A KCI Approach to Promote Intercultural Competencies for International Virutal Engineering Student Teams (InVEST)

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***Abstract*— Work in Progress: Engineering students need more than technical knowledge to meet the demands of the 21st century, they also require lifelong learning skills and inter-cultural knowledge. Intercultural learning is a global competence concept which is necessary for engineers to be able to work on complex global projects; immigrate to find work; collaborate and compete with multicultural colleagues; and work for international companies. Higher education institutions are exploring how to support and develop intercultural competences in students; however, in the engineering discipline studies are limited. Traditional study-abroad approaches have been adversely impacted by global events and challenges such as safety issues, health concerns, natural disasters, and political instability as well as students' financial and time constraints. In response, engineering education institutions and programs are exploring how to harness technology to satisfy academic and labor market needs in a scalable manner. This paper introduces the use of the Knowledge Community and Inquiry (KCI) pedagogical model developed by Slotta to design an inter-cultural learning course for student participants in the International Virtual Engineering Student Teams (InVEST) project. InVEST uses a blend of online social and collaborative experiential learning and synchronous video meetings to support students and educators involved in the project. The InVEST pilot project is aimed at bringing globally dispersed educators and their engineering students together to engage in cross-institutional and collaborative project-based learning via an online learning environment. The course is designed to assist students in gaining an appreciation of diverse cultures and working together on a project to co-construct new cross-cultural understanding.**

Keywords*— *Global virtual teams; Knowledge Community and Inquiry model; Global Competence; Intercultural competencies; collaborative experiential learning; Engineering Education, Global Competence

I. Introduction

In a growing globalized workplace, intercultural competencies have arisen as a high-priority valuable skill that employers seek in higher education graduates. Employers have attempted to address the skills gap by providing on-the-job training for graduates whilst looking to higher education institutions to support intercultural training and education of graduates. Engineering education institutions recognizing the 'perception' gap across instructors, students and employers, are exploring the use of technology in scaling the intercultural competency outcomes in graduates to satisfy labor market needs.

II. The Global Engineering Education Challenge

To tackle the challenges of an increasingly globalized economy in the 21st century, engineering students require global competence skills in addition to technical learning. Hence, it is pertinent for engineers to acquire intercultural learning to help them prepare for the workplace, where they will most likely work on multidisciplinary engineering teams with colleagues from different countries, collaborate in multi-contextual business settings and interact in transnational environments [1]. They may also be faced with global problems on large or complex projects, competition for business with peers across the globe or even the need to immigrate for work opportunities amidst a shifting engineering demographic [2] [3].

Over the years, many higher educational institutions and organizations have recognized the need for a global engineering education that can help engineers develop global competence skills needed to prepare them to live, work and succeed in a complex, multicultural and interconnected global environment [4] [5] [6]. According to a 2015 survey conducted by Hart Research Associates in the United States, 78% of surveyed employers in a public opinion research firm emphasized the

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importance of all students developing intercultural skills for their future employment [2]. Traditionally, organizations have responded to the global competence skills demand by developing business strategies such as global teams and intra-company transfers, while educational institutions explored strategies to invest in internationalizing their engineering programs as well as reforming their engineering curriculum [7].

III. Internationalization and Virtualization of Engineering Education

Conventional approaches for helping students acquire intercultural skills have focused on travel and international internships. However, this is not a viable option for many engineering students who may experience time constraints due to tight academic planning, work-life challenges or financial restraints. On the other hand, study abroad programs have been adversely impacted by global events including safety issues, health concerns, natural disasters and political instability according to an Open Doors 2017 report [8] [9]. An internationalized curriculum is necessary to educate future engineers whose tasks would be to solve society's problems that are no longer bounded by local contexts but are global [10]. For students that embraced study abroad opportunities, some have struggled with culture shock and failed studies from misunderstandings of the educational systems [11].

