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Assessment of an International Virtual Exchange Project with Civil Engineering Students from the US and Palestine: Global Competencies, Perceived Value, and Teamwork

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Abstract

This paper presents the results of a study conducted to assess the value of two iterations of an international virtual exchange (IVE) experience between universities in the US (Clemson University and Bucknell University) and Palestine (An-Najah National University) in 2021 and 2022. The focus of this study was a five-week collaborative project where civil engineering students enrolled in pavement design or environmental engineering courses at three universities were tasked to develop innovative solutions to a pavement related problem in one of five general areas.

Based on the course enrollments at each institution (i.e., 50 US and 19 Palestinian students in 2021 and 35 US and 51 Palestinian students in 2022), there were two treatment groups: IVE and non-IVE. In 2021 there were nine bi-national IVE teams and eight non-IVE teams composed only of students from Clemson University (US). In 2022, 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 (1) global competencies, (2) value of the experience, and (3) team dynamics.

The influence of the experience on the global competencies of the students in IVE and non-IVE teams was assessed quantitatively and qualitatively using pre- and post-program surveys 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. The value of the project experience for all students (i.e., IVE and non-IVE) was evaluated using a mixed methods assessment based on the "value-creation framework" of Wenger-Trayner et al. Four cycles of the value-creation framework were included in this assessment: (1) immediate value, (2) potential value, (3) applied value, and (4) realized value. Finally, teamwork was evaluated using the Individual and Team Performance (ITP) Metrics Peer Feedback and Team Dynamics survey.

Results showed that modifications made between the first and second project iterations, specifically cross-cultural dialogue modules, had positive impacts on the overall outcomes. 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 (sometimes referred to as "soft" skills) have been highlighted by the engineering profession. ABET, the accrediting body for engineering programs, points to these competencies in student learning outcomes 2, 3, 4, and 5 [1]. These student outcomes focus on engineering design solutions with consideration of global, cultural, environmental and social factors; communicating effectively; recognizing ethical and professional responsibilities; and the ability to function effectively on a team.

Endorsed by the National Academy of Engineering, the Grand Challenges Scholars Program (GCSP) [2], includes five competencies that engineers need to be able to tackle the wicked problems facing our society including the 14 Grand Challenges of Engineering (NAE) and the 17 UN Sustainable Development Goals. These five GCSP competencies are: Talent Competency, Multidisciplinary Competency, Viable Business/Entrepreneurship Competency, Multicultural Competency, Social Consciousness Competency. The American Society of Civil Engineers (ASCE) also emphasized the importance of these essential skills in the Civil Engineering Body of Knowledge [3].

In a report on the global state of the art in engineering education, Graham identified current and emerging global leaders in engineering education [4]. The report pointed to trends amongst the leaders including curricula that "emphasize student choice, multidisciplinary learning and societal impact, coupled with a breadth of student experience outside the classroom, outside traditional engineering disciplines and across the world." Other key features included an emphasis on problem-based learning, user-centered design, and online and blended learning [4].

Several of these skills can be achieved through Project-Based Learning (PBL), which is centered on the learner and often designed to engage the learner in authentic (real-life) problems, while the teacher's role is to guide and advise, rather than to direct and manage, student work [5-7].

With increasing globalization, cross-border collaboration is becoming more common in industry. As a result of this advancement, intercultural competence has become one of the essential skills required by today's engineers, in addition to the technical skills they possess. Global competencies comprise the ability of the masses or teams from different backgrounds and cultures, who possess good interactive skills to work together and embrace multiple perspectives [8]. To address and develop the global competencies of engineering students, universities offer and promote a variety of programs to help students develop these skills [9]. International exchange programs or international internships are standard among these [10]. International virtual exchange (IVE) programs are another option.

Students participating in study abroad programs have shown positive changes in intercultural competence, language proficiency, and intellectual and cognitive development. However, only relatively few enrolled undergraduate students participate in these travel-based exchange programs because of the associated costs and time commitments. Given these challenges, universities search for additional ways to enhance their students' global and intercultural

competence. With the advancement of collaboration technologies, Global Virtual Teams (GVT) have become necessary in multinational organizations. GVTs enable teamwork through internet-based platforms and connects members across different geographical regions who have no prior face-to-face interaction, working on common tasks and goals. Several universities across the world are trying to incorporate GVT-based IVE. Students who participate in these experiences get the opportunity to work across different time zones, with different cultural perspectives and educational practices, also adapting their working styles and approaches [11].

Parkinson noted that engineering students can appreciate culture, work, and communicate as a team irrespective of culture or ethnicity; can practice engineering on a global scale through international internships or virtual engineering programs; and hence deal with ethical issues [10]. The findings from the study of a course in intralogistics education was initiated and realized between the Technical University of Munich in Germany and Tongji University in China suggest that the GVT-based virtual exchange program was effective in improving the intercultural competency of engineering students [10].

O'Dowd argued that IVE had remained misunderstood and undervalued and was lost among different activities and opportunities [12]. However, over the past few years, the pace of IVE started to gradually accelerate. The Stevens Initiative was launched in 2015 to build global competence for young people in the US and the Middle East and North Africa (MENA) region. In 2016, UNICollaboration was launched to support the research and practice of IVE in university education. In 2017-2020, the European Commission granted funding for projects to provide training for university educators, and launched several other IVE initiatives. During 2020, UNICollaboration, Erasmus+ Virtual Exchange, and DAAD (German Academic Exchange Service) provided training and also launched several IVE initiatives [12]. All these initiatives envisioned the IVE to play an important role in its own right in the development of intercultural dialogue between young people. It is clear that IVE can be an important part of university foreign language education as we move forward into the next decade.

