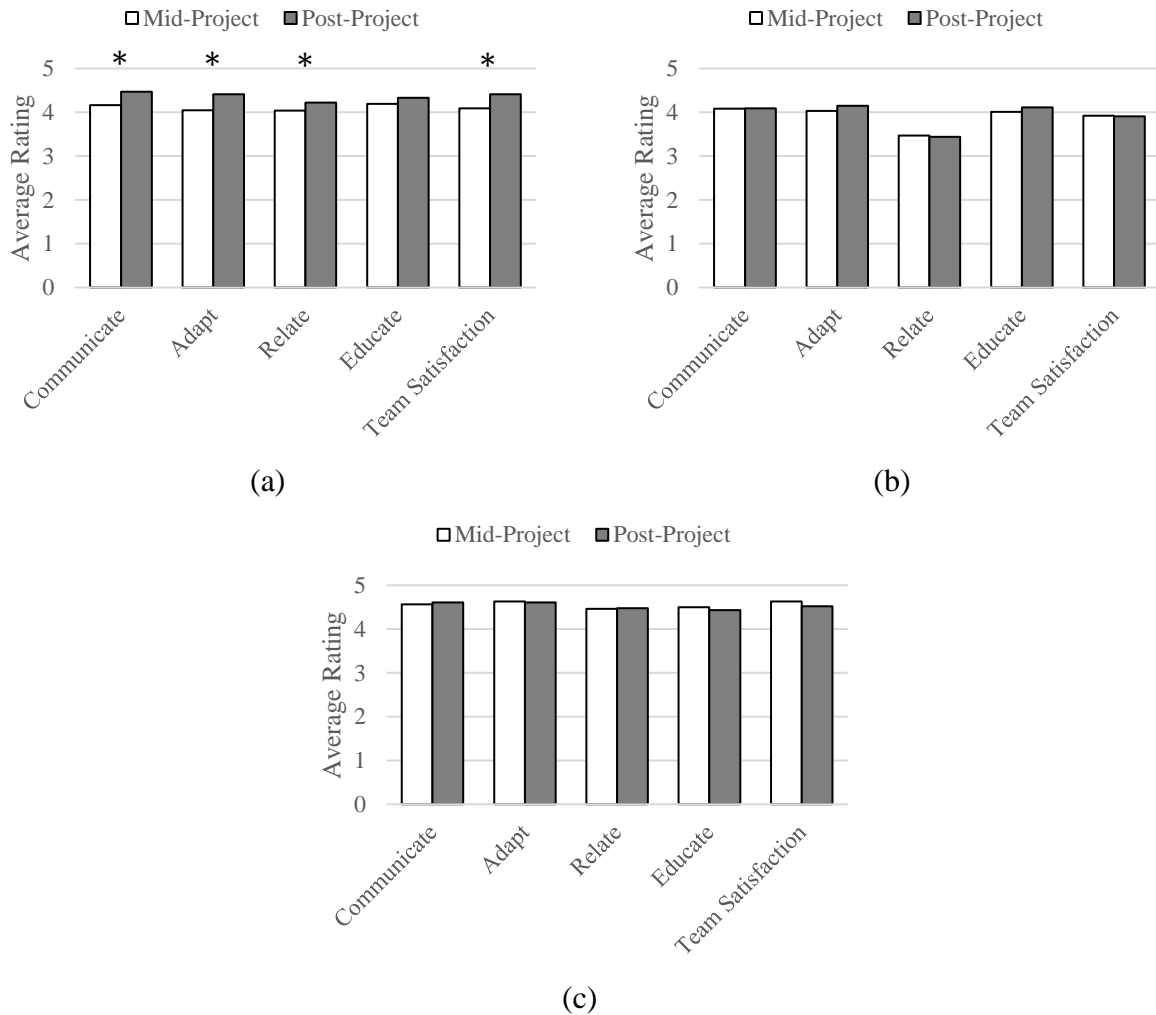

(a)

(b)

(c)

Figure 2. Team Dynamics results for (a) IVE teams, (b) Palestinian non-IVE teams, and (c) US non-IVE teams. *indicates statistically significant differences between the mid- and post-project survey results (α = 0.05).*

The individual performance and team dynamics results indicate that the pre-project cross-cultural dialogue sessions had positive benefits for the IVE teams. This is evident when comparing the results from the IVE teams to the non-IVE teams who did not participate in the pre-project dialogue sessions.

