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Article abstract

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An Example of Using Collaborative Online International Learning for Petroleum and Chemical Engineering Undergraduate Courses

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Abstract

This work describes an international collaboration experience carried out between our process design and petroleum property evaluation courses. This collaboration was developed as part of a partnership between the American University of Ras Al Khaimah (AURAK) in Ras Al Khaimah, United Arab Emirates, and Wayne State University in Detroit, Michigan, United States of America, using a program called Collaborative Online International Learning (COIL) from the State University of New York (SUNY) system. The COIL program provides training to faculty on engaging students in international and cross-disciplinary projects to promote skills needed in the current work force. The COIL training meetings facilitated pairing faculty of different disciplines in different parts of the world and provided a structure for developing a collaborative project. The collaborative project that we undertook in fall 2021, and which we detail throughout this article, was titled Upstream and Downstream of Petroleum Economics.

Keywords: international online learning, chemical and petroleum engineering, United States, United Arab Emirates

Introduction

A key skill in today's global work environment is the ability to work on multidisciplinary, multinational teams. This is typically not a skill that is taught in engineering courses, but it is vital that the next generation of engineers understands how to work in such a context. Doing this can be nontrivial due to the need to negotiate meeting times with time zone differences, to come to terms with different regulations in different countries when determining project management, and to understand the challenges faced in another discipline to come up with optimal solutions to engineering problems when in-person meetings are not available to hash out plans and provide greater ease of discussion between scientists with different expertise. Thus, enabling students to have experience performing work on multidisciplinary, multinational teams during their time as undergraduates and causing them to reflect on such experiences can provide them with an understanding of the challenges in accomplishing such a task and experience with trying different techniques for mitigating some of these before they hit the workforce.

The SUNY COIL Center has been training and equipping many professors at universities across the world to engage in cross-disciplinary projects with international partners in their courses. In 2021, AURAK and Wayne State University joined the list of schools participating in such programs. Collaborative online international learning programs have been successful for a variety of courses and at a variety of institutions worldwide, and examples of successful projects have been previously reported. For example, Marcillo-Gómez and Desilus (2016) reported a collaboration between courses for business administration students. They presented perspectives on the collaborative teaching experience between two faculty members, one at Saint Peter's University, Jersey City, New Jersey, USA, and one at Universidad La Salle, Mexico City, Mexico. A curriculum with course requirements had been designed based on four topics. The course's title was Communicating Between Cultures, and it was based on a textbook with the same title. Students learned about the distinctions between cultures through actual exposure to another culture without having to leave their homes as a result of this virtual partnership. Asojo, Kartoshkina, Jaiyeoba, and Amole (2019) reported a collaboration in a lighting design course at the University of Minnesota with Nigerian graduate architecture students to help students acquire global competency and offer them a real-life opportunity to experience handling design problems in cross-cultural situations. Two design projects in the lighting design course, The Store Retail Project in Nigeria and The Hotel Design Project in Owo, Nigeria, taught students in the United States how to incorporate aspects of Nigerian culture into their projects, while allowing the Nigerian students to practice giving their feedback in a specific cultural setting in any design project.

As further project examples, Munoz-Escalona, Cassier de Crespo, Olivares Marin, and Dunn (2022) performed a three-week virtual collaboration involving 82 undergraduate students from three universities in Scotland, Spain, and Venezuela. The project was a car dissection assignment in which students were to investigate car functionality, physics, materials, and manufacturing. The vast majority of students (93%) felt the project contributed to their technical understanding of the material, and the COIL activity increased their understanding of global manufacturing by allowing them to communicate with international peers. De Castro, Dyba, Cortez, and Pe Benito (2019) discussed a collaborative project in the context of a nursing program for providing nursing students in the United States and the Philippines with the training needed for working in a global context. Students at the University of Washington Bothell participated in the project through an elective course, while those at the University of Santo Tomas participated in a required course in their final year. The final part of the assignment was to create an infographic expressing the nursing specialty area that they had researched. Appiah-Kubi and Annan (2020) reported on a collaboration between the University of Ghana and the University of Dayton that aided students participating in the international learning projects in engaging with the course material. King de Ramirez (2021) described a collaboration focused on United States-Mexico relationships between students in the United States at a four-year college and in Mexico at a two-year college in a second language course.