Results of the above-mentioned IVE initiatives and others have commonly reported high levels of student satisfaction, development of cultural knowledge of the partner's country, and the development of foreign language skills. Furthermore, students would highly recommend such activities to their peers. However, students' empathy levels were not seen to have developed significantly [12].

Some studies reveal that virtual cross-cultural teamwork has benefited students from different locations, cultures, and time zones [13]. Teamwork skills from different regions with culturally different backgrounds prepare individuals to face the challenges of a global business environment [14]. Students would be well equipped for a professional phase of their careers if they could collaborate with an international team during their educational phase [14]. Moreover, international virtual exchange programs are not associated with high cost and investment compared to study abroad programs and are timely and more flexible; hence can be adopted as an alternative or supplement to study abroad programs [13].

IVE allows for international and intercultural interactions among students, which substantially lowers the barriers for participating in such exchange. It is clear that IVE has potential to

contribute to sustainability, and develop the ability to collaboratively contribute to the alleviation of global sustainability issues, such as climate change [15].

The InVEST (International Virtual Engineering Student Teams) program is a GVT program established in Canada. It was designed to create a realistic work experience for engineering students within a virtual global team project. They were involved in active experiments while learning and reflecting on a new experience with a learning concept known as global competency modules (GCMs), which is a key component of GVT that supports virtual learning and collaboration activities globally, including intercultural competence, decision making, communication, and relationship building. The InVEST study showed that intercultural activities provide a unique lens to students to exhibit intercultural sensitivities to virtual global team projects and can facilitate better collaboration with students from various institutions. The study also suggests that higher education institutions can utilize these learning approaches and enhance their engineering students' skills and instill valuable professional experience for their future roles as modern-day engineers [16].

The COVID-19 pandemic disrupted higher education institutions, leading to two-thirds of educational institutions shifting to virtual learning from traditional classes as per the International Association of Universities (IAU) Report [17]. The emergence of the COVID-19 pandemic catalyzed the development of virtual exchange programs and the required tools to make the programs possible to implement [18].

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.

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. One of the authors, Dr. Putman, has been using this project in his senior level pavement design course since 2016 for civil engineering students at Clemson University located in Clemson, South Carolina. The primary goals of this project have historically been focused on helping the students develop effective teamwork and communication skills, implement the design thinking process, and recognize the broader impacts of pavements on our society. To help students focus their efforts, they were given the following general areas to focus on a more detailed problem definition:

- Improving pavement performance in adverse weather
- Improving sustainability of (or with) pavements
- Improving safety of pavements

- Improving pavement construction practices
- Addressing budgetary constraints for pavements

In the summer of 2021, Dr. Putman partnered with Dr. Al-Sahili, a civil engineering professor at An-Najah National University (An-Najah) located in Nablus, Palestine to develop an international virtual exchange (IVE) experience for civil engineering students at both institutions. Since Drs. Putman and Al-Sahili both taught a similar pavement design course, they adopted the previously described project and added the goal of helping students develop global competencies. The Director of Virtual Exchange at An-Najah provided guidance and expertise in IVE throughout the project from concept to present. The project was implemented as an IVE project in the fall semesters of 2021 and 2022.

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 [19, 20].

- *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

Following each survey, results were shared with participants in individual reports. These reports provided an explanation of the individual results along with recommendations to help the participant improve in each area.

Team dynamics were measured through this survey using the team CARE model developed by O'Neill et al. [21]. 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

Additionally, the survey also assesses overall team satisfaction.

Global Competency

The Stevens Initiative, in consultation with RTI International, developed a set of statements to quantitatively evaluate the students' acquisition of key global competencies (knowledge of other cultures and country and comfort with cross-cultural communication and collaboration) as the result of an IVE experience. These statements were included in a survey administered to all students (IVE and non-IVE) before the project start and after project completion. In addition to answering questions based on their present perspective, the post-project survey asked participants to answer questions retrospectively. Retrospective survey items asked the students to think back to before they engaged in this project, reassessing themselves after the completion of the project. Additional questions were also developed for this project to measure the students' development of skills related to innovation and problem solving as well as equity and inclusion [22]. Qualitative survey items that allowed a space for students to reflect on their experience as well as demonstrate their ability to effectively communicate across language barriers were also included [23]. The survey questions are included in Table 1.

Table 1. 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

Perceived Value

As IVE programs have expanded throughout higher education, evaluation has become a priority—not just for the overall experience of participating in an IVE, but also for the value gained by participation. Measuring the 'value add' of experiences to students was identified by engineering education thought leaders as a next frontier in the field [4]. The evaluation framework for value creation by Wenger-Trayner, et al. serves as a measure for whether value was created or not and focuses on seven cycles of value-creation, of which the first four have been used in measuring value of IVE programs [24]. The first four cycles focus on

"completeness" thus providing an opportunity for participants to explain their value story [24]. The first four cycles of the framework are:

- *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 remaining cycles are transformative (or reframing) value, strategic value, and enabling value. The first four cycles feed the remaining three and all cycles inform each other and can occur during different times of the value-creation story. Figure 1 depicts the value-creation framework.

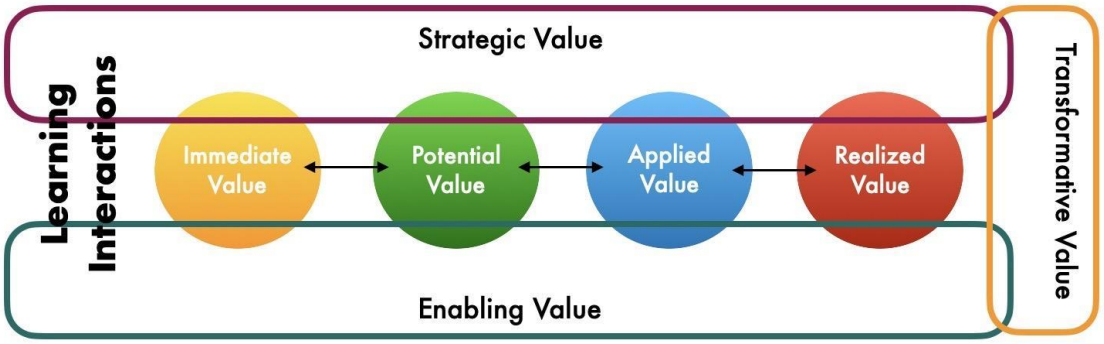


Figure 1. Value creation framework from Wenger-Trayner, et al. [24].

