Board 112: Work in Progress: Exploring the Impact of International Experiences on the Development of Students' Entrepreneurial Mindset

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WiP: Exploring the Impact of International Experiences on the Development of Students' Entrepreneurial Mindset

Abstract

International experiences, including collaborative online international learning (COIL) experiences that naturally increase accessibility, are of interest to many undergraduate students. These experiences provide educators a unique opportunity to develop a student's entrepreneurial mindset (EM). Additionally, hands-on experiences aligned with the National Academy of Engineering's (NAE) grand challenge themes (Sustainability, Security, Health, and Joy of Living) support connections between the experience, disciplinary knowledge, multicultural awareness, and EM. Through this Work-in-Progress (WiP) study, we seek to answer: 1) How do international experiences influence undergraduate science and engineering students' EM, and 2) How does the international experience modality (i.e., study abroad or COIL) impact development of EM? To understand the impact of these international experiences, we are designing a qualitative, parallel study across five U.S. institutions representing a mix of in-person and COIL international experiences for undergraduate students at different academic levels within science and engineering disciplines. We aim to connect transformative learning theory, focused on multiculturalism and connectedness, with international experiences using EM as the theoretical framework. While surveys will support understanding of multiculturalism gains and overall view of the experience, concept maps and reflections will be used to assess student's growth in EM connectedness. A description of each institution's partnership development and implementation is presented in this paper. We anticipate key results will include: 1) students' positive perception through engaged learning, 2) student growth in EM connectedness, 3) students' increased appreciation of multiculturalism, 4) all modalities support growth in student's EM and multiculturalism competencies, and 5) in-person international travel components demonstrate a larger increase in multiculturalism competencies due to cultural immersion. The team is finalizing plans for these experiences in fall 2023 and will implement the experiences and collect data in spring 2024.

Introduction:

International experiences, including collaborative online international learning (COIL) experiences that naturally increase accessibility, are of interest to many students [1]. These experiences provide educators a unique opportunity in which to develop a student's entrepreneurial mindset (EM). EM is a framework to encompass a multitude of essential skills, including the inclination to discover, evaluate, and exploit opportunities, all of which are critical for developing students into well-rounded engineers. The Entrepreneurial Student Entrepreneurial Mindset Assessment, as developed through The Ohio State University College of Engineering, details the assessment criteria to concentrate on three main areas which are expanded upon for varied focuses: Curiosity, Connection, and Creating Value. First, Curiosity is meant to explore concepts of empathy and interest for both a student's desired research field as well as engineering as a whole. Connection is marked to investigate the student's individual propensity for help-seeking behavior and open-mindedness for resolving solutions. Finally, Creating Value explores the altruistic tendencies of the student and their ability for idea creation. While there are varied assessment tools for quantifying an individual's EM, the values of Curiosity, Connection, and Creating Value are conceptual throughlines. Because concept maps are visual representations of knowledge and connections between topics and EM is a varied conceptual framework, pairing the two together as an assessment tool allows for the breadth of differing ideals of cross-disciplinary engineers to be measured on an equitable playing field. A flexible measurement tool such as concept mapping allows students to explore ideas creatively, while still allowing instructors to understand thought processes and knowledge development.

When connecting EM to international experiences, curiosity is developed through discussions with people from different cultures. Students have the opportunity to spark lifelong curiosity while developing an appreciation of differences with the realization that diverse perspectives lead to innovative solutions. Connection is created when students integrate information from multiple sources, domestic and international, to design a solution and further strengthened through reflective practices such as focus groups and/or concept maps [2], [3]. Finally, the students create value by designing a solution that considers needs of different populations thus supporting a better "global" solution to impact the most people.

