Implementing Collaborative Online International Learning (COIL) in Regular Engineering Coursework

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***Abstract*—This Innovative Practice Full Paper is part of a collaboration between a US and a Chinese university, in which two different online engineering courses, situated at the US university, were taught to mixed classes of students from both. Course content remained the same as standard offerings, and assessments had both individual and group components, specifically instructor-selected mixed-university groups. The first course was run in the spring 2021 semester, followed by a different course in the fall 2021 semester.**

International education offerings have been hampered by disruptions due to Covid-19, in addition to the usual barriers. Alternate models like collaborative online international learning (COIL) provide an avenue to continue international partnerships and expand their modalities. The current project is based on the COIL model but differs in two ways: the courses were not specially developed for COIL but adapted to it without changing course objectives, and the courses were taught solely by the instructors at the US university though administrative support was provided by both universities.

Data for this project was collected using student surveys, personal interviews, instructor reflections, and course assessments. Student survey data is qualitatively analyzed using thematic analysis, while personal interviews and instructor reflections are summarized by the authors. Student learning outcomes in both sections were compared to those in the sections offered only to on-campus students and found to be similar or slightly better. Student perceptions of the classes were positive despite substantial difficulties.

Instructors and students in these classes faced significant challenges like time zone differences and scheduling issues, technological barriers, and cultural differences leading to miscommunication. However, the collaborative aspects of the courses made them attractive for both groups of students, and opportunities for easy communication during synchronous class meetings made things run smoothly.

In addition to discussing the challenges and attractions, the authors make a series of recommendations on conducting a regular online course in STEM disciplines with students from two different education systems.

***Index Terms*—collaborative learning, international programs, online, online discussions**

I. Introduction

The value of a collaborative learning environment has long been well-established as a High-Impact Practice (HIP) in higher education [1]. Collaborative Online International Learning (COIL) takes the practice to an online environment and opens it up to a wider audience. This study presents the findings from an asymmetric COIL project undertaken by instructors from a US university, with support from a Chinese partner university but no instructional collaboration, in two different courses taught in the spring and fall of 2021, respectively.

A. Research Questions

The authors primarily sought to investigate three research questions, as listed below.

1) What are some challenges specific to COIL courses in engineering disciplines with US and Chinese students?
2) What factors in the courses were attractive to students?
3) Are student learning outcomes in COIL sections comparable to other sections of the same course?

To answer the above questions, the authors used a variety of tools to collect data. This included a journal maintained by each instructor during their course, regular feedback collected from students via surveys, individual interviews with students after course completion (post final grade submission) and learning outcome indicators used in accreditation and other processes. Each tool and the method of processing the data will be discussed briefly in the section discussing its results.

II. Background

The Covid-19 pandemic forced a massive and sudden change to online modality in classes across the globe, both in K-12 and higher education. In theory, most online-only classes can be taken by learners from across the globe, the premise that Massively Online Open Courses (MOOCs) are based on. However, online classes benefit from social presence and interactions between peers and instructors [2], something that is usually missing from MOOCs [3]. As Rubin and Guth [4] point out, intercultural dialogue and learning, the means of developing intercultural competence, have rarely been a key component of MOOCs.

Intercultural competence and collaboration are generally developed through physical mobility in the form of study-abroad programs, satellite campuses, or international student populations [5], [6]. While such programs have always had financial and logistical barriers, the Covid-19 pandemic exposed these programs to massive disruption on a far bigger scale [7]. Existing international partnerships have also come under threat with diminishing possibilities and higher barriers to travel.

A. Collaborative Online International Learning (COIL)

In recent years, COIL has been adopted as a cost-effective pedagogical approach to developing intercultural competence. Vahed and Rodriguez's [8] analysis suggests that *"COIL experiences positively influence intercultural awareness"*. Nava-Aguirre's work [9] discusses, in great detail, the planning and experiences of implementing COIL in four business school courses, and how it helped propel *"Internationalization"* of education *"at home"*. DeCastro et al. [10] discuss the design of a 6-week-long COIL segment in a nursing course to help students from the US and Philippines *"gain appreciation for working in multicultural professional nursing practice environments in the future"*. Hautala and Schmidt [11] describe a COIL project among geography students from Germany and Finland that culminated in a co-located workshop, with all students in the same physical space. Appiah-Kubi and Annan [12] organized an 8-week-long COIL program for students from the US and Ghana in materials engineering, and found that those students performed significantly better in project work when compared to other students who were not involved in the COIL program.

