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Developing Collaborative Online International Learning (COIL) projects in Engineering Education

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Meredith Blumthal became the Director of International Programs in the Grainger College of Engineering in 2017, and has 15 years of experience in international education. She collaborates with faculty members across the college to create international education opportunities for engineering students, including semester, short-term faculty-led and summer research experiences. Meredith has doubled faculty led programs since her start, and was instrumental starting COIL courses in engineering, and developing a community of practice of faculty around global virtual learning and short-term faculty led programs. Meredith is involved with the management of the double degree and exchange program with the ZJUI-UIUC Joint Institute, hosting over 200 Chinese exchange students each year. Meredith and her team recently launched a Global Engineering Ambassador Program, helping Grainger Engineering exchange students connect with local students during their time as well as serve as a resource for promoting study abroad across the college. Meredith is also collaborating with the Grainger First Year Experience to implement the Cultural Intelligence assessment into the first year curriculum, allowing engineering students to understand their capabilities to function in multicultural interactions. Meredith has undergraduate and graduate degrees from the University of Illinois at Urbana-Champaign. As a student, Ms. Blumthal studied abroad in the Netherlands and had a Foreign Language Areas Fellowship (FLAS) where she studied Quechua and conducted field research in Ecuador during her graduate program.

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Abstract ASEE 2022 Conference- International Track

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Background: With increasing awareness of the importance of undergraduate students having a global experience, institutions and educators have teamed up to provide opportunities for students to collaborate with their peers around the globe. Collaborative Online International Learning (COIL) is not new, but it has recently gained traction because of the pandemic, as a promising pedagogical method to deepen the global engagement of students without requiring travel abroad. The COIL pedagogical model connects professors and students around the world in an online learning environment to explore subjects, themes, issues, and ideas in a project-based learning experience. Although COIL has gained tremendous attention since the pandemic as a solution to the absence of student mobility, it has the potential to serve in a much larger capacity moving forward and benefit a larger student population. COIL projects present the opportunity to connect students with limited means or time to a global experience to combine their skills their skills to solve existing problems and gain cross-cultural knowledge without the need for travel.

Purpose: The purpose of this study is to understand the impact of a pilot of COIL courses run in fall 2020, spring 2021, and fall 2021 at the University of Illinois at Urbana-Champaign Grainger College of Engineering.

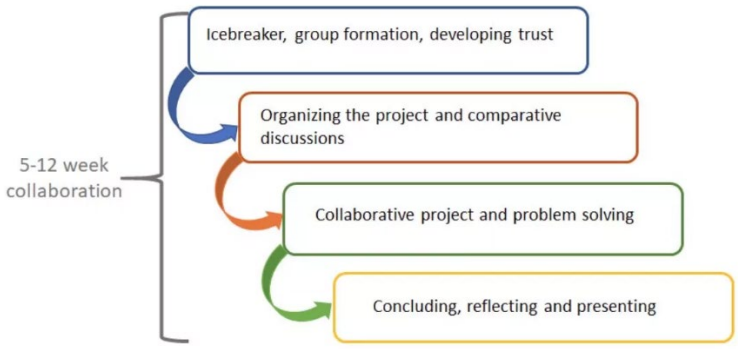
Methodology/approach: In a pilot study run in the fall of 2020 and spring 2021**,** 31 students across five COIL courses completed pre- and post-surveys to understand cross-cultural competency. In the fall of 2021, six COIL courses were surveyed both before and after. Survey instruments used included an existing tool and engineering-specific learning outcomes. For the cultural competency measures, we used a scale where students were asked to rate their level of agreement with a set of 12 statements. Additionally, we measured the following learning outcomes with a post-course survey based on a set of 20 questions; Intellectual Reasoning and Knowledge (IRK), Creative Inquiry and Discovery (CID), Effective Leadership and Community Engagement (ELCE), Social Awareness and Cultural Understanding (SACU), and Global Consciousness (GC). We ran statistical analyses to understand the gains in student cultural competencies.