With rapid advancements in technology, higher education institutions have also explored the use of digitalization to achieve strategic internationalization of engineering education by complementing incoming students' experiences with digital elements [12]. For instance, using a transnational online class to prepare international students for master's studies and using an online course to enhance a summer school research exchange for engineering students.

IV. Global Engineering Education Studies

Generally, studies indicate that many educators seem to be at a loss on how to incorporate cross-cultural competences, like intercultural communications, e□ectively into their curriculums [13] cited in [2]. While intercultural competence studies in engineering are limited, studies on engineering students tended to focus on program assessment or the instructor's perspective rather than on students actual competence levels [3][14].

Amongst the engineering studies available, there is some agreement that intercultural communication can be taught, however, there is also indication that a more active interpretation or demonstrable application of intercultural communication was not viewed as teachable in a classroom by students [2]. This perception gap in intercultural communication learning has also been observed amongst organizations. A study on large companies with over 10,000 employees found that while 59.9% valued the efforts of higher educational engineering institutions to prepare students for success in a global environment, only 27% of respondents felt that universities were successful in this mission [15].

There is a need for more studies on effective ways of teaching and incorporating intercultural competence knowledge and application in engineering curriculum. Engineering institutions can seek to harness technological environments to allow students from various locations to work together in meaningful projects. In their study, Rico-García & Burns [2] suggest creating more authentic intercultural experiences for students, facilitating digital interactions with culturally diverse students in real-time or designing real-world situations for students to work on together. Strenger [12] proposes the use of transnational education approaches to enable students "strengthen their intercultural competences while working on real engineering and technical problems, in online courses where they can conduct experiments, analyze and interpret their results in international teams."

V. International Virtual Engineering Student Teams

The International Virtual Engineering Student Teams (InVEST) initiative is based in the Institute for Studies in Engineering Education and Practice (ISTEP) at the University Toronto [16]. InVEST was established in 2019 with funding and support from the University of Toronto Faculty of Applied Science and Engineering. The faculty and researchers leading the InVEST set out to create cross-institutional research teams in collaboration with faculty at other universities. Using a variety of virtual tools and software the initiative is designed to support virtual teams in their endeavors through provision of instruction, training, and programs in areas inclusive of cross-cultural communication, team-work, decision making, conflict resolution, and virtual project management.

The InVEST project seeks to enhance international knowledge, experience and networks for collaborating engineering students and universities by providing global awareness learning experiences. InVEST aims to assist geographically dispersed students to gain an appreciation of their diverse cultures, reflect on associated cultural considerations and influences, integrate the newly acquired multicultural perspectives with their prior knowledge and experiences and demonstrate this in their engineering projects.

VI. Virtual Team Collaborations

A. Knowledge Community and Inquiry (KCI) Pedagogical Model

The knowledge community and inquiry (KCI) pedagogical model [17] guided the design of the cross institutional collaborative and experiential learning course. The engineering students shall be expected to engage in a knowledge construction learning activities regulated around engineering project themes with associated cultural considerations and influences. Knowledge artefacts that are generated during the learning process (e.g. notes, presentations or discussion comments) are aggregated into a shared community knowledge base, which serves as a persistent referent and resource for further inquiry. The contributions to the knowledge base give rise to emergent themes, challenges, or interests that represent the "voice" of the community.

B. Technology Enhanced Collaborative Learning

A computer-supported collaborative learning (CSCL) curriculum was developed and implemented for InVEST participants using an online technology environment. Students build social cohesion by participating in virtual icebreaker activities and working together in meaningful projects through a

blend of online social and collaborative learning, asynchronous group discussions and synchronous video meetings.

C. Study Plan

This study shall make new contributions to the advancement of intercultural competence education in Canada and internationally as well as global engineering education and practices. Specifically, it seeks to understand InVEST engineering students' perception of 1) cultural awareness; 2) intercultural understanding and application; and 3) intercultural communication via a virtual team collaborative environment. Secondly, it would explore how the cultural diversity of participants' backgrounds and experiences can be a productive feature for an online community of learners. Next it would investigate the significance of technology in fostering cross-cultural learning for a geographically dispersed virtual community of learners. The study shall also examine the KCI pedagogical model's capability to effectively support intercultural interactions in a virtual team environment. Lastly, it shall investigate engineering students' perception of virtual team collaboration.