B. Current Project

While the current project is based on COIL, as described in other studies mentioned above, there are some significant differences. All the above projects were specially-developed coursework or special segments within existing coursework, in the pattern of study-abroad programs. The current project takes two existing engineering courses in their entirety and delivers each to two groups of geographically-dispersed students, otherwise studying in two different educational systems. The course objectives remained unchanged, with course content delivered completely online and collaboration happening through regular assignments.

The second difference is that while existing COIL programs are jointly taught by instructors from both the partner universities, courses within this project were taught by instructors solely from the US university. While it can be tempting to brand this as a variation of a regular college course with international students, the intention of the course design was to foster collaboration between students from two different systems, as opposed to assimilating international students into the US system.

III. Context

The authors' home university, University of Wisconsin-Stout (UWS) is a Primarily Undergraduate Institution (PUI) in the US Midwest that has had a Memorandum of Understanding (MOU) with a well-ranked state university in central China, Zhengzhou University International College (ZZU). As per the MOU, a few students from ZZU were supposed to start their exchange semesters from the fall of 2020. However, when Covid-19 disrupted this plan, the two universities agreed to allow five students from ZZU to attend an online class with 15 students from UWS in spring 2021.

A different class was offered in fall 2021, as part of the same agreement, again with 5 and 15 students from ZZU and UWS, respectively. The spring 2021 class, named Course A in this paper, was taught by Instructor 1, one of the two co-authors of this paper. The fall 2021 class is named Course B and was taught by Instructor 2, the other co-author.

Both instructors had previously taught engineering coursework in English at ZZU, on campus in China as part of the MOU, and thus, had experience with teaching classes catering to students from both educational systems. Courses A and B were designed keeping such challenges as language barriers, technological barriers, and differences in time zones in consideration. Furthermore, the barriers to efficient COIL implementation and ways to overcome them, as shown by [5] proved a great source for course design. Both instructors also had prior experience teaching the same courses online with students only from UWS.

A. Logistics

Courses A and B were both offered at the Engineering & Technology Department at UWS. Course A is, in general, a sophomore course in multiple engineering programs while course B is usually taken by junior or senior year undergraduate students in Mechanical Engineering only. Course A was scheduled for Mondays and Wednesdays 7-8 pm CST (8-9 am or 9-10 am in China), in spring 2021, while Course B was scheduled for Mondays and Wednesdays 8-9 am CST (9-10 pm or 10-11 pm in China) in fall 2021. Class meetings were conducted over Zoom™.

B. Student Assessment

Each course used a variety of student assessment like weekly class activities and quizzes for all individuals, 3-4 group projects, and one pair project near the end. For group projects, students were divided up into groups of 5. In groups that consisted of students from both universities, there were either 2 students from UWS and 3 students from ZZU or 3 students from UWS and 2 students from ZZU. In course A, groups remained same for all group projects while in course B, groups were changed for each group project to ensure that all 15 students from UWS got to work with students from ZZU at least in one group project. For the pair project, students were free to choose their partner.

IV. Method

This section describes various data tools that are used to answer the research questions described in section I-A.