Findings: Early results indicate statistically significant improvements toward University of Illinois at Urbana-Champaign campus-level learning outcomes, specifically students improved ability to think logically and critically, improving their ability to consider a variety of perspectives, Social Awareness and Cultural Understanding and, Global Consciousness. There are variations between the individual courses as not all have equal improvements in all areas.

1. Introduction

We live and work in a global environment that presents many new and universal challenges for engineers and, as engineering educators, it is not sufficient to prepare students to only understand the fundamentals of technical skills. We must also prepare them to work effectively in global environments and across different cultures (Warnock et al., 2008, Stablein et al., 2022). With increasing awareness of the importance of undergraduate students to have global experiences and, in part, as a result of the global pandemic, the opportunity for Collaborative Online International Learning (COIL), though it has been around for 15 years, has recently gained traction. COIL provides a pedagogical method to deepen the global engagement of students without requiring travel abroad. The term COIL, developed by the State Universities of New York (SUNY) system, is an approach that brings students and professors together across the globe to learn and to collaborate as an integral part of their class experience (*What is COIL*, 2021). The COIL pedagogical model connects professors and students around the world in an online learning environment to explore subjects, themes, issues, and ideas in a project-based learning experience. Digital technology plays an important role in linking students and faculty from different countries together (De Castro et al., 2019). At its core, COIL is a collaborative project-based global learning experience in which instructors and other collaborators from different international institutions partner to design learning activities. Students partner to complete project activities sharing their various cultural contexts and experiences. COIL usually becomes part of the class as a 5–12-week engagement, enabling all students to have a significant intercultural experience within their courses of study. COIL extends international experiences to all students and faculty by facilitating online intercultural exchange. Effective COIL collaborations follow a recognized progression through specific phases outlined below.

Progression of COIL module



COIL Pedagogical Model https://online.suny.edu/introtocoil/suny-coil-what-is/

Although COIL has gained tremendous attention since the pandemic as a solution to the absence of student mobility, it is not just a short-term solution to the disruption campuses face today. COIL should be part of a comprehensive plan to advance internationalization for universities. Virtual engagement programs such as COIL and study abroad are not "zero-sum" alternatives, rather they complement one another and provide a more rich and seamless experience for students. The expansion of traditional study abroad alone will not meet the needs of engineering students. In fact, since COIL is not location-specific, students and faculty at

multiple sites are able to participate in a single COIL course, something not possible for most study abroad experiences.

On average, nearly half of the incoming Grainger Engineering first year students indicate on their new student registration homework that they are interested in a study abroad experience. However according to enrollment data, in AY 2018-19, only 20 percent of a graduating class have had such an experience by the time they graduate. Perceived and real barriers to studying abroad exist in engineering. Engineering students study abroad at a far lower rate than their peers across campus in the colleges of Agricultural Consumer and Environmental Sciences, (42 percent) and Business (54 percent). Many of the barriers of traditional student mobility are due to strict curriculum requirements, financial barriers, and other unseen barriers. Engineering students have far greater numbers of specific course requirements and longer prerequisite sequences than peers in other majors (Paschal et al, 2017). Often costs, perceived or real, are a barrier and Gordon (2014) cites financial concerns as the number one barrier to student participation in terms of direct program costs, but also the opportunity cost of lost income from part-time employment during the semester or full-time summer employment. Unseen barriers include a lack of family and friend support and an unwillingness to forgo leadership roles in registered student organizations.

In addition, traditional study abroad experiences can limit student participation among some demographics due to issues of student mobility. Traditional in-person student mobility for study abroad favors middle- to upper-class white females. Nationally women represent 67 percent of the students who go abroad (Institute for International Education, 2020). Even though women are underrepresented students in engineering, within the University of Illinois Grainge College of Engineering, women represent 75 percent of the students who go abroad. In AY 2018-19, ten percent of Engineering study abroad participants identified as Hispanic, and two percent identified as Black/African American. Overall, there are opportunities to both diversify and increase the number of Grainger students with a global experience. Therefore, by also investing in COIL, Engineering can promote international experiences through online participation, thereby eliminating the most significant issues of student mobility. An opportunity exists to broaden the level of participation of University of Illinois students in global learning opportunities and to position our students to be globally competent and locally relevant, while at the same time providing our students with the tools necessary to solve complex problems (Handstedt, 2018).

