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Advancing Student Perspectives through Bi-Institutional Hemispheric Collaboration in Humanitarian Engineering

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"Advancing Student Perspectives Through Bi-institutional Hemispheric Collaboration in Humanitarian Engineering"

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Abstract

In 2017 Metropolitan State University of Denver (MSU Denver) in Colorado and the Universidad del Valle de Atemajac University (UNIVA) in Guadalajara, Mexico partnered to implement a short term, bi-lateral student exchange program focused on studies in Humanitarian Engineering. This initiative was funded by the 100K Strong for Americas Grant aimed to promote "Building institutional capacity, increasing student mobility within the Americas, and enhancing regional education cooperation".

Humanitarian Engineering (HE) is a method of problem solving directed at cultivating the wellbeing of underserved people. It offers a platform to engage students in Service-Learning Activities.

This commencing international experience launched the establishment of a longer-term collaboration agreement between the two higher education institutions (HEIs) which evolved to include activities in COIL (Collaborative Online International Learning), and HE projects and courses.

This paper shares a course that was presented in two modalities though this cooperation with special attention paid to the outcomes as measured by a mixed methods survey and project evaluations. The learning outcomes are compared for a face-to face course and a COIL version of the same topic that engaged students in Humanitarian Engineering activities and are measured in three areas of: intercultural competencies, acquired Humanitarian Engineering and professional skills, and gained social consciousness. The outcomes from both courses are reported in this paper and show quantitatively that these two Humanitarian Engineering educational experiences provided a good forum to promote growth of skills in the aforementioned areas. The two modalities both showed growth, however, larger gains were witnessed in most of the categories for students who took part in the face-to-face course especially regarding students' perception in the areas of Intercultural competencies and gained social consciousness.

Background

In 2017 Metropolitan State University of Denver (MSU Denver) in Colorado and the Universidad del Valle de Atemajac University (UNIVA) in Guadalajara, Mexico partnered to create a collaborative course in Humanitarian Engineering. This 4-week course was planned through a proposal titled "Promoting Bi-institutional Hemispheric Collaboration through Study Abroad in Humanitarian Engineering" and selected by the 100,000 Strong for Americas education initiative sponsored by the U.S. Department of State, Partners of the Americas, and

NAFSA: Association of International Educators, and funded by ExxonMobil Corporation. The 100,000 Strong in the Americas program is an education initiative created "to increase the annual number of U.S. students studying in Latin America and the Caribbean to 100,000 and bring 100,000 students to the United States by 2020." [1]. It does this by fostering new partnerships among higher education institutions (HEIs) in the United States and the rest of the Western Hemisphere in student exchange and training programs with focus given to "building institutional capacity, increasing student mobility, and enhancing regional education cooperation" [1].

The objective of the initial partnership activities was to offer an innovative study abroad opportunity to American students to study within the hemisphere and to increase the number of Latin American, specifically Mexican, students studying in the United States. In terms of longer-range objectives, developing this course helped to build the foundations for a relationship between these HEI partners which has resulted in follow up courses and collaborative research in Humanitarian Engineering. This aligned with the theme of the 100,000 Strong in Americas initiative which "aimed to broaden the intellectual horizons of the participating students; establish a new partnership between two institutions of higher education; increase mobility of students and faculty; and the enrichment of curricula across the disciplines at the two Institutions of Higher Education" [1].

Humanitarian Engineering

Humanitarian Engineering is problem solving through engineering practices, in conjunction with complimenting knowledge from other disciplines, aimed at improving the conditions for vulnerable people. Humanitarian Engineering projects partner practitioners with beneficiary communities to enhance their conditions and improve their capacity [2]. This type of engineering is greatly needed. A large portion of the human population lives in situations of vulnerability, marginalization, and poverty. Approximately 1 in 10 people live without access to clean water, and nearly 4 billion people experience water scarcity for at least part of the year [3]. It is projected that, if no action is taken, water scarcity could lead to the displacement of up to 700 million people by the year 2030 [4]. Water challenges are just one of the obstacles facing the poor majority. Approximately 1.3 billion people faced food security issues in 2022, which is a 10% increase from 2021 [5]. A large gap also exists between people in developed nations vs. the developing world in the energy sector [6]. The nexus [7] of these issues impact health, education attainment, peace, and the environment. While engineers have traditionally focused on creating solutions for the developed world, the challenges for the poor majority have been underserved, "The majority of the world's designers focus on developing products and service exclusively for the richest 10%" [8].