1) Critical Incident Questionnaire (CIQ): Brookfield [13] developed the critical incident questionnaire (CIQ) consisting of five prompts, the responses to which are used to capture student feedback. In our project, the survey was conducted 5 times in course A and 3 times in course B at regular intervals over their respective semesters. They were anonymous and voluntary, with the following prompts:

- **Prompt 1**: At what moment this week did you feel most engaged with what was happening?
- **Prompt 2**: At what moment this week were you most distanced from what was happening?
- **Prompt 3**: What action that anyone (teacher or student) took this week did you find most affirming or helpful?
- **Prompt 4**: What action that anyone took this week did you find most puzzling or confusing?
- **Prompt 5**: What about the course activities this week surprised you the most? (This could be about your own reactions to what went on, something that someone did, or anything else that occured)

Originally designed to collect general feedback, the present authors use Phelan's [14] recommendations as guidelines to collect student perceptions of online learning. The survey was approved by the Institutional Review Board (IRB) at the authors' university (UWS), with blanket approval from ZZU for such surveys. To give an idea of the scale of responses collected, the number of responses to each prompt is listed in Table I. Student response data from the CIQ surveys is used to address research questions 1 and 2.

2) Instructor Journal: Keeping journals of class activities can be a means to improve awareness and be a more reflective teacher [15]. Instructors for both courses noted down highlights and personal experiences during synchronous class meetings in a regular manner. We use this data to address research question 1 and make recommendations for future COIL classes.

3) Personal Interviews: At the end of Fall 2021, after grades were submitted, an email asking for personal interviews was sent out to all students from course A in Spring 2021 and course B in Fall 2021. The interview questions were constructed from tips shared by Jacob and Furgerson [16]. The email contained the list of questions that were approved by the IRB at UWS. Nine students volunteered to give interviews, three of them from ZZU. All interviews are conducted online on Zoom™ or Microsoft Teams™. The interview questions and summary of students' responses are presented in section VII. This data is used to address research questions 1 and 2.

4) Learning Outcomes: To address research question 3, learning outcomes in both courses are compared with their corresponding sections that were offered online and had students only from UWS. The results are presented in section VIII.

V. Results: Critical Incident Questionnaire Surveys

This section presents a thematic analysis of student reflection data obtained from CIQ surveys in courses A and B. Table I shows the number of student responses to each prompt in the CIQ surveys for both courses.

TABLE I
Number of responses to the five prompts in the CIQ survey

	Prompt				
	1	**2**	**3**	**4**	**5**
Course A	29	27	27	23	26
Course B	39	33	37	28	30

The authors applied the six-step thematic analysis process described by Braun and Clarke [17], with an inductive, "bottom up" approach to developing themes out of survey responses. The entire process is demonstrated visually in Figure 3.

For each course, responses from all CIQ surveys were aggregated and categorized into the five prompts, each response being a data extract, in line with the first step of familiarizing ourselves with the data. The authors then reviewed the data extracts in the second step, assigning one or more initial codes for each, based on semantic content rather than latent views. All codes were then organized into subthemes, based on similarity of content, and further grouped into larger themes, through consensus between both authors. The third step thus completed, the authors reviewed the data extracts again, comparing them with the respective theme. In this fourth step, the authors either decided to move data extracts to a different theme or keep them as is, again by consensus.

Table II displays the four themes that emerged, with a brief description of each for a quick reference. In the final step, the four themes are named and the frequency of their appearance is calculated, as shown in Figure 1.

Below are elaborations of each theme, with examples of student responses.

1) Collaboration: This is a theme that encompasses responses referring to collaborating with peers. Overall, this theme is dominant with the frequency of 35.2 % as shown in Figure 2. With regards to prompts, as shown in Figure 1, this theme occurs mostly in prompts 1 and 5 for course A and prompts 1, 2, and 3 for course B. Students found collaborating with peers engaging and helpful. An example of this from prompt 1 in course A would be:

> *"Honestly, how well my group and I did on the group project, considering we have members from China, finding good times to work together was limited, but we did it and were able to communicate ideas fairly easily and did a good job working together."*

Some students faced difficulties in collaboration, as shown in the following example from prompt 2 in course B:

> *"We had a lot of trouble doing group work this week. Like jet lag, Due to the time difference, we failed to communicate with each other in time, and we failed to reach a unified opinion on some issues in advance."*

2) External Factors: This theme relates to student responses that mention factors outside course, such as busy