Global Competency

Figure 3 summarizes the percent of respondents who indicated that they either agreed or strongly agreed with the statements in the respective areas. The results clearly show significant increases in the knowledge of culture and country for the students on IVE teams. Prior to the project, only about 20% of all students (IVE and non-IVE) agreed or strongly agreed that they were knowledgeable of the life and culture of the other country (either the US or Palestine). After this experience, 77% of the students on IVE teams agreed or strongly agreed they had a knowledge or understanding of the other country, while only 28% of students on non-IVE teams felt the same. The slight growth in the knowledge of the non-IVE students is potentially due to the fact that non-IVE students were part of the same courses as the IVE students and, therefore, it was likely that the IVE participants shared some of their experiences and indirectly impacted the non-IVE students.

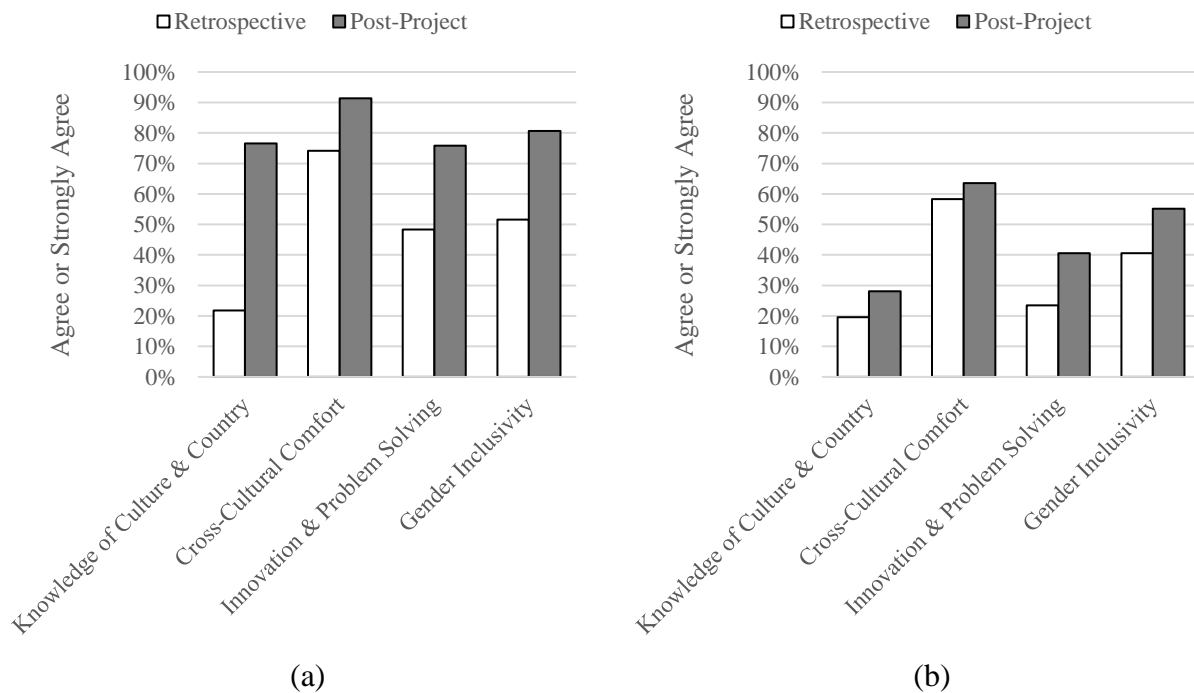(a)   (b)

Figure 3. Global Competencies survey responses based on retrospect and following completion of the project for (a) IVE students and (b) non-IVE students.

The area with the least, but still significant, growth for the IVE students was in their *Cross-cultural Comfort*. After the project, about 91% of IVE students (increase of about 17%) indicated that they had a sense of comfort around and working with people from other cultures. The non-IVE students experienced only a 6% gain (58% pre-project to 66% post-project). The results also indicate that the IVE students had greater comfort levels going into the project compared to the non-IVE students.

These quantitative data were reinforced by the qualitative results where IVE students shared significantly more responses identifying higher self-confidence when working in an intercultural team, whereas the non-IVE student responses primarily highlighted their preference to work in teams with their friends, for example. Additionally, when asked whether the students had any tricks or strategies to overcome language barriers, the US IVE student responses increased significantly in the post-project survey. In the pre-project survey the responses were more general and abstract with a focus on attitude (e.g., "communicate as much as possible," "be open"). However, in the post-project survey, the responses were more concrete focusing on specific things they do or did during the project. This could explain some of the improvements seen in the teamwork assessment.

Both IVE and non-IVE students showed growth in *Innovation and Problem Solving* as part of this experience, but the growth was greater for the IVE students (28% for IVE and 18% for non-IVE students). Finally, all students gained a greater appreciation for gender inclusivity over the course of this project, but the growth was greater for the IVE students (about 29%) compared to the non-IVE students (about 14%).