Many STEM international experiences align with the National Academy of Engineering (NAE) grand challenge themes which are shown to support connections between the experience, disciplinary knowledge, multicultural awareness, and EM [2-4]. This is particularly valuable for STEM majors, as some research indicates they lag behind their non-STEM peers in multicultural awareness. Initially, the NAE grand challenges consisted of fourteen goals for improving life which have now been arranged into four themes: sustainability, health, security, and joy of living. All sites in this study will have a connection to these four NAE grand challenges themes.

To connect our study to other published works, we will use the transformative learning theory (TLT), which Mezirow first proposed in the 1970s. TLT describes when an adult learner experiences something that challenges their existing ideas and creates a change in perspective [5]. TLT is used in international training experiences for teacher candidates as a framework on how to develop culturally responsive teaching skills [6-8]. Adding to this, we aim to show that

international experiences create transformative learning which support development of EM. We also intend to examine the effectiveness of COIL, as previous studies have shown it to promote intercultural competency but noted its dependence upon adequate pre-training to contextualize the cross-cultural experience [2], [9], [10].

Herein, we describe the initiation and initial stages of our cross-institutional project to answer: 1) How do international experiences influence undergraduate science and engineering students' EM, and 2) How does the international experience modality (i.e., study abroad or COIL) impact development of EM?

Team formation:

Team members initially met during the Networking, Ideation, and Collaboration (NIC) workshop [11] offered by APA-ENG (March 29-31, 2023). The NIC workshop is an intensive, nine hour workshop that provides participants with foundational knowledge to conduct Scholarship of Teaching and Learning (SoTL) research. During the workshop, participants hear from experts in EM, Science of Teaching and Learning (SoTL), and how to identify potential publication targets. The workshop is also very interactive and provides multiple opportunities to meet others with similar interests and begin developing a collaborative idea for proposal. From this workshop, our team was formed and submitted a proposal to be considered for the next APA-ENG workshop in the series: the Archival Publication Authors (APA) workshop [12].

The team's proposal was accepted for the APA workshop. During the twenty-hour APA workshop, our team heard from experts in SoTL, completed assignments related to our topic, and received feedback from our mentor. While the information provided during the APA workshop was valuable, the most appreciated component was having a mentor with whom we were able to meet regularly to discuss ideas and receive feedback to guide us in the "homework" as well as project planning. Through this workshop, the team was able to connect our initial concept (study abroad) to educational literature, design a study, and make a plan to pilot the project.

Development of the pilot study:

Utilizing the SMART framework [13], we refined research questions to ascertain the impact on students of the different types of experiences with the goal of establishing best practices to enhance students' EM. During the pilot offering of each experience, qualitative data will be collected to understand what went well and areas of improvement. Additionally, the pilot phase will serve to identify how to implement a standard data collection process amongst sites. Post pilot-phase will employ a qualitative and quantitative, parallel study across five U.S. institutions representing a mix of in-person and COIL international experiences for undergraduate students at different academic levels within science and engineering disciplines. To support a holistic understanding of student's experiences and growth, data from pre/post surveys, reflections, and pre/post concept maps that students create will be used to answer the research questions.

Description of pilot activities at each institution

Team members from five institutions (Midwest, Southeast, and Northeast R1 Public Institutions, Midwest Regional Private R2 Institution, and Midwest Regional Private Institution) will offer

experiences in different modalities (in-person (travel), hybrid (COIL +), and online (COIL)) and address themes of the National Academy of Engineering's (NAE) Grand Challenges. Table 1 details characteristics of each experience by institution.

One institution is a Southeast R1 Public University whose location allows for cross educational partnerships with industry leaders such as SAS, Cisco, IBM, and Lenovo. By leveraging these connections to garner a diverse and skilled student body, we can aid in the professional development of our cohort through study abroad opportunities to Ecuador and Czech to aid in the conceptualization of engineering solutions to global challenges for first-year engineering students.