TABLE II
THEMES AND DESCRIPTIONS

Theme number	Theme	Description
1	Collaboration	Collaborating and working with peers, including international ones
2	External factors	Factors outside class and personal issues
3	Communication	Opportunities to communicate with the instructor, or communication from the instructor, or presentations to peers
4	Course design	Course content and workload, class atmosphere, perceptions of instructor caring about class issues

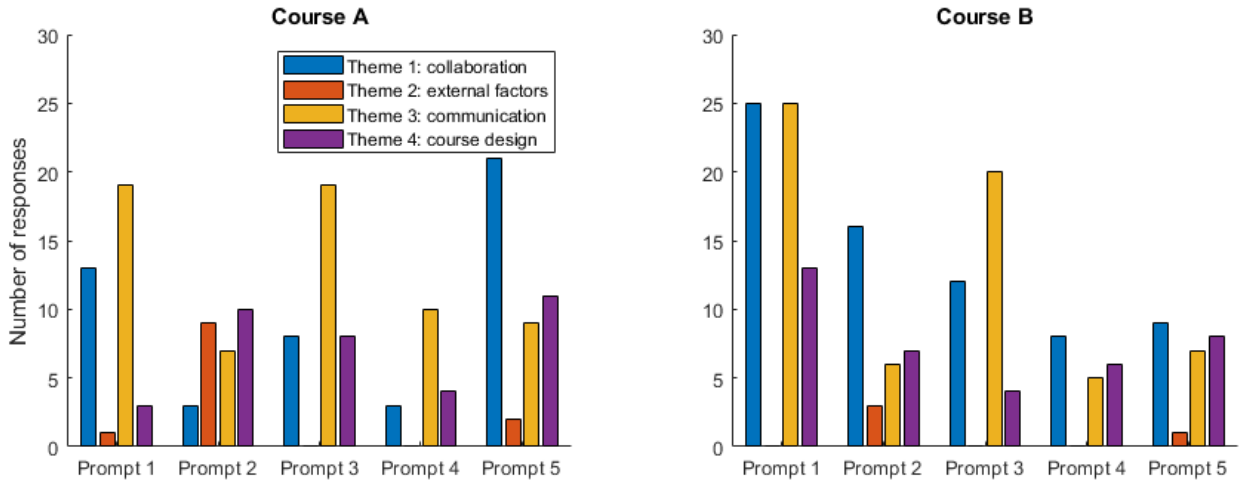

Fig. 1. Number of responses for themes 1 through 4, for each prompt in the CIQ survey and course.

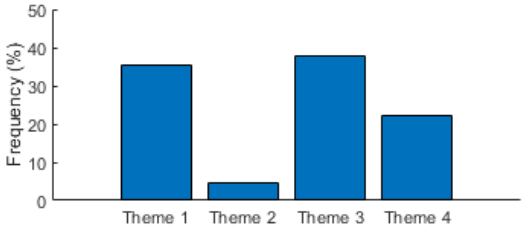

Fig. 2. Frequency of themes 1 through 4 for all prompts and both courses combined.

workload in other courses. This theme has the lowest overall frequency of 4.8 % as shown in Figure 2. Most student responses belonging to this theme are in prompt 2 (see Figure 1). Students felt distanced from the course when they had heavy workload in other courses. An example of this from prompt 2 in course A would be:

> *"A lot of my other classes got pretty heavy on the work load this past week, so trying to squeeze it all in with the group projects needing to get finished up was tough, but we made it work."*

3) Communication: This theme encompasses student responses that mention about class discussion, interactions among students, communication from the instructor, etc. This theme is the most dominant one with highest overall frequency of 37.9 % (see Figure 2). It is mostly seen in prompts 1 and 3 in both courses A and B (see Figure 1), which indicates students find communication encouraging and helpful. An example of this from prompt 3 in course A would be:

> *"When people ask specific questions on problems because then you go more in depth into the why."*

Another example of this from prompt 1 in course B would be:

> *"I was most engaged during the in class activities and the instructor's interaction with the students."*