COIL offers an additional pathway to international experiences. It provides an opportunity to capitalize on internationalizing the engineering curriculum by introducing COIL project courses into the engineering curriculum through the revamping of existing courses to include a COIL project. Benefits of a COIL course include access for geographically bound students and an accessible, cost-effective authentic intercultural experience, which complements and supports related aspects of students' development during their undergraduate degree program through employing teamwork, collaboration, communication skills (de Escalona, 2019). Students bear no additional financial cost for participation in a COIL course, and, with no travel, students can maintain engagements on campus with RSOs, stay on track for graduation and maintain employment opportunities.

While COIL is not a substitute for traditional study abroad programs, COIL project courses allow the University of Illinois to preserve and to grow its portfolio of international offerings allowing for a long-term commitment to internationalization of the engineering curriculum by adding a second pathway that does not require students to physically leave

campus. To quote Brian Whalen, former Executive Director of the Forum on Education Abroad (2020),

"*We no longer define education abroad strictly as students literally crossing national borders. Rather, we should conceive of it as an educational framework that promotes the mobility of students' minds -- minds engaged in confronting other cultures and worldviews that help overcome their biases. Education abroad has always used geography as a point of definition, but now we have begun to view it as an educational model that can be practiced in a wider variety of forms.*"

This paper describes research that was designed to measure the cultural competency of engineering students and campus-level learning outcomes at the University of Illinois, measured within courses that included a COIL project. This is a first step to determine how effectively COIL-based projects embedded into the curriculum develop these skills for students. Freshmen students were given a survey, which included Cultural Competency, defined as the ability to effectively interact with people from diverse cultures and recognize the importance of cultural differences (Bielefeldt 2008), campus learning outcome measures, and results from these surveys are presented below.

2. Methodology

COIL courses were set up for Fall 2020 and Spring 2021, based on best practices from SUNY COIL and DePaul University. Furthermore, the University of Illinois joined the SUNY COIL partner's network over the 2020 summer to gain access to resources and tools to best implement COIL courses.

In addition to COIL pedagogical training, a survey instrument was developed in collaboration with the Center for Innovation, Teaching and Learning at the University of Illinois to develop and administer a pre-and post-survey assessment focused on measuring the student learning experience in the First-Year Experience electives with COIL projects. The Cultural Competency survey items come from an American Society for Engineering Education paper, "Assessing Cultural Competence in Engineering Students" by Angela Bielefeldt of the University of Colorado at Boulder (Bielefeldt 2008).

Courses which are part of the Grainger First-Year Experience were chosen to test out COIL-based projects. Many of these courses are part of a recruitment and retention program and include the label "Scholar". The students participate in a yearlong course experience, as opposed to those who participated in a semester experience. The target audience for the "Scholars" participants are women, historically underrepresented groups, and state residents. Appendix A provides specific course descriptions, student projects and length of projects of the five First-Year courses.

A univariate ANOVA was conducted to compare students' cultural competency pre-course knowledge based on course section. Then, a univariate ANOVA was conducted to compare students' cultural competency post-course knowledge based on course section. Finally, a repeated measures ANOVA was conducted to check for the difference between pre- and post-course means by course section.

3. Results

The following five Grainger Engineering First Year courses were surveyed.

University of Illinois Grainger College of Engineering First Year Courses Analysis, AY 2020-21

Table 1. Description of courses and students surveyed AY2020-21

Section	Term	N students who took…		
		Pre-course survey	Post-course survey	Both surveys
Career Scholars	Fall 2020	4	7	3
Global Disaster Resilience Scholars	Fall 2020	11	9	9
Global Service Learning	Fall 2020	6	6	6
Global Sustainability Scholars	Fall 2020	6	7	4
Virtual Svc Learning Projects	Spring 2021	15	10	9
TOTAL		42	39	31

Cultural Competence (CC) Measures

For the cultural competence measures, students were asked to rate their level of agreement with a set of 12 statements with these instructions:

Please tell us how much you personally agree or disagree with the following statements.