D. Design Frameworks

1) Social Constructivist Learning

The InVEST project applies the social constructivism learning theory [18] as it takes a learner-centered approach to the course design and implementation. The engineering students' diverse knowledge, experiences and cultural background shall be incorporated into the virtual team's guided collaborative inquiry activities to form an online learning community that is culturally sensitive.

2) Community of Inquiry (COI)

To create an effective online educational experience for InVEST participants, the three elements of the Community of Inquiry (COI) framework, namely teacher presence, social presence and cognitive presence, were intentionally designed into a collaborative and project-based blended learning course as depicted in Figure 1 [19].

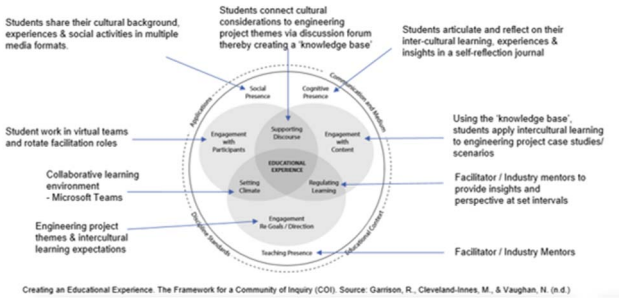

Fig. 1 Framework for Community of Inquiry

VII. Methodology

A. Pilot Study Design

A design-based approach shall be utilized examine the engineering students' perceptions of intercultural learning and virtual team collaboration throughout the InVEST program. Design-based research (DBR) provides certain affordances well suited for a study of a theoretical curricular design, with successive iterations that follow design, analysis and re-design cycles [20], thereby allowing for any modifications and augmentations in the design to reveal themselves in the data.

First, a qualitative pre-instruction questionnaire shall be completed before the course by a control group and the trained engineers to get insights about their cultural orientation, their previous knowledge and experiences, the factors which they considered important for a successful virtual collaboration. Then a post-instruction quantitative component shall be completed at the end of the course by the trained engineers to understand the engineering students' perceptions about intercultural learning and virtual team collaborations in a technology environment. Findings from the study shall be used to evaluate the effectiveness of the intercultural learning curriculum and to re-design future cycles of the study. Feedback received from the engineering students shall also be utilized to improve the learning experience for future InVEST students.

B. Data Collection

A mixed methods approach to data collection shall be employed to validate data from various sources. In addition to the questionnaires, other sources of data include researcher observation notes, technology tool analysis, design materials and online activities of the engineering student participants. Periodic "debriefing" interviews or surveys with the instructors and facilitators will help determine the effectiveness of the curriculum design and learning program.

C. Theoretical Lens

The essential idea of social constructivism is that learning is constructed, and knowledge is comprehended through active social interaction with others and is shared rather than an individual experience [21]. A social-constructivist lens will be utilized to analyze the students' asynchronous contributions, observations of their online interactions with others, other learning artifacts, and their responses to technology-based curriculum activities to understand their experiences and level of intercultural awareness, understanding and application.

D. Participants

InVEST participants are self-selected students to teams of cross-institutional collaboration projects. The students will participate in both the technical project component under the supervision of their university faculty member and the intercultural learning component provided by the InVEST team. This provides an opportunity for the students to acquire and demonstrate intercultural skills, refine their leadership, teamwork skills and learn new technology tools which they need to use in the workplace, thereby increasing their employability.

VIII. Conclusion

This study is expected to help promote the internationalization of engineering education. Using the KCI method, the InVEST team aims to facilitate experiential intercultural learning for engineering students in participating teams while adding to the body of research and literature in the field virtual engineering teams. The research aspires to add to the tools and pedagogy in educating engineering students to

become capable 21st century practitioners with life-long learning and inter-cultural skills.

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