4) Course Design: This theme encompasses student responses mentioning about course workload, atmosphere in class, methods of instruction in class, instructor's understanding of students' problems and workload. This themes has an overall frequency of 22.1 % (see Figure 2). This theme is seen across all prompts. An example of this from prompt 1 in course A would be:

> *"Yes, but I definitely felt it was a more laid-back week with our presentations being on Tuesday and Thursday being used as an overview for what will be happening in the next week. Would have been a bit overwhelming with a quiz on Thursday."*

An example of this from prompt 5 in course B would be:

> *"I was surprised it took a large amount of time to get through the questions the instructor had for each student during the class activity questionnaire."*

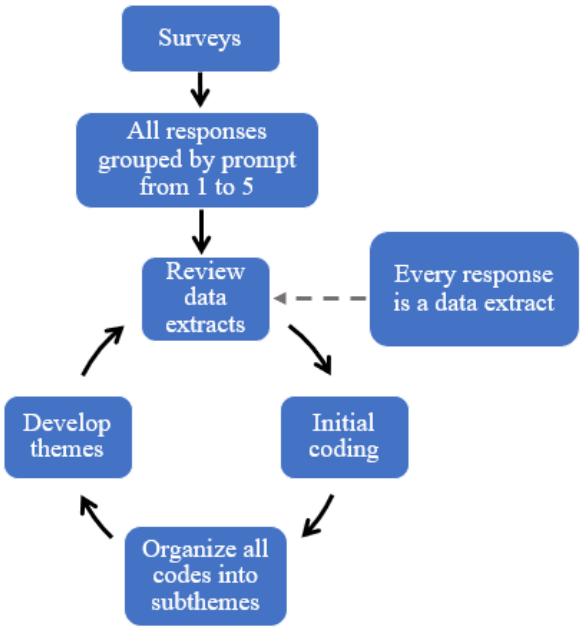

Fig. 3. Steps in the thematic analysis process.

A. Credibility of Qualitative Analysis

The authors followed three of the provisions that Shenton [18] suggested to promote confidence in the credibility of this qualitative analysis.

1) Adoption of well-established research methods: The authors adopted CIQ surveys by Brookfield [13] as the tool to gather student feedback, which was then analyzed following Braun and Clarke's [17] six-step approach to qualitative analysis. Both the survey tool and the analysis method are, thus, well-established.

2) Familiarity with the culture of participating organizations: As mentioned in Section III, both the authors had experience of teaching at the US university, UWS, and the Chinese university, ZZU, prior to teaching the online courses discussed in this paper. As such, both authors possess an adequate cultural context and background for this work.

3) Triangulation with other methods: In addition to thematic analysis of survey data, the authors have also interviewed a few students from these classes, results of which are discussed in Section VII. The interview responses do not throw up any contradictions to the qualitative analysis data and compensate for any limitations in survey data.

VI. Results: Instructor Journals

This section is based on entries from a journal maintained by each instructor, documenting class activities, sudden disruptions and challenges, and their thoughts, to preserve the memory of running the courses. The objective was to figure out what challenges may have not been foreseen prior to starting the program, by combing through the journal entries. The paragraphs below provide the gist of the unforeseen challenges that cropped up during the conduct of the course.

A. Course A

1) Initial attempts to get US students to use Chinese apps like WeChat were hard because of app-related policies. After a while, the instructor settled on MS Teams as the communication medium for all students, given that it is available in both countries.
2) Chinese students were not used to learning management systems (LMS) like Canvas and had a difficult time initially. However, it was made easier by two students who had prior experience of the LMS from English as a Second Language (ESL) classes they had taken prior to this course.
3) In the beginning, the instructor would sometimes refer to the US students by their university and Chinese students by their country. Instances like these should be avoided from the beginning to set the tone for an inclusive classroom.
4) The instructor made a few attempts at generating interest in cultural exchange by posting about Chinese new year on Teams or talking about their experiences of different kinds of food when visiting China. However, there were few takers and exchanges like these didn't catch on within class time, even during relaxed conversations.
5) Disruptions outside the class made collaborations difficult. Many US students mentioned how some of the Chinese students almost dropped out in the middle of the semester. It turned out that the Chinese students had day-long labs for about two weeks and barely had any energy for classes and collaborations at night.
6) The Chinese students were happy to interact with the instructor privately but except for one, did not speak much during live class meetings.