The possible answer categories are:

1. *Strongly agree*
2. *Moderately agree*
3. *Slightly agree*
4. *Neither agree nor disagree*
5. *Slightly disagree*
6. *Moderately disagree*
7. *Strongly disagree*

Higher scores are desirable, representing a higher level of cultural competence, so some of the items were reverse-scored to accomplish this. (Reverse scoring means that "Strongly agree" is scored as a 7 instead of a 1, "Moderately agree" is scored as a 6 instead of a 2, etc. The respondents never see the scoring numbers in the questionnaire, only the verbal labels for each point.) The means and standard deviations presented in Table 1 reflect this reverse scoring, as noted. In addition, we assessed the Cultural Competency scale for internal consistency (reliability) using Cronbach's alpha statistic. In so doing, we discovered that two of the items (7 and 10) detracted from the overall reliability of the scale, and so removed them from the calculation of the composite CC score. The resulting alpha reliability coefficient is .79 which represents an acceptable level of internal consistency.

Table 2. Cultural competence item means and standard deviations for students in the University of Illinois Grainger College of Engineering First-Year Experience Seminars, AY 2020-21

Cultural Competence (CC) Items	Pre-course Survey		Post-course Survey		Notes
	Mean	SD	Mean	SD	
1. The technology that is used in the United States is likely the best technology to use to solve similar technical problems in other countries.	3.40	1.88	3.03	1.27	
2. There is a single best solution to every engineering problem.	2.24	1.46	2.05	1.30	
3. It is important for engineers to consider the broader potential impacts of technical solutions to problems on minority racial and ethnic groups in the affected population.	1.69	1.14	1.54	.88	reverse scored
4. Technical constraints and criteria are the most important elements determining the success of an engineered solution.	4.59	1.26	4.18	1.59	
5. Most engineers in the United States would define an engineering problem similarly to each other.	3.93	1.57	4.00	1.40	
6. Engineers in the United States would define an engineering problem similarly to engineers in other countries such as India or China.	3.83	1.68	3.46	1.48	
7. If two teams of engineers design different solutions to an engineering problem, stakeholders are likely to disagree on which solution is better.	3.35	1.08	3.24	1.26	reverse scored, dropped from composite
8. The technology that is used on the United States mainland is not likely to be the best technology to use to solve similar technical problems in other countries such as India or China.	3.63	1.37	3.00	1.59	reverse scored
9. Engineers are able to design good solutions to engineering problems if given sufficient technical data, even without visiting the community or talking with stakeholders.	2.80	1.38	3.49	2.04	
10. I would be equally comfortable teaming with an engineer from the United States as one in India or China.	2.43	1.45	2.23	1.35	reverse scored, dropped from composite

11. Given a range of engineering designs to solve a particular problem, different stakeholder groups are likely to agree on which design is best.	4.08	1.58	4.49	1.72	
12. I expect that a water treatment plant designed for a 100,000-person city in Illinois would also be a good solution for a 100,000-person city in {Focus Country} if the inlet water quality were similar	3.10	1.70	3.21	1.75	
10-Item Composite CC score	3.32	.88	3.24	.90	
Number of Students	42		39		

A univariate ANOVA was conducted to compare students' cultural competency pre-course knowledge based on course section (see Table 3). In the pre-course survey, students in the Career Scholars and Virtual Service-Learning sections showed significantly higher CC scores than the other three sections. These two sections started with a higher average level of cultural competence than the other sections at the beginning of their courses. Then, a univariate ANOVA was conducted to compare students' cultural competency post-course knowledge based on course section (see Table 3). In the post-course survey, there are no statistically significant differences between means for each section. This is not an unsurprising result as students self-selected into the Virtual Service-Learning course. What is surprising is the higher level in the Career Scholar courses, as these students did not know that this course would include a global component when they registered for the course.