As IVEs become more prominent in higher education—to address global challenges—evaluation of the value they create is critical. This assessment allows for better design of IVE experiences and ensures students have a positive and meaningful experience participating in an IVE. While not many have looked at the value of an IVE, Calix and Prusko suggest the value-creation framework as a useful tool to understand the value story of students [25]. They also suggest this framework as a collaborative tool for researchers studying IVE. The value survey was administered to students following the completion of the project.

First Offering—2021

In the first iteration of the project in 2021, there were 50 students from Clemson University (US students) and 19 students from An-Najah (Palestinian students). All students were senior and graduate level civil engineering students. Due to the difference in enrollment numbers between the two universities, it was determined that there would be two types of teams: IVE and non-IVE teams. The IVE teams were comprised of two US students and two to three Palestinian students for a total of nine bi-national IVE teams. The remaining 32 US students made up eight non-IVE

teams of four students each. For the IVE teams, students self-selected a partner from their university to work with on a team, then each pair was randomly assigned to a pair from the other school to form the team. The non-IVE teams self-selected their entire team of four.

The only formal assessment in the 2021 offering was for individual and team performance using ITP Metrics. The Global Competency and Value surveys were administered, but received very low response rates.

Peer Feedback results are summarized in Figure 2. In 2021, the students on IVE teams demonstrated significant improvements in Communication over the duration of the project. There were slight increases in the other areas (Capabilities, Standards, Focus, and Commitment), but the differences were not significant. There were generally no changes in the peer evaluation scores for the non-IVE students throughout the project. The improvement in communication in 2021 was likely the result students becoming more familiar with each other and how to best communicate. In this first offering, no specific scaffolding was in place to facilitate improvements in team performance.

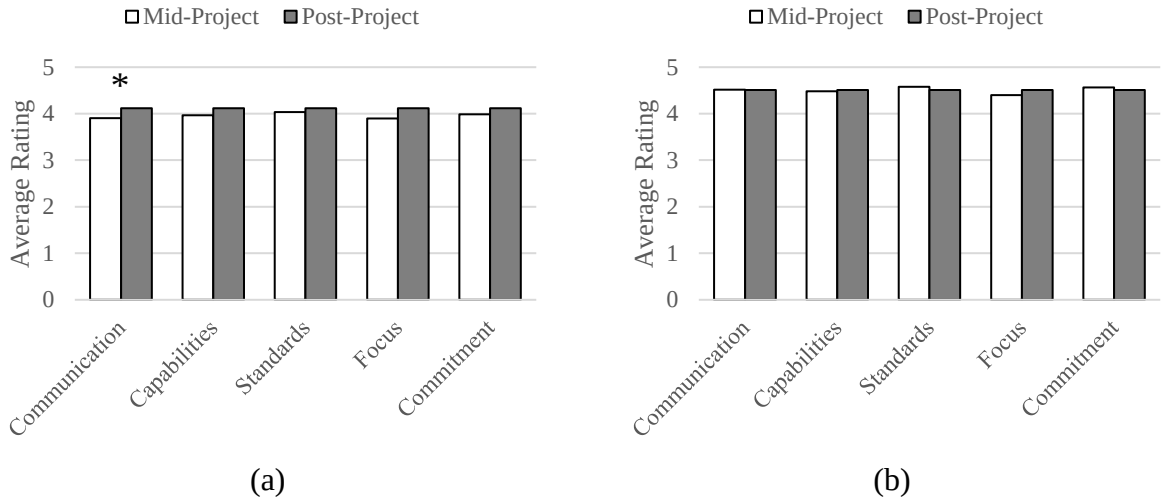


Figure 2. Peer Feedback results from 2021 for (a) IVE and (b) non-IVE teams. *(* denotes a statistically significant difference between the two surveys; $\alpha = 0.05$)*

The four primary categories of team dynamics (Communicate, Adapt, Relate, and Educate [CARE]) and overall team satisfaction from 2021 are summarized in Figure 3. Teams generally showed slight improvements in all areas over the course of the project, but the changes were not statistically significant. The only exception was that the IVE teams showed significant growth in the Adapt category. While the results of the IVE teams were not compared to the non-IVE teams, the values shown in Figure 3 are relatively similar for the two different groups (IVE and non-IVE). These results were not directly compared due to the fact that the IVE teams were comprised of students from two different countries and the non-IVE teams were made up of students from the same institution in the US. It was recognized that there could be potential differences in the approach to peer evaluation in the different countries that could affect the

comparison. Additionally, the familiarity of the students on the non-IVE teams could also influence the values at the early stages of the project.