B. Course B

1) Recording the live class meetings were helpful for all students for linguistic and other reasons, but the instructor had forgotten to do so a few times early on.
2) Online breakout rooms during live class meetings were not helpful due to limited time and hesitation among students to initiate discussions. Instead, calling on individual students with questions, with everyone in class present online, worked better.
3) In multiple instances, software used in class would slow down or crash, possibly due to heavy burden from video conferencing and recording.
4) Instructor would initially ask students to use search engines to find common engineering parameters for problem-solving, something often used in engineering classes in the US. However, Chinese search engines are often not designed to find these, putting the Chinese students at a disadvantage.
5) In some instances, students from China would suddenly stop communicating with their groupmates in the US. When asked about it outside class by the instructor, the Chinese students mentioned about high-pressure exams at their home campus preventing them from investing

much time on this course.

It is noteworthy here that both instructors are used to teaching in a US learning environment, both face-to-face and online, and their courses are, perhaps, already tuned to US students' needs. Thus, a lot of the challenges may appear to deal more with the Chinese students simply due to them coming from a different educational system.

VII. Results: Personal Interviews

This section summarizes responses from personal interviews of students who had taken one of the courses or both. There were nine interviewees in total, three of them from ZZU and six from UWS. Each interviewee was asked the same set of questions, listed below, and their responses were collected as notes. The investigators then sieved through the data, building a summary of all the responses to each question. The summary is presented here under each question.

1) **How did you end up taking this course?**
   a) Was it the schedule that fit well?
   b) Was it the online modality?
   c) Did someone in your university ask you to take this?

   Fitting in with their schedules was a top priority for most responses, with some explicitly mentioning that having the live class meetings at night was a big benefit. Responses from ZZU highlighted the role played by students in recruiting others for the program.
2) **Tell me about your previous experience in courses similar to this.**
   a) like physics, mechanics, etc.
   b) online courses, not necessarily in same discipline

   Respondents had mixed experiences in online classes, some emphasizing that their positive experiences were due to substantial preparation by the instructors while the negative ones were caused by having to effectively self-teach from textbooks. One student was specifically upset about a previous course with no live meeting times and just a few recordings uploaded to the LMS. Most respondents preferred interactions with peers and the instructor during live class times, compared to lecturing.
3) **Tell me something about the overall course experience that you enjoyed very much?**
   Most respondents enjoyed group activities and assignments, with students from China specifically mentioning how much they liked working with their US peers. Using real-world examples for the assignments was popular and so was the format of uploading pre-recorded lectures followed by live class meetings.
4) **Tell me something about the experience of taking the course that was really difficult?**
   Time zone differences and scheduling issues had proven to be the biggest difficulties, with some explicitly mentioning how language was not actually much of a barrier. A few responses asked for more time for interaction during class meetings while others felt under-prepared to handle the topic, possibly reflecting different prerequisite courses in different universities.
5) **How was your experience of the live class sessions?**
   a) Were they useful?
   b) Did you enjoy them?
   c) Could they have been made better?

   Interacting and asking questions of the instructor, and listening to others asking, were widely recognized as the most helpful elements of the live class meetings. A few responses discussed how additional class meeting time, especially for group work, would have been helpful. One student mentioned that breakout rooms, tried in one course for the first 3 weeks, were not useful however.
6) **How was the workload for the class?**
   a) Too much, too little, or just right
   b) An activity you wanted more of
   c) An activity you wanted less of

   All respondents unanimously agreed that the workload was perfect, not too much or too little. Some respondents would have preferred more individual assignments while others would have liked more group assignments.
7) **How was working with your groupmates?**
   a) Was it helpful to work with others?
   b) Did you have trouble communicating?
   c) Did you have trouble scheduling meetings?