A repeated measures ANOVA was conducted to check for the difference between pre- and post-course means by course section. Thirty-one students in the five course sections took both the pre-and post-course surveys (see Table 3). Those students, on average experienced a small, statistically insignificant decline in cultural competence scores over the course of the term. This could be explained by students overestimating their CC in the pre-survey and correcting it during the post-survey. Three sections showed a small increase, and two showed a small decrease in cultural competence, but there are no statistically significant differences between pre- and post-course scores. On the pre-course survey, Career Scholars and Global Service-Learning had significantly higher scores than the other sections (see Table 3). There are no statistically significant differences in gains scores, or normalized gain scores.

Table 3. Pre-and Post-course Cultural Competency Scores and Score Changes by Course Section

Term	Course	Pre-course survey			Post-course survey			Both Surveys				
		N	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean Change**	**Std. Dev .Gain**	**Mean Norm. Gain**	**Std. Dev. Norm. Gain.**
Fall 2020	Career Scholars	4	3.99	.56	7	3.59	.46	3	-.90	.36	-.34	.22
	Global Disaster Resilience	11	2.95	1.02	9	2.83	.93	9	-.24	.74	-.09	.22
	Global Service Learning	6	2.92	.51	6	3.12	1.17	6	.20	.95	.05	.26
	Global Sustainability Scholars	6	2.85	.55	7	2.80	1.02	4	.10	1.77	-.02	.43
Spring 2021	Virtual Svc Learning Projects	15	3.76	.80	10	3.76	.59	9	.02	.63	-.02	.20

Further, when we look at the data from the perspective of sex, there are no statistically significant differences by sex on either survey or the gain score. N is too small to compare within a section, therefore the comparison is between all participants in all the first-year course sections (see Appendix B). Only one international student took the survey, so it is not possible to test if there was any statistically significant difference. No significant difference was found by race/ethnicity on either the pre- or post-course survey as shown in Appendix B.

Learning Outcomes Measures

Our learning outcomes measures are based on a set of outcomes endorsed by and employed by the University of Illinois for our courses. The five learning outcomes are:

1. Intellectual Reasoning and Knowledge (IRK): Acquisition of broad and deep knowledge across academic disciplines and fields. (8 survey items)
2. Creative Inquiry and Discovery (CID): Application of knowledge to promote inquiry, discover solutions, and generate new ideas and creative works. (3 items)
3. Effective Leadership and Community Engagement (ELCE): Building and sustaining productive relationships to respond to civic and social challenges at local, national, and global levels, creating positive change in their communities. (3 items)
4. Social Awareness and Cultural Understanding (SACU): Development of a critical and reflective orientation toward such social and cultural differences as race, indigeneity, gender, class, sexuality, language, and disability (4 items)
5. Global Consciousness (GC): Discovery of how complex, interdependent global systems—natural, environmental, social, cultural, economic, and political—affect and are affected by the local identities and ethical choices of individuals and institutions. (2 items)

For the learning outcomes measures, at the **end** of the course, we ask the students a set of 20 questions with these instructions:

Each college course you take may help you improve your abilities in a variety of areas. For example, some courses may improve your critical thinking skills; some may improve your communication skills; and some courses may not improve your abilities in any area at all. Please indicate how much your abilities have improved in the following areas AS A RESULT OF your enrollment in ENG 177. We are interested only in the improvement that you attribute to this particular class: ENG 177.
How much have you improved your abilities to do the following things as a result of ENG 177?

Then the 20 learning outcome items are presented with the following possible answer categories:

1. *Not at all*
2. *A little*
3. *A moderate amount*
4. *Very much*
5. *An extraordinary amount*

We used a univariate ANOVA with LSD post hoc test and calculated effect size. Table 4a shows that students in the Virtual Svc Learning Projects section felt they improved their ability to think logically and critically to a greater degree than students in the other sections (Eta^2 effect size is .25). No other statistically significant differences between the means were found.