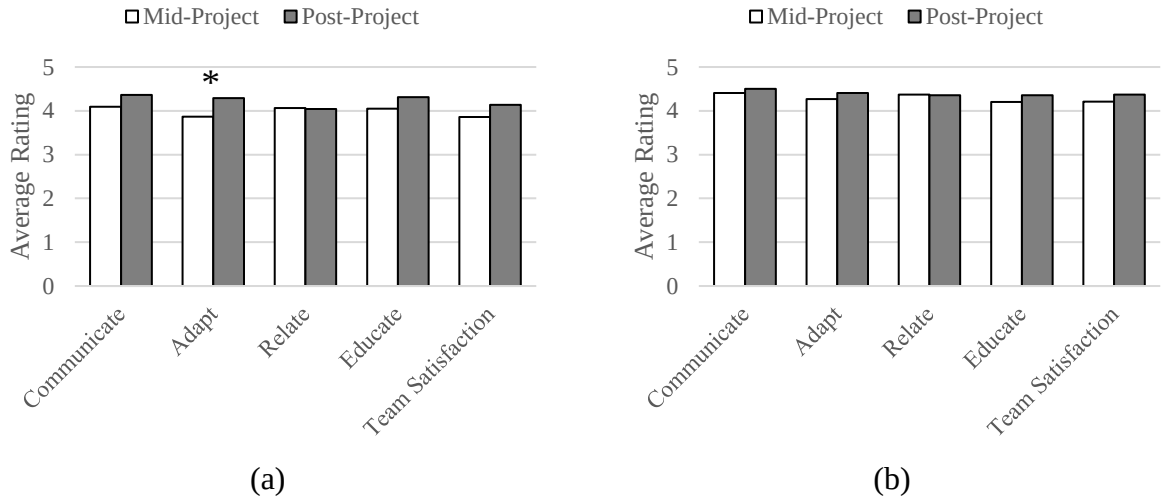


Figure 3. Team Dynamics results from 2021 for (a) IVE teams and (b) US non-IVE teams. *(* denotes a statistically significant difference between the two surveys; $\alpha = 0.05$)*

Based on the first experience, Drs. Putman and Sahili decided to continue this collaboration in the Fall of 2022, but realized that improvements needed to be made to address some issues identified in 2021 the offering. In this second iteration, the following changes were implemented in response to lessons learned from the first offering and due to other circumstances.

> Change 1: Addition of students from Bucknell University, a small, private National liberal arts university located in Lewisburg, PA. This university was included when Dr. Putman took a new position there. Two senior-level civil engineering students from Bucknell took part in the project. This change also resulted in a new faculty member and graduate student instructor joining the team from Clemson.
>
> Change 2: Addition of third-year civil engineering students from An-Najah enrolled in an introductory environmental engineering course. This more than doubled the number of students from this institution. It also engaged a second faculty member from An-Najah.
>
> Change 3: Implementation of cross-cultural dialogue sessions for IVE teams prior to the start of the project. These sessions were developed based on the feedback, observations, and lessons learned from the 2021 iteration of the project. 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. 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.

Change 4: Dedication of class time for teams to work together. 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 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.

Change 5: More robust assessment of the project. In addition to assessing individual and team performance, we proactively planned assessments to evaluate development of global competencies and to learn more about the perceived value of the experience by the students.

Second Offering—2022

In 2022, 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. As with 2021, the IVE teams consisted of two US and two Palestinian students. 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.

To help compare the 2021 and 2022 offerings, Table 2 summarizes the participants, timelines, activities, deliverables, and other relevant details.

Teamwork

Peer Feedback results from 2022 are summarized in Figure 4. In 2022, students participating on IVE teams demonstrated significant growth in Communication, Abilities, and Commitment over the duration of the project as evidenced by increases in their peer evaluation scores in these areas between mid-project and post-project evaluations. The changes in the areas of Standards and Focus, while positive, were not statistically significant. This shows that the interventions implemented in 2022 were effective in helping students be better team members on a multi-national team.

Table 2. Summary of the project experiences in the 2021 and 2022 versions.

	2021	2022
Participants	• 9 IVE teams (18 US and 19 Palestinian students) • 8 US non-IVE teams (32 students)	• 9 IVE teams (18 US and 18 Palestinian students) • 5 US non-IVE teams (17 students) • 7 Palestinian non-IVE teams (33 students)
Project Timeline	5 weeks (Sept. 13 – Oct. 18)	8 weeks (Sept. 28 – Nov. 16)
Pre-project Activities	IVE kickoff meeting (one hour) to introduce team members via Zoom. Ice breaker questions to initiate conversations.	Synchronous IVE cross-cultural dialogue sessions facilitated by UN certified facilitators through Soliya. Two sessions of two hours each via Zoom (Weeks 1-2). Three facilitators worked with two teams and another with three teams.
Team Meetings	Teams scheduled meeting times on their own outside of class time. Portions of some US class meetings were made available for project work.	One US class period per week (Wednesdays at 3:35-4:50 pm EDT) was dedicated to project work throughout the project duration. An-Najah IVE students joined synchronously via Zoom. Faculty covered a different aspect of the Design Thinking process each week, then IVE teams worked in breakout rooms, while US non-IVE students worked together as they chose. Faculty checked in with each team and provided feedback on progress reports and addressed issues raised in reflections as appropriate.
Deliverables	• Proposal • Progress Report • Digital Poster • Presentation (via Zoom)	• Team Contract • 3 Progress Reports (Problem Definition, Ideation, Prototype) • Digital Poster • Presentation (via Zoom) • Weekly individual reflections
Communication	Zoom, WhatsApp, Email	Zoom, Email, Google Classroom
Assessment	• ITPMetrics Peer Feedback & Team Dynamics survey (mid- and post-project)	• ITPMetrics Peer Feedback & Team Dynamics survey (mid- and post-project) • Global Competencies survey (pre- and post-project) • Value survey (post-project)