This article describes the project carried out between the petroleum engineering course at AURAK and the chemical engineering course at Wayne State University.

What Is COIL?

COIL, which stands for collaborative online international learning, is a program for international learning partnerships at the university level. It was facilitated by following the model taught by the State University of New York (SUNY) COIL Center. A COIL collaboration involves coordination between two university courses, often in different disciplines, in different parts of the world. Professors of these courses organize a collaborative project for their students to work on that will increase students' understanding of their own discipline, as well as prepare them for the global and multidisciplinary work environment. The projects are carried out via virtual meetings between the students, and therefore lower the barrier to global learning that would exist in, for example, a study abroad program. Students learn skills in working with individuals in other cultures and languages, building teams virtually, and learning to think about problems more comprehensively from multidisciplinary perspectives. At the end of the project, students reflect on the experience to consider what they learned and how they could implement improvements in their collaborative work in a multinational, multidisciplinary team when they encounter this in the increasingly global workplace (Rubin, 2015).

Why Is COIL Valuable for an Engineering Education?

For many students at universities throughout the world, an experience in a COIL collaboration may be their first experience working on a team with someone living, at the time of the collaboration, in another part of the world. As our world becomes more interconnected, we can expect that employers will expect recent graduates to form multinational teams in the workplace. Though professors are often used to these types of interactions due to the global nature of academia, there are many aspects of such collaborations that surprise students the first time they encounter them, such as needing to schedule meetings when time zone differences are significant. COIL thus forms a one-of-a-kind learning experience that provides students with exposure to not only practical roadblocks in forming multinational teams, but also exposes them to other cultures, and helps them to develop the intercultural competencies required to work effectively with people from other cultures. It could be argued that this is necessary to ensure future career success, and that it is therefore becoming an important requirement of the undergraduate curriculum. An effective COIL collaboration between two professors will also serve to strengthen the content of a course and could provide a foundation for future student experiences such as studying abroad. It is a process, a time for reflection, and an opportunity for both students and instructors to grow (Guth & Rubin, 2015).

One of the greatest benefits of COIL as part of an undergraduate engineering education is the workforce development that it provides. Engineers from various disciplines work together every day around the world to help each other solve problems that an engineer from one discipline does not have the capability of solving alone. A COIL project uniting students not only from different parts of the world but also from different disciplines of engineering, helps to mimic the work environment in a course and provides students with an understanding of how to work on multidisciplinary collaborative projects to come to conclusions that are best for a team. Despite this being a recognizable benefit for students and one that they could put on their resumes to stand out to employers, every engineering curriculum is often so full of content to keep students up-to-date, not only with the traditionally expected skillset of the discipline but also with emerging areas, that it can be more difficult to see how a new type of project might fit within a course in a way that is beneficial to students. This paper describes a project recently implemented between a chemical engineering course at Wayne State University (WSU; United States of America) and a petroleum engineering course at the American University of Ras Al Khaimah (AURAK; United Arab Emirates), along with a discussion of how and why this project was able to benefit students, to encourage other engineering educators to consider implementing similar programs using this example.