Table 4a. Learning outcome item means by course section for students in the University of Illinois Grainger College of Engineering First-Year Experience Seminar:

Learning Outcome Items	Career Scholars	Global Disaster Resilience Scholars	Global Service Learning	Global Sustainability Scholars	Virtual Service Learning	All Sections
Intellectual Reasoning and Knowledge (IRK)						
Think logically and critically	2.43	3.22	3.00	2.57	3.80	3.08
Identify credible sources of information	2.43	2.67	2.67	2.14	3.30	2.69
Solve problems using evidence	2.43	3.22	2.50	2.29	3.20	2.79
Communicate in writing	2.57	3.11	2.67	2.71	3.60	3.00
Communicate orally	2.86	2.44	3.67	2.43	3.50	2.97
Think in creative ways	2.71	3.22	3.83	2.29	3.30	3.08
Deeply understand your	2.86	2.56	3.00	2.29	2.70	2.67

chosen field of study						
Explore questions or problems from more than one disciplinary viewpoint	2.71	3.78	3.50	3.00	3.50	3.33
8-item Composite IRK score	2.63	3.03	3.10	2.46	3.36	2.95
Creative Inquiry and Discovery (CID)						
Analyze data, creative works, literature, or information to investigate problems	2.14	3.11	3.00	2.57	2.90	2.77
Ask compelling questions related to your area of interest or major	3.43	3.33	3.17	2.71	3.00	3.13
Convey new ideas	2.29	3.22	3.50	3.00	3.30	3.08
3-item Composite CID score	2.62	3.22	3.22	2.76	3.07	2.99

We used a univariate ANOVA with LSD post hoc test and calculated effect size. Table 4b shows that students in the Career Scholars section did not report improving their ability to consider a variety of perspectives as much as students in the other sections (Eta^2 effect size is .30). Table 4b also shows that in the dimensions of Social Awareness and Cultural Understanding and Global Consciousness there were two roughly homogenous subsets of course sections: Students in the Career Scholars and Global Sustainability Scholars sections reported lesser improvement in their abilities on these items than students in the other three sections. (Eta^2 effect sizes range from .29 to .43)

Data was analyzed by race, and sex and very few statistically significant results were found. Appendix 3 shows that Hispanic students felt they improved their ability to identify sources of credible information to a greater degree than white students (Eta^2 effect size is .20). Data shows that men felt they improved their ability to communicate orally to a greater degree than women (Cohen's d effect size is .48). No other statistically significant differences between the means were found.

Table 4b. Learning outcome item means by course section for students in the University of Illinois Grainger College of Engineering First-Year Experience Seminar:

Learning Outcome Items	Career Scholars	Global Disaster Resilience Scholars	Global Service Learning	Global Sustainability Scholars	Virtual Service Learning	All Sections
Effective Leadership and Community Engagement (ELCE)						
Collaborate with others effectively	3.00	3.78	4.33	2.86	3.70	3.54
Consider a variety of perspectives when making decisions as a group	2.43	3.89	4.33	3.50	3.60	3.55
Develop ways to give back to your community	2.14	3.78	3.67	2.86	3.00	3.10
3-item Composite ELCE score	2.52	3.81	4.11	2.98	3.43	3.38
Social Awareness and Cultural Understanding (SACU)						
Work in diverse teams	3.14	3.44	4.00	2.86	4.00	3.51
Participate in discussions about cultural differences with others	2.29	4.00	4.33	3.00	3.50	3.44
Explore multiple perspectives	2.57	3.78	4.33	3.14	3.80	3.54
Have a deeper understanding of different social and cultural groups	2.43	4.33	4.17	3.43	4.10	3.74
4-item Composite SACU score	2.61	3.89	4.21	3.11	3.85	3.56
Global Consciousness (GC)						
Identify factors that make a difference in how communities around the world operate	2.00	4.33	4.17	3.00	3.70	3.49
Appreciate how events in one	2.29	4.33	4.17	3.00	3.60	3.51

location can have a global impact						
2-item Composite SACU score	2.14	4.33	4.17	3.00	3.65	3.50

4. Summary and Conclusions

Continued implementation of the survey will provide a stronger sample set and a better understanding of the impact of COIL courses on student learning outcomes. Higher Cultural Competency Scores in the pre-survey versus the post-survey are likely due to students overrating their skills in this area and developing awareness and cultural humility in which they rank themselves more appropriately in post surveys.