At the midwest regional private institution, the modality of the study abroad program is travel. The study is planned to be carried out for three years across different study abroad programs in connection to three grand challenges, sustainability, health, and joy of living. The pilot study is planned to be carried out in Spring 2024 for the interim study abroad programs focusing on the grand challenge 'Joy of Living'. The survey data will be collected for the engineering/science undergraduates as enrolled in different study abroad programs in Amsterdam, Edinburgh and Dublin, Rome, Singapore and Thailand. The participation in the survey questionnaire will not be a part of course grading for the pilot study.

For the midwest R1 public institution, an inaugural COIL pilot (with a university in India) was offered in Summer 2023. STEM rising sophomores through rising seniors at the midwest R1 and rising juniors in India participated in an eight-week grand challenge experience; the midwest R1 students focused on a health grand challenge (rural healthcare). Students from both institutions met synchronously four times during the eight week period; synchronous sessions included a grand challenge related lecture and active learning activities in groups that mixed students from each university with the culminating session being grand challenge presentations with peer and instructor feedback.

At the Midwest private R2 institution, one author has an already established COIL program with Columbia University. This partnership involves students from chemical engineering taking a Transport Phenomena course at both institutions. The students traditionally simulate a Transport Phenomena process, which could include heat, mass, or momentum transport, using COMSOL multiphysics. To augment the multicultural experiences and the COIL format, and using transport phenomena courses, students will develop sustainability modules using the NAE Grand Challenges for Engineering [3], [6]. For example, students could look at "make solar energy more economical" and find current practices in both countries for solar energy generation. Once identified, students will provide recommendations to enhance the process economically. Teams (4 -5 students) will record their presentations in a PodCast setting, and videos will be shared with all the students in both classes. English/Spanish will be used with subtitles in English/Spanish so everyone is comfortable preparing and watching the videos. Peer reviews and instructor feedback will be provided for each module developed by students.

The Northeast R1 institution was planning a spring break travel course to Honduras alongside a different midwest R1 institution during Spring 2024. Due to travel restrictions at the northeast

institution, the course offering was canceled. The format of the course was on drinking water treatment and supply along with the history of Honduras. Students would pick a topic to study during their visits to water treatment plants during the travel course, collect information during their course, and complete a report upon their return. The additional midwest institution may still be able to participate in this study as their course will still be run in Spring 2024. In the meantime, the northeast R1 institution is planning a course offering to Ecuador based on long-standing connections with two NGOs there made for a project on water supply in a rural village. The course is planned to be a spring break course during Spring 2025 with trips to multiple communities, meetings with the two NGOs, and assessment of the completed phases of the water supply project.

Table 1. Description of experiences, students, and focus at collaborating institutions.

Institution	**Modality**	**Grand Challenge**	**Student Level**	**Major/discipline**
Midwest R1 Public Institution	COIL	Health	Sophomore/Junior	Interdisciplinary
Southeast R1 Public Institution	travel	Sustainability	Freshman/first year	Interdisciplinary
Midwest Regional Private Institution	COIL+	Sustainability		Chemical engineering
Midwest Regional Private R2 Institution	COIL	Sustainability, NAE Grand Challenges	Junior/Senior	Chemical Engineering
Northeast R1 Public Institution	Travel planned but now TBD due to restriction on travel to planned country	Sustainability	Sophomore/Junior	Civil & Environmental Engineering

Academic year 2023-2024, including summer 2023, served as the pilot offering for each institution. While team members previously communicated to understand each offering, this year was the first offering that employed international experiences in the courses at each institution, allowing for identification of challenges, commonalities, and areas of improvement. Team members who have begun their experiences communicated challenges that arose in the planning and offering stage. And, after all institutions offer one iteration of the experience, team members will meet in summer 2024 to further discuss the process, what went well, what did not go well, and how data collected could be standardized amongst institutions while not hindering other

needs from each institution. However, at this point, the team has already identified challenges and are considering processes to address these.