   Scheduling meetings between Chinese and US students was difficult for everyone. Assignment deadlines did not work the same way for the two cohorts, effectively reducing the time available to actually work on the assignment. There was substantial miscommunication between US and Chinese students but most such responses also mentioned that this was not due to any language barrier.
8) **If you had to change any one thing about the course, what would that be?**
   Most respondents would have liked more class meeting time specifically earmarked for working in groups. Chinese students would have liked to interact more with US students. One respondent would have liked more demo labs during the live class meetings.

VIII. Results: Learning Outcomes

This section presents a comparative analysis of learning outcomes in both courses, comparing them to online offerings of the same courses that were populated wholly by students from the US university.

TABLE III
COURSE A: MEAN SCORES ON A SCALE OF 1 TO 4 AND STANDARD DEVIATION FOR THE THREE LEARNING OUTCOMES INDICATORS ASSESSED FOR ACCREDITATION

Learning outcome indicator	COIL section		non-COIL section	
	Mean	Standard deviation	Mean	Standard deviation
1	3.5	0.7	2.7	1.3
2	3.3	0.6	3.2	1.0
3	2.8	1.0	3.6	0.9

TABLE IV
COURSE B: MEAN SCORES ON A SCALE OF 1 TO 4 AND STANDARD DEVIATION FOR THE THREE ASSESSED COURSE OBJECTIVES

Course objectives	COIL section		non-COIL section	
	Mean	Standard deviation	Mean	Standard deviation
1	3.4	0.6	3.1	0.6
2	3.2	0.6	3.0	0.8
3	3.1	1.0	3.1	1.0

A. Course A

Course A is part of the curriculum of multiple accredited engineering programs at the authors' university and is regularly assessed for specific student learning outcomes. The indicators for these outcomes are decided by faculty in charge of maintaining program accreditation and stay constant across instructors and offerings.

In spring 2021, while instructor 1 taught the COIL section of Course A, instructor 2 was teaching another non-COIL online section of the same course with only students from UWS enrolled in it. Table III shows the mean scores of students for each indicator of learning outcomes, as assessed by their respective instructors i.e. the authors of this paper, on a scale of 1 to 4.

B. Course B

While Course B is not regularly assessed for accreditation purposes, it is a part of an accredited program and needs to satisfy course objectives approved by the university's curriculum committee. Instructor 2 had taught a non-COIL online section of the course in spring 2021, prior to teaching the COIL section in fall 2021. Both sections had assessments meant to test achievement of specific course objectives among students, as listed in Table IV. Table IV shows the mean scores of students for three course objectives, as assessed by instructor 2 on a scale of 1 to 4.

IX. DISCUSSION

This section briefly discusses what authors found with regards to each research question, from the results of the different kinds of data analysis shown in Sections V to VIII.

1) **What are some challenges specific to COIL courses in engineering disciplines with US and Chinese students?**
   a) *Time zone differences and scheduling issues* - Not only did time zone differences hamper availability to meet outside class, they also led to other related issues. Interviewees mentioned different energy levels among collaborators due to this. Some perceived the assignment deadlines to be effectively much earlier. If the deadlines were at night, it was morning for students in China and vice versa, so last-minute rush was not possible and the actual time to work on the assignment was a much smaller window.
   b) *Miscommunication* – Specifically, multiple students emphasized that it was not a language barrier but a deeper form of disconnect. US students expected communication about things that Chinese students did not think to notify, and sometimes, both parties seemingly agreed on a plan only to realize that they had meant different things. There were also sudden drops in communication from the Chinese side due to external factors that were baffling to US students.
   c) *Technological differences* – Very few apps work effectively in both US and China. US students could not make accounts in WeChat due to rules and limits on new users while most apps commonly used by US students did not work in China. The choice of unusual apps like MS Teams for group communication put a damper on collaboration. Similarly, availability of information for problem-solving was not equitable because Chinese students often did not have access to parameters collected by US search engines like Google.
2) **What factors in the courses were attractive to students?**
   a) Good opportunities for communication with the instructor, whether as reminders and tasks from instructor to students or Q&A sessions with the class, were very popular with everyone. Students really liked getting to use class time to mostly ask questions, listen to others ask them, or discussing problems that they had difficulty understanding. Even freewheeling chats that made for a warm, easygoing atmosphere were appreciated by students from both countries and by those who didn't necessarily contribute themselves. Clear communication of timelines and deadlines, and explanations of assignment expectations was also much appreciated.
   b) Despite all the hiccups, students loved the collaborative aspects of the assignments, whether with students in their own university or with those across the globe. Satisfaction from collaboration ranked highly in the thematic analysis of student feedback as well as in personal interviews, even when students mentioned the difficulties.