Early results indicate statistically significant improvements toward the campus-level learning outcomes, specifically their improved ability to think logically and critically, improving their ability to consider a variety of perspectives, Social Awareness and Cultural Understanding and, Global Consciousness. There are variations between the individual courses as not all have equal improvements in all areas.

In addition, preliminary data from fall 2021 which is incomplete at this time, indicates that the overall reliability for internal consistency (reliability) for the Cultural Competence Scale using Cronbach's alpha statistic, the resulting coefficient is only .61, which represents a middling level of internal consistency. Better cultural competence scales may be available, and we plan to further investigate for future work.

5. References

Bielefeldt, A. (2008, June). *Cultural Competency Assessment.* Paper presented at 2008 ASEE Annual Conference & Exposition, Pittsburgh, Pennsylvania. DOI 10.18260/1-2--4275

de Escalona, P. M., de Crespo, Z. C., Olivares, M., Dunn, M., Graham, C., & Hamilton, L. (2019, April). Using collaborative online international learning as an approach to promote curricula internationalization in engineering. In Realising Ambitions: Proceedings of the 6th Annual Symposium of the United Kingdom & Ireland Engineering Education Research Network (pp. 129-138).

Division of Data Management https://www.dmi.illinois.edu/ Accessed May 2021.

Foronda C, Reinholdt MM, Ousman K. Cultural humility: a concept analysis. J Transcult Nurs. 2016;27(3):210-217.

Gordon, P.J., Patterson, T. & Cherry, J. (2014). Increasing international study abroad rates for business students. *Academy of Educational Leadership Journal, 18*(3), 77-86.

Institute of International Education. (2020). "Profile of U.S. Study Abroad Students, 2000/01-2018-19." *Open Doors Report on International Education Exchange*. Retrieved from https://www.opendoorsdata.org

Hanstedt, Paul. *Creating Wicked Students: Designing Courses for a Complex World*. Stylus Publishing, 2018.

De Castro, A. B., Dyba, N., Cortez, E. D., & Genecar, G. (2019). Collaborative online international learning to prepare students for multicultural work environments. *Nurse educator*, *44*(4), E1-E5.

Stablein, M. J., Gonzalez-Crus, J., Talbot, J., Walters, R., Fernández-Frey, M., Ramírez, M., Rosado Casanova, B., Heemstra, J., Marshall, A.-M., & Rodríguez, L. F. (2022). *Compound[ing] Disasters in Puerto Rico: Pathways for Virtual Transdisciplinary Collaboration to Enhance Community Resilience,* manuscript in review Global Environmental Change

Warnick, G., et al. 2008. Globalization: A new frontier for capstone courses. Proceedings of the 2008 ASEE Annual Conference & Exposition. Pittsburg, PA: ASEE.

McKim CA. The Value of Mixed Methods Research: A Mixed Methods Study. *Journal of Mixed Methods Research*. 2017;11(2):202-222. doi:10.1177/1558689815607096

Paschal, C. B., & Crist, I. S., & Rowe, C. J. (2017, June), *Strategies for Successfully Increasing Engineering Study Abroad Participation* Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2--28853

"What is COIL?" https://online.suny.edu/introtocoil/suny-coil-what-is/ Accessed 2 May 2021.

Whalen, Brian. "Education Abroad in a Post-COVID-19 World. *Inside Higher Education*. https://www.insidehighered.com/views/2020/04/14/how-covid-19-will-change-education-abroad-american-students-opinion April 2020. Accessed 4 May 2021.

Appendix A. University of Illinois Grainger College of Engineering First Year Course Detailed Information