Courses, Project, and Universities Involved

Collaborating Courses

The COIL collaboration between AURAK and WSU was carried out between the courses Petroleum Property Evaluation at AURAK and Product and Process Design at WSU. Though there is synergy between petroleum engineering and chemical engineering as disciplines given the refining pipeline for oil, it is not immediately obvious how to fit a new, common project into both courses that would not overwhelm students or take away from the content in either class. To develop such a project, we considered first our primary goal in this collaboration: to prepare students for future jobs where they could expect to be placed on multidisciplinary, multinational teams where they need to understand the challenges faced by their colleagues enough to work together to form solutions that satisfy their colleagues' constraints as well as constraints within their own discipline. This led us to consider a model that would represent the type of framework of a team in industry—one in which people with different skill sets come together to solve a problem where each has already applied the methods of their own discipline. Their goal is to learn enough from their colleague about an alternative discipline so that they can start to see new ideas for achieving a common goal together. We therefore developed a project that would help students practice this, learn to communicate the challenges of their own discipline to colleagues in another discipline, or prepare to understand their colleagues' work. They would also practice attempting to brainstorm workable solutions to engineering issues that go across disciplines together, again replicating a job environment. As a teaching tool, since it is well accepted that individuals learn more by teaching than simply learning, this project also provides a framework for the petroleum and chemical engineering students to understand their own discipline more clearly because they have to prepare to communicate it to their team members in the other discipline.

The Project: Problem Solving in Upstream and Downstream Cost Interactions

The project developed was at the intersection of petroleum and chemical engineering, involving both oil extraction (on the petroleum side) and refining (on the chemical engineering side). Specifically, the project involved two components for both the petroleum engineers and the chemical engineers. The first part of the project focused on an individual cost analysis in the engineering discipline (i.e., the petroleum engineers performed an economic evaluation to showcase the benefits of using gas injection to maximize production efficiency from a well while reducing environmental impact and costs for extraction and refining; the chemical engineers were required to perform a cost analysis of an Aspen Plus simulation that contained an atmospheric distillation column that is commonly used in petroleum refining). In the second part of the project, students from both disciplines came together to discuss their individual results and consider how the cost and design of the overall upstream-to-downstream process might be modified to provide an improved system. The teams in the second part of the project consisted of four to five chemical engineering students from WSU and one petroleum engineering student from AURAK. There were six teams to accommodate the class sizes in the two different courses.

Project Methodology and Guidelines

The project lasted throughout the majority of the semester, though through most of the semester, no active work was required on the project. Students were assigned partners for this project early in the semester and then required to have a group meeting via software such as Zoom or Microsoft Teams within approximately the first month of the course. The goal of that meeting was for students to get to know one another and determine how they would most prefer to function together as a unified team when the group component of the project would be due two months later. The deliverable from this meeting was a statement signed by all team members, indicating that all members of the group had met once before the due date of the meeting. This statement was to have also stated the date that the first team meeting after the individual component of the project (Part I) was due would occur. Notably, some students preferred to turn in a screenshot of all of them meeting as proof of the meeting instead of a statement.

After the initial meeting, about another month elapsed during which the cost analysis for the individual part of the project (Part I) was carried out. A benefit of breaking up the project into the individual, discipline-focused component and the multidisciplinary component is that this facilitated students continuing to learn the key aspects taught in the courses in the context of the economic evaluation techniques specific to their own discipline. This provided a framework for avoiding any loss of content in the courses despite adding a new project.

After the deadline for Part I, the students were required to work together on their teams to develop a report (expected to end up around two to five pages) covering the following topics before the final deadline a month later:

1. A description, written by WSU students, regarding where the highest costs come from in the petroleum process and how these might be mitigated by changing the petroleum process alone. This should have been developed by having a second virtual call with the team where the petroleum

engineering students explained their cost analysis methods and results to the chemical engineering students, so that the chemical engineering students could summarize key points from the petroleum engineering analyses to demonstrate comprehension of the information conveyed to them by their colleagues.

2. A description, written by AURAK students, regarding where the major costs come from in the refining process and how these might be mitigated by changing the refining process alone. This should have been developed by having a second virtual call with the team where the chemical engineering students explained their cost analysis methods and results to the petroleum engineering students, so that the petroleum engineering students could summarize key points from the chemical engineering analyses to demonstrate comprehension of the information conveyed to them by their colleagues.