c) A few students specifically mentioned how much they liked having live class meetings at night, despite not being asked directly. Most students in these courses were from a traditional group, those who attend school full-time and take most courses during the day. Yet, instead of feeling tired, students appreciated when class time was at night and even asked for longer meeting times for better collaboration and communication.

3) **Are student learning outcomes in COIL sections comparable to other sections of the same course?** As can be seen from the results outlined in Section VIII, and Tables III and IV, overall learning outcomes are similar for both classes, whether it is Course A, taught by two different instructors during the same semester, or Course B, taught by the same instructor during different semesters. Course A individual outcomes are different (though they average out pretty evenly) but that is at least as likely to be the effect of having separate instructors. Course B actually does better in all indicators when compared to the non-COIL section, despite being taught by the same instructor.

X. Recommendations and Conclusion

The authors make the following recommendations on conducting a regular online course in STEM disciplines with students from two different education systems.

1) **Familiarization with technology** - Near the beginning of the course, set aside some time to demonstrate and practice working with technological tools in the course like the learning management system (LMS), chatting apps like the MS Teams mobile version, and video-conferencing software like Zoom. Set up small tasks for points that would allow students to build a routine around using them. Provide handbooks and similar resources for parameters and quantities, rather than allowing students to reply on search engines.
2) **Synchronous class meetings are important, but do not use them for lecturing** - Almost all responses from students appreciated synchronous class meetings and talked about the benefit of sharing, communicating with the instructor and peers, listening, etc. It is necessary to establish substantial social presence in online classes. Use class time primarily for that. Schedule some time every week specifically for student groups to collaborate on assignments, with mild instructor supervision ensuring that everyone is present. It is clear from student responses that this is far more beneficial than *teaching* during meeting time.
3) **Assign collaborative work, and facilitate scheduling** - Collaborative assignments and project work were immensely popular among all students, despite scheduling and time zone issues. Assign meaningful collaborative work and actively facilitate smoother scheduling. This can mean using a substantial amount of class meeting time for group work among students, surveying students on availability near the beginning of the course and assigning members to groups accordingly, assigning one person in group to organize meetings outside class times and take attendance, etc.
4) **Instructors need to be familiar with the educational systems of all groups of students** - Much of the miscommunication among group members, mentioned as one of the challenges, arose out of one group of students not knowing the context of the other. Chinese students often stopped communicating when they were suddenly swamped with difficult exams or day-long labs at their home campus. US students underestimated the difficulties of communication beyond simple language barriers. Instructors familiar with both educational systems are necessary to navigate such issues successfully. The present authors' familiarity with ZZU and the Chinese educational system proved invaluable in resolving such issues.
5) **Schedule as many night classes as possible** - If the class is primarily taken by a traditional college student population, schedule as many classes at night as possible. With time zone differences of 13 hours, like that between US and China, this can mean out of two meetings every week, one can be in the morning and one at night, for each country. Popularity of the night class option was a surprise pop-up from the personal interviews of students.

To conclude, it is not necessary to design special coursework or collaborate on teaching to foster intercultural learning through online classes. Courses in the regular curriculum can be adapted sufficiently without any changes to student learning outcomes. The present project provides a window into some of the specific challenges and benefits of doing so. Further work needs to be done to measure the extent of intercultural competence being developed by students taking similar coursework.

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