Course	Description	Project Topics	Deliverables	# of weeks	Team meeting structure	Team Composition
Career Scholars	Career Scholars develop the enhanced skills required in the engineering workplace, be it team dynamics, leadership skills, intercultural competency, or communication techniques. The course uses a hands-on, interactive, discussion/team-based approach with active learning exercises to prepare you for your professional career.	Team #1 Analyze the current state in which Pet-Care startup-up in Spain stands and come up with various ways of how the start-up bring visibility and awareness about its product in the US market. Team #2 Analyze the competitors, target audience and quantify the market for an AI startup in Colombia.	Project Proposal, mid-point status Update, Final Project report, final presentation, and specific project deliverables depending on project goals.	12	Teams arranged meetings with project supervisors and had check-ins with instructors/ partner liaisons.	Students were placed on teams of 3-4 based on interest in partner organization work and topics.
Global Sustainability Scholars	This course develops students' cultural intelligence as they also learn about sustainability applying those skills to engineering projects on campus and with organizations in Trinidad and Tobago.	Team #1: Research on the use of satellite mapping/tracking to detect fires early. Team #2: Explore methods to develop a portable water device to transport water "uphill" to fight fires. Team #3: Explore other technology that may aid FACRP's fire prevention, detection, and suppression activities (I.e. Sirens)	Project Proposal, mid-point status Update, Final Project report, final presentation, and specific project deliverables depending on project goals.	12	Teams had periodically scheduled meetings in class with community partners. All other meetings were scheduled by teams outside of class.	Students were placed on teams of 3-4 based on interest in community partner organization work and topics.

		Team #4: Research Eco Lodge Designs Team #5: Research Renewable Energy Systems Team #6: Research and design of floating bridge				
Global Disaster Resilience	Through case studies, interactive projects, hands on activities, and study tours, students will investigate background cultural, political, and social factors that provide context for specific disaster-prone regions. Students will initiate their training in not only the design of, but also the assessment of the resilience of potential technological solutions when responding to current and anticipated challenges for regions under consideration. Students will work with local communities, aid organizations, and peer institutions in the identification and implementation of sustainable responses.	Team #1: Rainwater collections greenhouse collection Team #2: Rainwater collection basketball court Team #3: Rainwater collection pollinator garden	Project Proposal, mid-point status Update, Final Project report, final presentation, and specific project deliverables depending on project goals.	16	Teams had periodically scheduled meetings in class with community partners. All other meetings were scheduled by teams outside of class.	Students were placed on teams of 2-3 based on interest in community partner organization work and topics.
Global Service Learning	Through case studies, interactive projects, and	Team #1: design a low-tech drip irrigation system	Project Proposal, mid-point	8	Teams arranged meetings	Students were placed into teams

	hands-on activities students will learn the fundamentals of service learning and technical skills that will guide them in future project work. In this course students will have a virtual service-learning experience with partners from across the globe working on real projects.	for school gardens in Bolivia. Team #2: convert existing health and safety protocols for COVID-19 into smaller digestible social media posts and posts for WhatsApp distribution in Bolivia.	status Update, Final Project report, final presentation, and specific project deliverables depending on project goals.		with project supervisors biweekly and had check-ins with instructors/ partner liaisons.	based on their skills set from their resumes and their ability to meet with project leaders in Bolivia outside of class time.

Appendix B. Cultural Competency Scores and Score Changes

Table B1. Pre-and Post-course Cultural Competency Scores and Score Changes by Sex

		Pre-course survey			Post-course survey			Both Surveys				
Term	**Sex**	**N**	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean Change**	**Std. Dev .Gain**	**Mean Norm. Gain**	**Std. Dev. Norm. Gain**
Fall 2020/Spring 2021	**Female**	26	3.13	.88	27	3.09	.86	20	-.10	.99	-.07	.28
	Male	16	3.62	.81	12	3.59	.94	11	-.09	.78	-.04	.24

Table B2. Pre-and Post-course Cultural Competency Scores and Score Changes by Race/Ethnicity

		Pre-course survey			Post-course survey			Both Surveys				
Term	**Race/Ethnicity**	**N**	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean (max 7)**	**Std. Dev.**	**N**	**Mean Change**	**Std. Dev .Gain**	**Mean Norm. Gain**	**Std. Dev. Norm. Gain.**
Fall 2020/ Spring 2021	**Asian**	10	3.45	.62	8	3.46	.91	8	.00	.93	-.02	.28
	Hispanic	15	3.32	.93	11	3.74	.79	8	.33	1.02	.06	.24
	Other	5	3.18	1.17	4	3.13	1.16	3	.33	.91	.08	.21
	White	12	3.27	.97	16	2.83	.78	12	-.56	.68	-.19	.23