Perceived Value

Overall, students found value in the project with each cycle having ratings mostly greater than 7 out of 10 as summarized in Figure 4. The results indicate that the IVE experience generally did not add much value to the project as the perceived value realized by the students on IVE teams was similar to that of students on non-IVE teams. The Palestinian students realized significantly greater value than the US students in Cycles 2, 3, and 4 (Potential, Applied, and Realized Value), independent of whether they were on an IVE team or not. One potential explanation for this has been seen in previous studies that have shown that Palestinian students are regularly more likely (6-20% more likely) to recommend IVE experiences to their peers than US students [11, 13-15]. The fact that they would recommend such an experience likely points to the value they see in the experience. Further reflection on these results, led the team to believe that the difference could also be due to the past experiences with project-based learning. The US students regularly participate in PBL throughout their educational experience, so this was just another example of working in a team on a project. In contrast, while the Palestinian students work collaboratively in their courses, the structure used in this project was different than what they may have typically experienced. Therefore, this experience was different and perhaps provided additional value to them regardless of whether they were on an IVE team or not.

Specifically, more so than the US students, Palestinian students recognized the following that resulted in their increased perceived value of the experience. With respect to Potential Value (Cycle 2), Palestinian students felt that, through this experience, they gained new skills; changed their understanding of pavements; learned new tools or processes; found a new voice through their collective learning; and saw opportunities for learning that they did not see before. Cycle 3 measures Applied Value, where Palestinian students noted that they will use the knowledge and skills from this project in the future; their experience will inform future learning opportunities; and their experience will help them be a better team member in the future. Finally, after participating in this project, Palestinian students felt that they achieved something new and are more confident in their knowledge, skills, and abilities, which are linked to Cycle 4 (Realized Value).
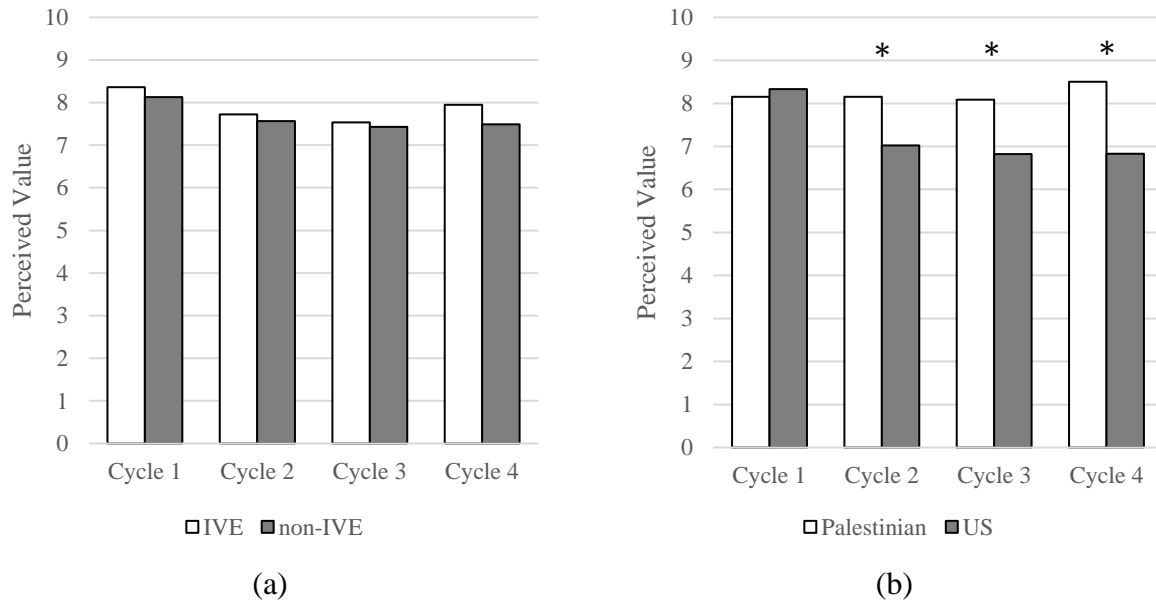
Figure 4. Summary of value survey comparing (a) IVE students to non-IVE students and (b) Palestinian students to US students. *indicates statistically significant differences between groups (α = 0.05).*

The qualitative responses were in alignment with the quantitative data in that the responses from the IVE and non-IVE students revealed similar sentiments. Generally, the students found the project contributed to a better collaborative learning experience while also sharpening their research, communication, and critical thinking skills.

Conclusions

The results of this study show that IVE experiences can have a positive impact on teamwork and global competency development of engineering students, while also being a value-added activity. Specific conclusions from this study include:

- The individual and team performance was positively impacted for the students on bi-national IVE teams. This was further enhanced through the implementation of cross-cultural dialogue sessions and dedication of class time for project work. The students on non-IVE teams did not exhibit such development.