Humanitarian Engineering aims to address these challenges. As an emerging field though, approaches for best practice methodologies are still being established and studied. Along these lines, pedagogy that promotes best learning for students in this area is also being developed. As an evolving topic, there is a natural drive to try new approaches. These conditions promote research into new techniques and technologies targeted at improving the well-being of vulnerable people.

Among the approaches that have shown success in local, small-scale context are designs that can be classified as Appropriate Technology (AT). Appropriate Technology is a term for solutions with the intention to meet the needs of communities based on their available resources, capacity and, significantly, the input of the people in the community. AT was originally called "Intermediate Technology" by Schumacher in his book "Small is Beautiful" [9]. As he put it, these solutions are "small-scale, decentralized, labor intensive, energy efficient, environmentally sound and locally controlled" [10]. A meta-analysis of the literature that has reported on AT found common terms such as "community input, affordability, adaptability, simplicity, etc." [11]. Schumacher defined technology as "appropriate" if it met the following criteria:

- Created jobs where people live
- Affordable enough for common use
- Required simple tools and techniques
- Used local materials
- Made things for local use

To achieve these criteria, Appropriate Technology requires participatory methods to be employed. The community where the technology is to be used must be involved in the decision-making process for selecting and implementing it. Best methods then incorporate a community study with stakeholder input so that the scope of the problem is well understood [12].

Appropriate Technology projects through Humanitarian Engineering educational experiences offer an opportunity for a high impact practice in education, Service-Learning.

While the term "Service-Learning" has been used to define a wide array of educational experiences (i.e., "volunteerism, community service, field studies, and internships") [13], in the context of this paper, Service-Learning is defined as a pedagogy that combines applied action learning (in Humanitarian Engineering) with outcomes that benefit the communities where the projects are implemented.

The Experiences

The following section describes two programs that took place in the partnership between Metropolitan State University of Denver (MSU Denver) in Colorado and the Universidad del Valle de Atemajac University (UNIVA) in Guadalajara, Mexico : A Face-to-Face HE course, which incorporated field experience and was offered through study abroad (2017), and a Collaborative Online International Learning (COIL) version of this HE course held in 2021.

The Face-to-Face HE Course

In the summer of 2017, an initial study abroad course launched the collaboration between the two HEIs. 10 students from each institution participated in a 1-month program focused on Humanitarian Engineering. This was presented through a combination of classroom exercises and field work projects. Classroom lectures introduced concepts such as HE methodology, regional history, discussion on religion and how it relates to the local people, lessons on poverty,

public health, Appropriate Technology, etc. The field work projects occurred in 2 locations: A rural Mexican farm, and a low resource village in the hills southwest of Guadalajara, Mexico. For the project portion of this experience, students loosely followed the CARE model [14] of Sustainable Community Development. Caldwell's CARE "Project Design Handbook," [14] offers a structure of good practices in community development projects. While it was initially intended for public health interventions, the CARE model lends itself well for HE projects. This model emphasizes a holistic and systematic approach to gathering community information and applying it to direct the solutions. It promotes inclusive identification of community issues and aims to recognize underlying causes for community concerns. The following diagram comes from the CARE handbook and illustrates the methodology sequence and relationships.