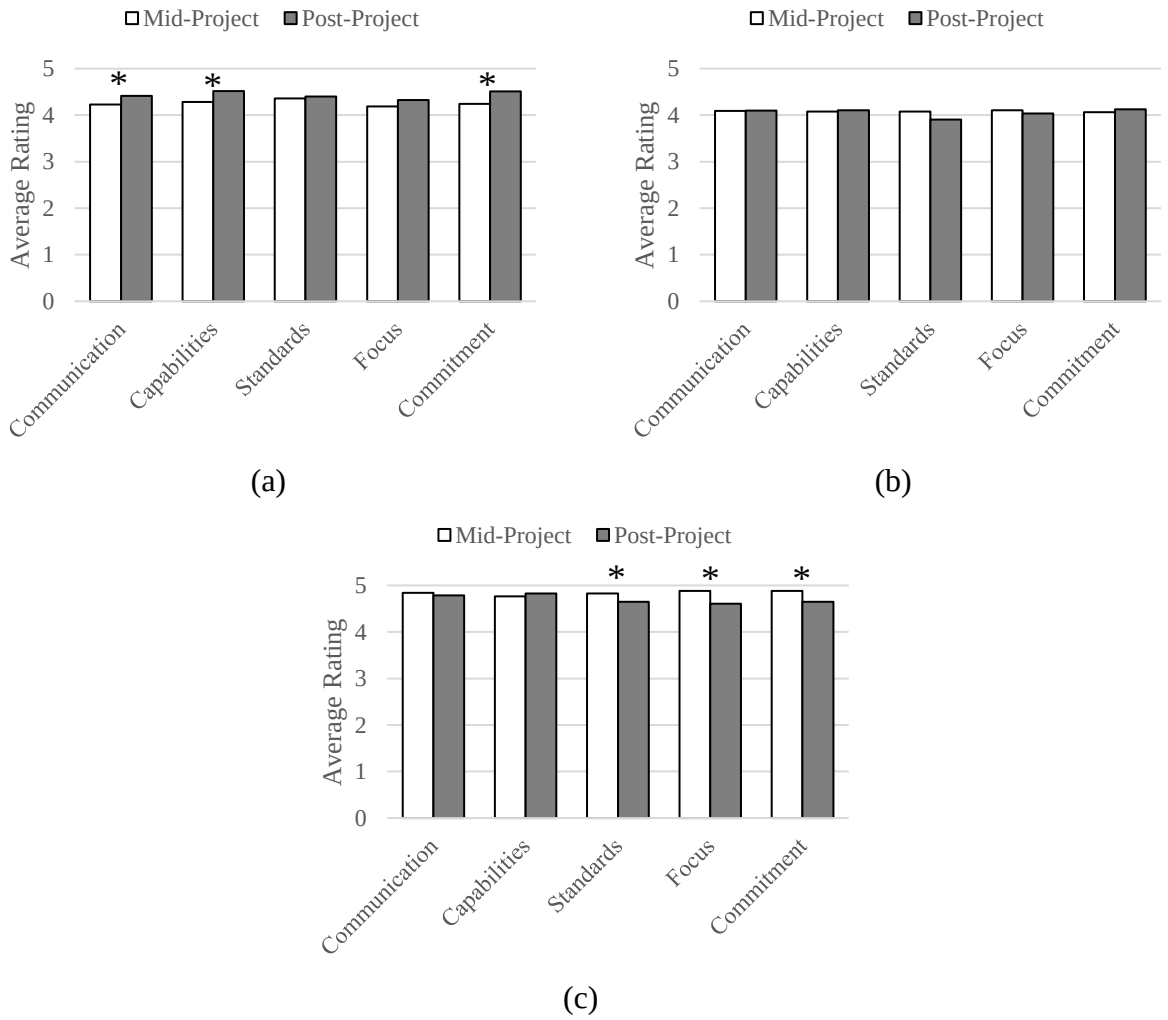


Figure 4. Peer evaluation results from 2022 for (a) IVE teams, (b) Palestinian non-IVE teams, and (c) US non-IVE teams. *(* denotes a statistically significant difference between the two surveys; $\alpha = 0.05$)*

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. As a reminder, with the exception of Changes 4 and 5 for the US non-IVE teams, the interventions implemented for the IVE teams were not implemented for the non-IVE teams. Non-IVE teams were generally treated as they had been in 2021.

When analyzing the results from the US non-IVE students, it was observed that the ratings from the mid-project evaluations were quite high in all categories compared to the Palestinian non-IVE students and IVE students. This raised the question within the research team about potential differences in peer evaluation ratings in the US and other countries. Are US students more likely to rate students higher in peer feedback than students from other countries, and if so, is this due to cultural or other influences? Language barriers could have also influenced the initial ratings as

anyone speaking in their native language may feel more confident and less stressed. Another potential reason for this was that all of the US non-IVE teams were self-selected whereas that was not the case for all of the Palestinian non-IVE teams. For the IVE teams, while students self-selected a student they'd like to be paired with, those pairs were randomly assigned another pair from the opposite institution. Therefore, personal relationships and/or familiarity may have influenced the mid-project US non-IVE peer evaluations more than others. However, as the project progressed, the actual performance on the team may have had more of an influence on the post-project ratings as noted by the decline in multiple categories.

As shown in Figure 5, the IVE teams exhibited significant growth in team dynamics over the duration of the experience in 2022, specifically in the areas of Communicate, Adapt, and Relate. The overall team satisfaction also significantly improved. The non-IVE teams comprised of either just US students or Palestinian students, however, did not exhibit any significant changes in team dynamics over the course of the project. In fact, as with the individual performance, the US non-IVE teams generally showed slight declines in multiple categories throughout the duration of the project.

Additionally, when comparing the different categories for all teams, the results were relatively similar for the most part. The Palestinian non-IVE teams had a lower score in the Relate category than the others. This could be due to the fact that unlike the US non-IVE teams, these teams were comprised of students from two different classes at the institution and were from different class years (i.e., third and fourth year). Finally, not all of the Palestinian non-IVE teams were self-selected, rather some of the students were assigned to teams, which could have had an impact on team performance. Because some teams may not have had a connection prior to this project, and because they did not have the intentional dialogue sessions like the IVE teams, their feelings of equity, conflict, and trust—all components of the Relate category—may have been impacted more so than the other categories.