- The IVE experience had positive impacts in all areas of students' global competency growth over the course of the project with the greatest growth exhibited in the knowledge of the other country and culture.

- The Palestinian students, regardless of whether they were on an IVE team or not, perceived greater value of the project experience than the US students indicating that the overall structure of the project-based learning components may have been more valuable for the Palestinian students than the IVE experience itself.

Lessons Learned and Recommendations

- An IVE experience can be intimidating or stressful for some students. The use of cross-cultural dialogue sessions can help ease the transition to an IVE experience. It is recommended that a similar type of team forming activity be done for any team project, regardless of whether it is an IVE project.

- It is recommended to allocate common time for students to work together on the project. This is especially true for IVE experiences as dedicating class time to synchronous project work made it easier for teams to coordinate their schedules, especially with the challenge of a seven-hour time difference. This improved the overall quality of the experience and work product while also improving overall team satisfaction.

- The regular feedback provided by the instructors during the weekly meetings was beneficial for the IVE teams.

- It is recommended to coordinate common class/team meeting times in advance to avoid inconvenient times. In this project, the dedicated common meeting time was at 3:35-4:50 pm local time for the US institutions, which was 10:35-11:50 pm local time in Palestine. While the Palestinian students on IVE teams participated in each meeting, the late time was not ideal for them.

- Prior to this experience, the faculty had never participated in IVE. With the help of an experienced facilitator in the Director of Virtual Exchange at An-Najah, they were able to incorporate IVE into their existing classes without sacrificing existing learning outcomes. This has been a rewarding experience and we encourage others to consider incorporating IVE where it makes sense. We also recommend identifying someone with experience to help guide you through the process.

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Appendix A. Global/cultural competency survey statements

Category	Statement
Knowledge of Other Culture & Country	I know the cultural traditions of the other country
	I know about the daily life of youth in the other country
	I understand common issues facing youth in the other country
	I know the etiquette and rules around verbal and/or nonverbal communication in the other country
Cross-cultural Comfort	I feel self-confident and comfortable socializing with people from other cultures
	I feel uncomfortable when I am with people who are speaking a language I do not know
	I feel comfortable interacting in a multicultural team
Innovation & Problem Solving	I have innovative ideas to solve global issues
	I can solve complex global problems
Awareness of the Importance of Gender Inclusivity	I am knowledgeable about existing gender dynamics in society, and the role gender plays in our daily lives and interactions, including in academic settings
	Creating a team environment that is inclusive of all members regardless of gender, race, or ethnicity is important
	Gender-inclusive course material is very important

Likert scale: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree

Appendix B. Value survey

Value Cycle	Statement
Cycle 1 Immediate Value	Consider your group meetings and rate the level of each of the characteristics below. *Scale: 0 (poor) to 10 (excellent)* • Level of participation • Quality of engagement
	How would you rate your group meetings in each of the categories below? *Scale: 0 (poor) to 10 (excellent)* • Fun • Inspiring • Friendly
Cycle 2 Potential Value	Thinking about your participation in this group project, rate your level of agreement for the following: *Scale: 0 (strongly disagree) to 10 (strongly agree)* • I have gained new skills. • My understanding of pavements and pavement performance has changed. • My group participation contributed to my learning. • I have learned new methods (tools or processes). • I have a new voice through our collective learning. • I see opportunities for learning that I did not see before. • I have learned how to collaborate more effectively as part of a team.
Cycle 3 Applied Value	Thinking about your participation in this group project, rate your level of agreement for the following: *Scale: 0 (strongly disagree) to 10 (strongly agree)* • I will use the products/knowledge/skills from this project in the future. • I will connect with my group members in the future. • My experience in this group will inform future learning opportunities. • My experience in this project will help me be a better team member in the future.
Cycle 4 Realized Value	Thinking about your participation in this group project, rate your level of agreement for the following: *Scale: 0 (strongly disagree) to 10 (strongly agree)* • I achieved something new by participating in this project. • I feel more confident in my knowledge, skills, & abilities after participating in this project.

Open-ended questions to elicit each student's value creation story.

1. Consider your group meetings and describe a meaningful activity you participated in and your experience of it (e.g., a conversation, a working session, a component of the project, etc.).

2. Describe a specific resource this activity produced for you (e.g., an idea or a document) and why you thought it might be useful.

3. Describe how you used this resource in the Innovative Pavement Solutions project and what it enabled that would not have happened otherwise.

4. Explain how it affected your success (e.g., being a better student, satisfaction with group work, your grade, etc.).