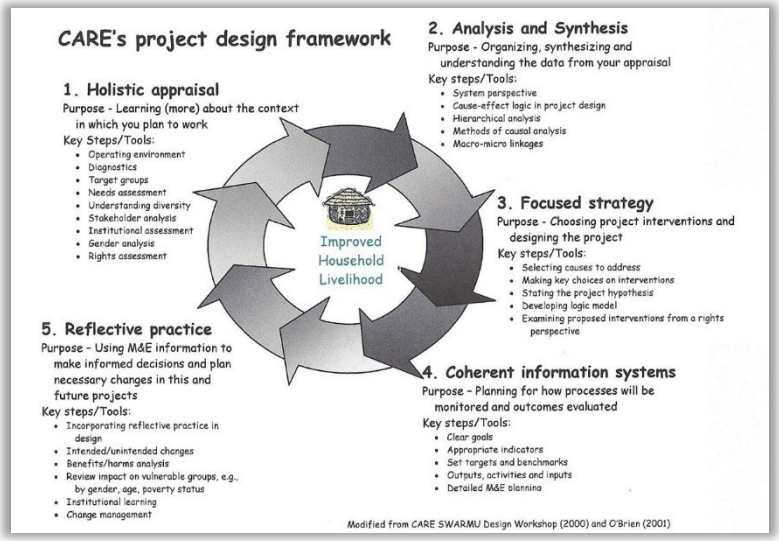

Fig 1: CARE model

It was a great benefit to this project that University X in Mexico had an established relationship with both the farm and community where these projects occurred. This allowed the students to work with these partners more easily. This access facilitated students to ask questions and gather information from the various stake holders at both the farm and the community which helped them understand the challenges of each scenario and drove the solutions they developed to be in accordance with Appropriate Technology parameters. The CARE model helped create a map to do a needs assessment. The primary data gathered was also supported by secondary data and generalized background information. By the time the projects were selected, students understood the environment they were working with both from local conditions context and, more broadly, from a cultural perspective. In example, one learning module of the classroom portion was an overview of the history of the region and the culture of the people. This background was developed through an introduction of local politics, religion, and historical events which influence current conditions. From the data and input gathered, students identified beneficial projects which were possible to implement in the scope of the time and resources of the course and which met the identified needs of the community. The projects decided on were:

- A rainwater catchment system that was integrated into a raised bed learning garden for the local elementary school
- Latrine improvements for one household (which included a roof over the latrine and a handwashing station)
- A low-tech ventilation system to mitigate indoor air pollution for the cooking area of one home
- A literature review for bio-gas scrubbing technology which might be used for improving the service of methane produced on the farm.

These projects were then implemented at the later stages of the course.

In 2021, the partner universities repeated the Humanitarian Engineering course; however, it was done exclusively online (due to the pandemic lockdown).
This time it was presented as a COIL course [15]. The COIL model was developed by the State University of New York (SUNY) COIL Center [16] and provided the blueprint to organize the material (previously offered in in 2017) in a virtual environment. In addition to the returning HEI partners, faculty, and students from two other institutions also took part: La Universidad Pontificia Bolivariana (UPB Medellin) in Colombia, and SRH Heidelberg in Germany. As with the 2017 program, the course was divided into lectures and projects. However, these had to be done virtually due to the restrictions imposed by the pandemic, so lectures and team meetings took place through Zoom. As with the 2017 face-to-face course, the program was presented over a 4-week time frame. The topics of lecture closely matched the 2017 version. However, a slight variation was made in that there was a more intentional effort to link course material to the United Nations Sustainable Development Goals [17]. Additionally, the beneficiary communities were now to be the places where these students resided. Students were assigned to breakout rooms where they did group work on activities. High emphasis was placed on methodology for analyzing capacity and vulnerabilities of communities, and, as in the previous experience, the CARE model was loosely followed.

The COIL experience diverged from the Face-to Face course in the way community data was gathered. Because of the lockdown, during the community assessment portion, students were restricted from being able to interview the stakeholders in the communities. Instead, this experience leveraged the “funds of knowledge” of participating students [18], gathering perspective and input directly from the students about their own communities and their needs. This approach relies on the cultural experiences of students as part of the learning activity. In this case, the student groups focused on local needs they could identify from their own experiences. This local knowledge from imbedded experiences of the students helped identify issues that could be addressed through Humanitarian Engineering in their towns [19].

The 4-weeks of courses was followed by a 1-week workshop consisting of 2 hours per day activities in which students from the partnership universities worked on teams in Zoom breakout rooms to conceptualize solutions for the problems in their communities that they identified using the methodology presented in earlier lectures. As such, the workshop facilitated a service-learning experience that connected perspectives of students from different parts of the world for projects that could assist their local communities.

Methodology

To access the outcomes of these two programs, a survey was developed and given to the participants of the two courses (Appendix A) both before and after their experience. The questionnaire used for the analysis in this paper was the exit questionnaire (applied after the experience) which consisted of 11 items under the category of "Skills" and 8 items in the category of "Social Awareness". Participants were asked to rate each category through qualitative descriptors according to the individual perception about their growth. The response options consisted of, “Minimum, Little, Regular, A lot, and Totally”. These responses were later scored in a Likert scale format ranging from 1 to5, where 1 is the lowest score (corresponding to a “Minimum” response) and 5 the highest (corresponding to a “Totally” response).
For data analysis, the frequencies of each category were obtained for both groups, the face-to-face (EP) and the COIL groups, and compared. The values are expressed in percentages; these percentages were compared to determine whether there were similarities or differences between the two groups in their leaning for the surveyed categories.