As with the individual performance, the 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 2021 to 2022. In 2021, there were no such interventions and both IVE and non-IVE were treated equally. In 2022, the intervention was only applied to the IVE teams, not the non-IVE teams.

Global Competency

The Global Competency survey described previously was administered before the project began and again after the project was completed to assess participant growth with respect to cultural competency, innovation, and inclusivity. In the post-project survey, in addition to answering the questions based on their position after the project experience, participants were asked to reflect back on before they started the project to answer the questions in retrospect.

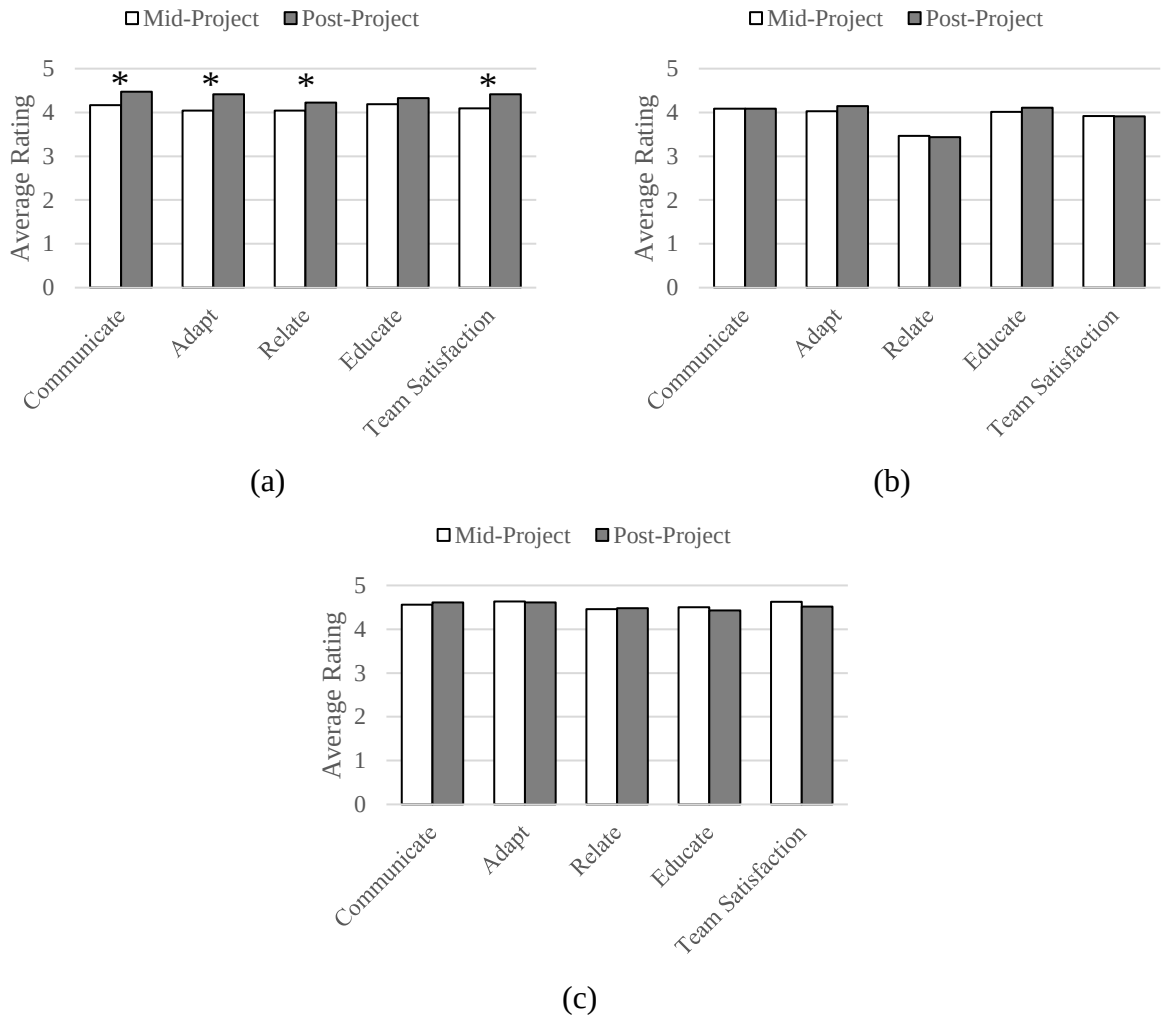


Figure 5. Team Dynamics results from 2022 for (a) IVE teams, (b) Palestinian non-IVE teams, and (c) US non-IVE teams. *(* denotes a statistically significant difference between the two surveys; $\alpha = 0.05$)*

The results presented in Figure 6 summarize the percent of respondents who indicated that they either agreed or strongly agreed with the statements in the respective areas. Only the data for the post-project survey are included due to the low response rate from one group of students to the pre-project survey. The use of retrospective questions is recommended due to the fact that students tend to rate themselves relatively higher in pre-program surveys than they would after reflection following the program [26]. However, when comparing the results of the pre-project survey responses to the retrospective responses in the post-project survey, they were generally similar with a few exceptions.

Four of the survey questions are related to the students' *Knowledge of the Other Country or Culture*. 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.