Discussion on challenges encountered

Cross-institutional team challenges (APA-ENG team)

- When the academic year begins, everyone instantly becomes busier. Therefore, regular meetings are essential to maintain forward progress. With cross-institutional collaboration, there is no chance of "chatting in the hallway"; so, it is essential to have recurring meetings scheduled. Additionally, it is beneficial to make these meetings "working meetings" in which the team actively completes something tied to the project instead of discussion only.
- Adequate time needs to be built in to secure IRB approval. This includes (1) identifying who will support the project, allowing time for those supporting to complete the required IRB training, and adding them to the protocol and (2) submitting the protocol and waiting time for review, revision, and final approval.

International experience challenges (comments from all sites)

- Including a pilot offering before starting the cross-institutional data collection is beneficial. This allows for understanding how each institution handles/supports international experiences and allows each instructor to experience the course first.
- Uncontrollable situations may hinder plans. One site's travel plans were canceled due to security concerns.
- There may be travel restrictions for international students. Identify the options offered by the institution.
- Recruitment of students may be easier for academic year offerings, particularly considering concerns with the availability of financial aid for credits taken outside of this window.
- Early recruitment of students for travel courses is essential, because costs are shared across students, and low enrollment can make the costs prohibitive.
- Shared travel arrangements between institutions require careful planning, as there can be great benefits to sharing costs for things like transportation, food, lodging, and translators. However, students from different institutions cannot share housing accommodations, and institutions may need to draft individual contracts for shared vendors for liability reasons.
- As with many surveys, the response rate may be low.
- Synchronous meetings when large time differences exist are difficult. For the midwest R1 who collaborated with a university in India, this required students to meet outside typical course times (at night in one location and early morning in another location).
- Having an established lead time for designing and offering the pilot, including meetings between both faculty/institutions, is beneficial for a smooth offering. A suggested timeline would be one semester of planning between collaborators in parallel with recruitment of students.

Next steps

In summer 2024, the team will reconvene to review commonalities, discuss challenges and identify processes to implement to address these; at this point, four of the sites will have completed a pilot offering and the fifth site which is planning an experience in 2025 can benefit from insight gained in the other offerings. Following this, the team will revisit the initial qualitative and quantitative data collection plans set forth to see how those fit into each situation, and if needed, the team will make adjustments to standardize the data collection process.

Quantitative analysis (once reasonable sample size is achieved): Concept map data traditional scoring will be used (count the concepts and connections) [14], [16]. The implementation of concept maps to analyze the growth both before and after the experience of students involved in this study abroad program serves as a tool to quantify the experiential learning data in a format in which one can fully understand the breadth of what students garner from the experience. In opposition to a standard reflection essay or survey research data, the use of concept maps as an assessment tool allows for a thorough outline of relationships between ideas and concepts and how they individually connect those ideas and concepts organically [14], [16].

Qualitative analysis: Pre/Post surveys will include validated questions for assessing multiculturalism [9], demographic questions, site location (for coding), and five point Likert scale questions on student's perceptions of this experience. Concept maps [16] and reflections [13-21] will be scored using rubrics.

To understand the impact of experience modality, the approaches below will be used; however, data from two years may need to be used, as only one school is in-person/travel for this offering.

Quantitative analysis (once reasonable sample size is achieved): A statistical comparison of concept map data traditional scoring between modality groups will be used to determine any significant difference.

Qualitative analysis: Survey data and rubric scored concept map data collected for RQ1 will be grouped by modality and analyzed to determine commonalities and differences. This data will be valuable as it presents the student perspective as well as measured growth from the validated questions and rubric scored concept maps and reflections.

References

[1] Rubin, J., “Embedding collaborative online international learning (COIL) at higher education institutions.” *Internationalisation of Higher Education*, vol. *2*, pp.27-44, 2017.

[2] A. M. Lucietto and L. Russell, “Comparison of Pre-Intervention IDI Results from STEM and Non-STEM Undergraduate Students,” *Journal of Global Education and Research*, vol. 4, no. 2, pp. 113–124, Dec. 2020.