Subsequently, the "t" test was applied to each category to determine statistically the existence of significant differences through the P-value between the outcomes of the face-to-face students in 2017 and the COIL modality students in 2021. Forty-three undergraduate students distributed in these two groups participated and were evaluated. The findings are as follows:

Findings

Acquired Knowledge in Humanitarian Engineering and Professional Skills

This area is measure by 11 questions. For most of the 11 items in this category, the responses indicated that the differences existed between the face-to face and COIL groups. While some differences were small, several categories showed significant variation.

When comparing the percentages of the frequencies in the two groups (EP and COIL), in the strengthening of their “Business Vision”, both group survey results showed from 64 to 70% of the students perceived “a lot” or “totally” for their learning and 30% of the students checked “regular” learning; In Creativity, 70 to 80% of the students in both cases expressed “a lot” or “totally” for their learning; Notably, 77 to 90% of the EP students indicated that the experience strengthened their “Decision making” “a lot” or “completely”. In this category, 15% of the COILs responded “minimally” or “little”; In “Self-management”, 60% of EP students answered “regular” and 40% checked “a lot” or “totally” for their learning; Of the COIL group, 21% answered “regular” and 61% indicated “a lot” or “totally”. According to the frequencies obtained in the categories of “Information management”, “Communication Technologies”, and “Critical thinking and Problem solving”, a range of 80 to 100% of the students in both cases expressed that the strengthening of their skills went from “regular” to “totally”.

The application of the t-test for each category found significant differences between the groups for the following skills:

Unlike the face-to-face students who had a perception of “a lot” or “totally”, the COIL modality students mentioned that “Communication and teamwork” (18%) and “Oral and written communication” (42%) had learning perceived as “regular” or “little” with a value p=0.0209 and

p=0.0340 respectively. Other language with a value p=0.0023, demonstrates a significant difference between the 100% of the EP students who perceived a strengthening as “totally”, versus the 73% of the COIL students who perceived “a lot” to “totally”.

The results indicate that the positive perception about the development of their skills was generally higher in the face-to-face modality than in the COIL modality. Skills related to practice presented the greatest differences while skills related to desk work and documentary research were rated similarly in both groups. It is notable however that in the category of “self-management”, those of the COIL modality perceive that they had greater gains than those of EP. Notably, this is the only skill category where the COIL students indicated greater growth than the EP students. We assume this outcome is a result from differences in the structures of the courses: The EP students worked in independent teams only with the guidance of the HEI facilitators while the COIL students were exclusively engaged with their peers via breakout rooms.

Intercultural competencies and gained social consciousness

When comparing the percentages of the frequencies in the two groups (EP and COIL), 85 to 90% of the students in both cases perceived the strengthening of their social awareness about “Ethical commitment”, “Solidarity and Concern for the Common Benefit”, “Service and Social Commitment” from “a lot” to “totally”.

90% of the EPs and 67% of the COILs perceived the “Strengthening of their Cultural Identity” from “a lot” to “totally”; 12-20% in both groups perceived little or minimal strengthening in “Promotion of Democracy and Justice”; and in “Respect for Differences”, 10 to 15% of the students perceived gains in this category to be regular in both groups.

After the application of the t-test in to compare both groups for each item, significant differences were found between the following attitudes towards a social conscience:

Unlike the face-to-face (EP), who 80% had checked “totally” to indicate strengthening of the “Promotion of Human Dignity”, only 33% of the COIL modality students perceived gains in this area as “totally” while 48% checked “a lot”. This difference between the groups in this category was significant with a value p=0.0095. We assume this difference is due to the contact that the students in the face-to-face modality had with people in the community they worked with vs the online format of COIL which was inherently disconnected from community contact.

In “Care for the Environment”, 6% of the COIL modality students perceived growth as “regular”, while the EP students perceived that they learned “a lot” or “totally”, a significant difference with value p=0.0391. Although the EP students were in the field and the COIL students were not, we assume that previous research as part of their regular curriculum on environmental issues helped students in both groups to have minimal differences in this category.