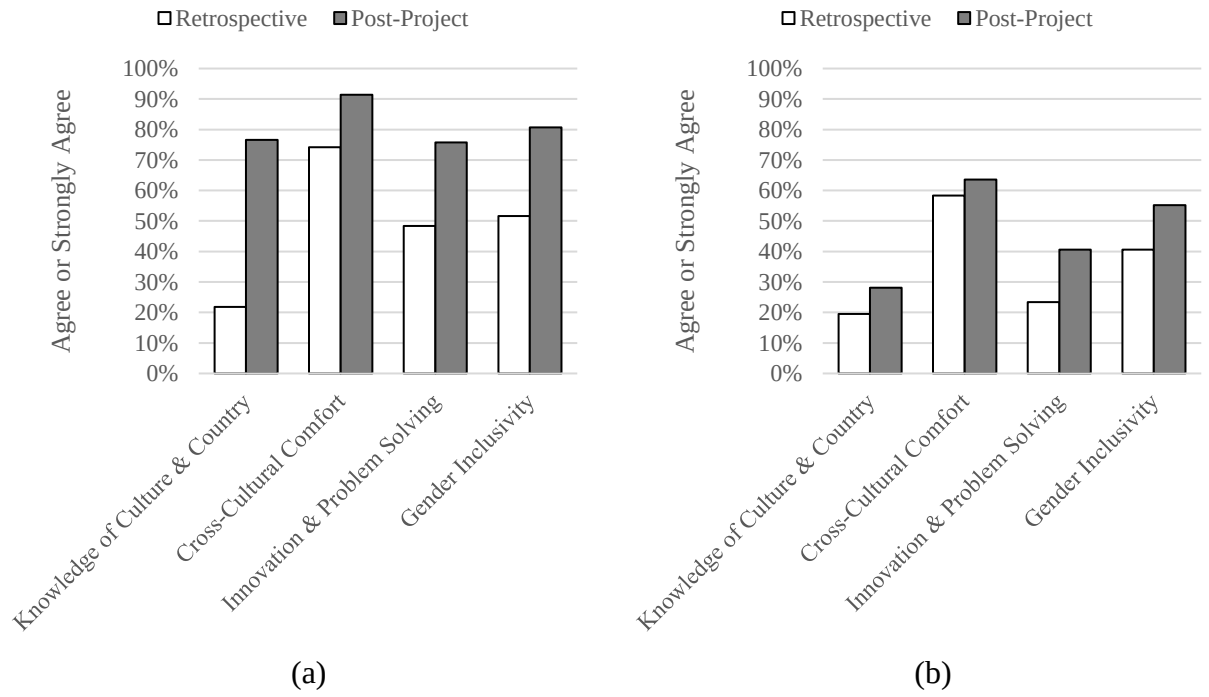


Figure 6. Global Competencies survey responses based on retrospect and following completion of the project for (a) IVE students and (b) non-IVE students.

The area with the least, but still significant, growth for the IVE students was in their knowledge of the etiquette and norms relating to verbal and/or nonverbal communication in the other country—*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). It was noted that the IVE students had greater comfort levels going into the project compared to the non-IVE students. This result is not surprising as most IVE participants self-selected to participate on an IVE team, whereas all non-IVE students preferred not to participate on an IVE team.

These quantitative results 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

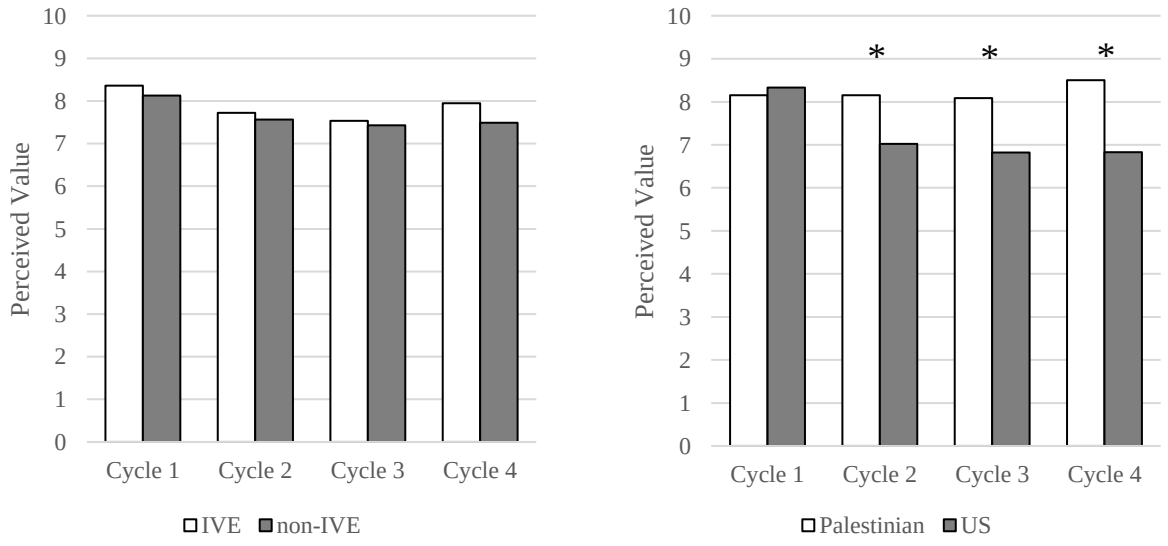
tricks or strategies to overcome language barriers, the US IVE student responses increased significantly in the post-project survey. In the pre-project survey the responses were more general and abstract with a focus on attitude (e.g., “communicate as much as possible,” “be open”). However, in the post-project 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 in 2022.

Two survey questions focused on the level of innovation and ability to solve complex global problems—*Innovation and Problem Solving*. While both IVE and non-IVE students showed growth as part of this experience, the growth was higher for the IVE students (28% for IVE and 18% for non-IVE students). Again, the IVE students considered themselves more innovative and able to tackle complex problems going into the project compared to the non-IVE students.

Finally, *Awareness of the Importance of Gender Inclusivity* was the focus of three survey questions. All students gained a greater appreciation for gender inclusivity over the course of this project, but the growth was, once again, greater for the IVE students (about 29%) compared to the non-IVE students (about 14%).