[3] Katsouleas, T., Miller, R. and Yortsos, Y., “The NAE grand challenge scholars program,” *The Bridge*, vol. 43(2), pp.53-56, 2013.

[4] Beylefeld, A. “They went, they saw, they learned: medical students' reflections on community clinic visits.” *Innovations in Education and Training International*. vol. 51(2), 2014.

[5] Kitchenham, A. (2012). Jack Mezirow on Transformative Learning. In: Seel, N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_362

[6] https://www.engineeringchallenges.org/challenges.aspx

[7] Zhu, R., et al., “Transformative learning and the development of cultural humility in social work students.” *Social Work Education*, pp.1-16, 2022.

[8] Jacobs, J. and Haberlin, S., “Transformative learning within an international teaching experience: Developing as emerging culturally responsive teachers.” *Action in Teacher Education*, vol. 44(2), pp.104-12, 2022.

[9] A. Naicker, E. Singh, and T. van Genugten, “Collaborative Online International Learning (COIL): Preparedness and Experiences of South African Students,” *Innovations in Education and Teaching International*, vol. 59, no. 5, pp. 499–510, 2022, doi: 10.1080/14703297.2021.1895867.

[10] Chwialkowska, A. "Maximizing cross-cultural learning from exchange study abroad programs: Transformative learning theory." *Journal of Studies in International Education* vol. 24(5), pp. 535-554, 2020.

[11] https://apa-eng.asee.org/program-components/nic/

[12] https://apa-eng.asee.org/program-components/apa/

[13] “Establishing your S.M.A.R.T. objectives.” OHSU Community Research Coalition HUB. https://www.ohsu.edu/sites/default/files/2018-12/S-M-A-R-T-101-final.pdf accessed 17 August 2023.

[14] Bodnar, C. A., Jadeja, S., and Barrella, E. , “Creating a Master “Entrepreneurial Mindset” Concept Map" Paper presented at 2020 ASEE Virtual Annual Conference Content Access, June 2020, Virtual Online. 10.18260/1-2--34345

[15] Hammer, M. R., Bennett, M. J., and Wiseman, R. “Measuring intercultural sensitivity: The intercultural development inventory.” *International Journal of Intercultural Relations*, *27*(4), 421–443, 2003.

[16] Besterfield-Sacre, M., et al., “Scoring Concept Maps: An Integrated Rubric for Assessing Engineering Education,” *J. Eng. Educ.*, vol. 93, no. 2, pp. 105–115, 2004,

[17] “Intercultural Knowledge and Competence VALUE rubric.” *Association of American Colleges and Universities, 2009* https://www.aacu.org/initiatives/value-initiative/value-rubrics/value-rubrics-intercultural-knowledge-and-competence

[18] “Integrative and Applied Learning VALUE rubric.” *Association of American Colleges and Universities, 2009* https://www.aacu.org/initiatives/value-initiative/value-rubrics/value-rubrics-integrative-and-applied-learning

[19] Hylton, J. B., and Hays, B. A., “Modifying the VALUE Rubrics to Assess the Entrepreneurial Mind-set” Paper presented at 2019 ASEE Annual Conference & Exposition, Tampa, Florida. June 2019.

[20] Li, C. Q., & Harichandran, R. S., & Erdil, N. O., & Nocito-Gobel, J., & Carnasciali, M. (2018, June), “Investigating the Entrepreneurial Mindset of Engineering and Computer Science Students” Paper presented at 2018 ASEE Annual Conference & Exposition , Salt Lake City, Utah. 10.18260/1-2--30726

[21] Martine, M. M., & Mahoney, L. X., & Sunbury, C. M., & Schneider, J. A., & Hixson, C., & Bodnar, C. A. (2019, June), “Concept Maps as an Assessment Tool for Evaluating Students' Perception of Entrepreneurial Mind-set” Paper presented at 2019 ASEE Annual Conference & Exposition , Tampa, Florida. 10.18260/1-2--32533