Discussion

Both courses yielded data that showed statistically significant impact on student growth in all the areas measured. While the two modalities both showed growth, larger gains were witnessed in

most of the categories for students who took part in the face-to-face course. The exception to this trend were the results in the category of "Self-Management Skills" where greater development was indicated by the COIL group. It is conjectured that the online format of the COIL course, and perhaps the context of the social isolation caused by the Covid lockdown under which this took place, contributes to this result. It would be interesting to gather additional data for another COIL course and compare results. We assume that the context of lockdown influenced the survey in the "Self-Management Skills" category. Further investigation would help understand these results.

Although both modalities generated positive results in the major categories of "Humanitarian Engineering" and "Professional Skills", the face-to-face experience had an especially greater impact on students' perception in the areas of "Intercultural competencies" and "Gained Social Consciousness". (i.e., promoting human dignity, concern for the common benefit, service, and social commitment). We can speculate that the direct interaction with the community that benefited from the work of the students may have contributed to a bigger and more connected impact for these areas vs. the online experience, which is, by virtue of its format, less personal.

Social inquiries lend themselves to bias error and often the data should be viewed in context and regarding its limitations. These findings should therefore be considered with respect to several common sampling biases.

Response Bias

Some respondents might answer survey questions in a misleading or untrue way. This is called "Response Bias" or "Survey Bias." In example, participants in this study may feel pushed by social pressure to answer the questions in a way that they perceive will align with their peers' views. Additionally, the way the survey is presented with context to the course might impact sway responses. This is common bias on self-reporting surveys, especially with respect to issues of personal traits and attitudes [19].

Self-Selection Bias

Group dynamics may influence survey answers. By joining a group, individuals in effect self-select to be part of that group. This can cause bias with nonprobability sampling. "Self-Selection Bias", is prevalent for groups which have characteristics, demographics or beliefs not held by a larger sample of "others" outside the group. Motivation tend to cause bias to the data, making determination of causation more difficult. For example, there may be a numerous and varied differences between those in the Humanitarian Engineering Course presented in this paper (such as socioeconomic status or motivation), that are not found in students outside the group [19].

Work forward

This research reviewed the student groups without reference to demographics, nationality, gender etc. We are also interested to see how the data varies by demographics. Specifically, we are interested to examine the data on outcomes for US vs Latin American students and as divided by gender. On this topic, both Humanitarian Engineering experiences had a higher-than-average

female participation (as compared to traditional engineering courses). We would like to examine how or why Humanitarian Engineering courses are showing this trend (while also recognizing that our sample size is relatively small). Additionally, to support the hypothesis related to the variance between the groups, additional face-to face course and COIL courses could be run to collect further data for comparison.

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Appendix A: Survey

Humanitarian Engineering as a teaching- learning tool (AEES)
Educational studies allow us to evaluate our formative work to demonstrate the effectiveness of international courses like this in the development of professional skills and attitudes towards a social conscience in students, within the framework of the construction of a "technological and innovation system" alternative to the dominant in Latin America. In this way, we can continue this work and achieve a social impact.
We ask that you please dedicate approximately 10 to 15 minutes of your time to respond REFLECTIVELY and HONESTLY to this survey, only then, the results as a whole, will help describe, explain and improve these initiatives.

We remind you that the decision to answer this survey is yours, it is free, nobody forces you. By answering and sending it, you mean that you agree that the data is used and published for academic purposes.

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If you give us the opportunity to follow up on your learning, it will help us to generate better results in our study.

For the following questions assigning the following values for you responses in respect to how much the experience helped your leaning in the indicated category:
Minimum (1), Little (2), Regular (3), A lot (4), Totally (5)

To what extent has the Humanitarian Engineering Workshop-Seminar (IHES) strengthened the following professional competencies in you? *

1)Communication and Teamwork
2) Oral and Written Communication
3) Information Management
4) Management of Communication Technologies
5) Critical Thinking
6) Creativity
7) Command of another language
8) Problem Solving
9) Decision Making
10) Business Vision
11) Self-Management

12) Care for the Environment
13) Promotion of Human Dignity
14) Commitment
15) Solidarity and concern for the Common Benefit
16) Cultural Identity
17) Promotion of democracy and justice
18) Respect for Differences
19) Service and Social Commitment