Perceived Value

The value survey aims to create a value-creation story. Through the quantitative questions for the four cycles as well as the open-ended questions about specific experiences, we can piece together the value students found in this project experience. Overall, students found value in the project with each cycle having ratings mostly greater than 7 out of 10 as summarized in Figure 7.



(a) (b)

Figure 7. Summary of value survey comparing (a) IVE students to non-IVE students and (b) Palestinian students to US students. *(* denotes a statistically significant difference between the groups; α = 0.05)*

The quantitative results reveal that while the IVE experience generally added value to the project, the differences were not statistically significant, therefore the value was similar for both IVE and non-IVE groups. While all students generally perceived similar immediate value of the project (Cycle 1), the Palestinian students realized significantly greater value than the US students, independent of if they were on an IVE team or not in Cycles 2, 3, and 4 (Potential, Applied, and Realized Value). 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 [26-29]. The fact that they would recommend such an experience likely points to the value the 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 see 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).

Finally, participants responded to four open-ended questions related to the value cycles which was a way for students to share their value-creation story. Overall themes were identified for each question and generally were related, building on the value in each cycle:

- *Cycle 1 – Immediate Value*: Learning about people and culture; working together to design a solution; focusing on specific project aspects; and having a positive group experience
- *Cycle 2 – Potential Value*: Organization and sharing of technology tools; using research tools; helping with project design; and contributing to an increase in knowledge
- *Cycle 3 – Applied Value*: Idea sharing; working well as a group; and gaining knowledge about project content
- *Cycle 4 – Realized Value*: Better group experience; better student; smooth experience; and better design solution

The qualitative responses were in alignment with the quantitative data as 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

Based on the results of this study, it is evident that IVE experiences can have a positive impact on teamwork and cultural competency development of engineering students. Additionally, students find value in project-based learning experiences. Specific conclusions from this study include:

- Students participating on bi-national teams as part of the IVE experience exhibited growth in the ability to effectively communicate over the course of the project. This shows that students were able to adapt their communication styles to overcome language and cultural differences. The non-IVE students did not show significant growth, likely because they did not have to overcome the same challenges since they were from the same institution as their teammates. This was evident in both offerings, indicating that the changes added in 2022 were not solely the reason for this growth of students on IVE teams, rather it was the IVE experience itself.
- While individuals on IVE teams improved in their ability to communicate effectively in the first offering (2021) without scaffolding, team dynamics only improved in their ability to coordinate and progress towards goals (Adapt) for IVE teams while non-IVE teams did not show growth in this area.
- The individual and team performance was positively impacted by the implementation of the changes made in 2022. Specifically, the addition of cross-cultural dialogue sessions and dedicated class time appeared to have enhanced communication, perceived abilities, and commitment to team progress for students on IVE teams. The students on non-IVE teams did not exhibit such development. In fact, the US non-IVE students actually showed a decline in their emphasis on quality, focus on the project, and commitment to the team over the course of the project.
- The interventions in 2022, specifically the cross-cultural dialogue sessions resulted in beneficial impacts on team dynamics for the IVE teams, including overall team satisfaction. The non-IVE teams did not exhibit improvement in team dynamics, thereby demonstrating the benefits of the cross-cultural dialogue sessions.
- The IVE experience had positive impacts on the students' global competency growth over the course of the project. The greatest growth was seen in the knowledge of the other country and culture, but substantial growth was also realized in cross-cultural comfort, innovation and problem-solving confidence, and awareness of the importance of gender inclusivity. These gains are due to a combination of the IVE experience and scaffolding, along with the students' pre-disposition as these gains were greater for the IVE students than the non-IVE students.
- The Palestinian students, regardless of whether they were on an IVE team or not, indicated that they saw greater value of the experience in value Cycles 2, 3, and 4 (Potential, Applied, and Realized Value) than the US students. This indicates that the IVE experience itself did not have an impact on the overall perceived value of the project

experience, but the structure of the project-based learning components may have added value for the Palestinian students.

- It was evident that student gains significantly improved in the second IVE offering (2022), which was attributed to the introductory cross-cultural dialogue modules offered to students during the team forming stage in advance of project work.
- While cross-cultural differences are inevitable on IVE teams and can present challenges not present in non-IVE teams, these differences should be embraced as potential learning opportunities. Assessment of IVE participants should take into consideration these additional challenges.

Lessons Learned and Recommendations

- The pre-project cross-cultural dialogue sessions helped the IVE teams establish a foundation of trust and open up on a personal level, separate from the project focus, which helped them learn how to work effectively as a team. 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. This would be especially helpful if teams are being formed from multiple courses and/or institutions, or if student teams are assigned rather than self-selected.
- 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.
- 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 not only improved the overall quality of the experience and work product, but also led to improved overall team satisfaction. It is recommended to allocate common time for students to work together on the project. This is especially true for IVE experiences, but would also benefit non-IVE experiences.
- The regular feedback provided by the instructors during the weekly meetings was beneficial for the IVE teams. It is recommended to extend this practice to any project team, IVE or not.
- The instructors did not coordinate class meeting times in advance, therefore the dedicated common meeting time was at 3:35-4:50 pm local time for the US institutions, but this was 10:35-11:50 pm local time in Palestine. While we made this work, it is recommended that the meeting time for classes at all institutions be coordinated up front.
- This research covered a wide range of evaluation items and somewhat in general terms. Future research could focus on a specific evaluation item(s), and look deep into the individual and team attainment of specific skills and competencies, as these might better explain the results and provide more lessons to be learned. The use of additional research tools such as key informant interviews and focus group discussions is also recommended to provide additional insights and nuance to the quantitative data.
- 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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