3. A description from all students of how changing an aspect of the petroleum process could affect the refining process cost and design, and how changing an aspect of the refining process could affect the petroleum process cost and design. This description was to have been developed through a group conversation and brainstorming session at the second virtual call of the team.

To facilitate the development of this report, students were required to have met at least one additional time after Part I was completed and then to have provided validation that they had done so (a signed statement was requested, but some students again preferred screenshots).

One of the potential pitfalls of this project was expected to be that a single student in the group might spearhead the discussion of the chemical engineering material, since there were four to five chemical engineering students on a team. To prevent a single student on the chemical engineering side from doing that work instead of it being a team collaborative effort, chemical engineering students were required to individually turn in slides that teach about the cost analysis performed in Part I and that could be used as part of a collaborative discussion in teaching the petroleum engineering student about what they did during the second group meeting. In a similar vein, to prevent one student from being involved in brainstorming the relationships between petroleum and chemical engineering during the second meeting, all students were required to turn in slides that showed thoughts they had on ways to change the petroleum process to lower the costs of the refining process and to change the refining process to lower the costs of the petroleum process. Though it was stated on the requirements for the project that the students should create this during an individual brainstorming session at their second group meeting for at least 5 minutes during the second team meeting, some students did not realize that they needed to do this and completed the slides after instead.

One of the most important aspects of the project was that by the end of the project, students were required to submit individual reflections on what they learned both professionally and technically in this project and how they would approach a collaboration of a similar nature at their jobs in the future in a different way after seeing what worked and what did not.

Results and Analysis

After splitting the two classes into six groups to apply design economics concepts in upstream and downstream projects and identify major sources of cost in a process and ways to reduce these costs, Wayne State students were individually required to cost analyze an Aspen Plus (Version 12) simulation that contained an atmospheric distillation column that is commonly used in petroleum refining. However, the AURAK students were individually required to do an economic evaluation using Oracle Crystal Ball software that proves the benefits of using gas injection in order to maximize production efficiency while reducing environmental impact and costs for extraction and production. In this section, we reflect on how the students critically thought about the problem, as well as how feedback received from student discussions and reflections indicates what they learned and what can be improved:

1. Students were able to comment on relationships that they saw between the oil extraction and refining processes, showing that they were able to recognize major technical points. They noted the primary relationship that the process "makes money" from selling the products of the refining process, while the feedstock costs of the refining process are heavily impacted by crude oil extraction. Some of the points discussed by students included enhanced oil recovery techniques and how those could impact downstream processing, or discussed non-design factors impacting costs such as taxes or trying to lower equipment costs. These types of discussions reflect that students were actively engaged in thinking about the various sources of costs and their relationships to overall metrics. It could be argued that the discussion of such points, and trying to think creatively through this problem-solving process when there is not a clear answer, is part of where the strength of this project lies from a student learning perspective. Specifically, having this type of creative brainstorming exercise with people they do not know encourages students to engage to make newcomers to the group feel welcome. It is also a lower-stakes brainstorming session, because there is no professor involved to tell them if they got the "right answer," which may help to promote creativity and deeper discussion with peers than might occur in a class environment. This provides a framework for helping students take more ownership of their work.

2. Some of the feedback included that it would be helpful if they knew a bit about the other engineers' topics before learning about them. It may be helpful to provide greater guidance to students on how to prepare a discussion for a multidisciplinary audience and prepare to hear such a talk to aid in communication.

Evaluating and Analyzing the Students' COIL

In evaluating the application of these three principles—engage students in content, promote student-student interaction, and strive for presence—we found that the students demonstrated intercultural communication knowledge, sensitivity, understanding, and competency. The COIL project was successful because of the following aspects:

1. The students had to explain tools from their discipline to one another in the COIL project, which facilitates learning and ownership of material.

2. The project had a defined timeline.

3. Despite the time difference between the two universities, the students scheduled meetings in advance with goals for what to accomplish during the meetings.

We consider that this project aided students in collaboration, teamwork, and critical thinking. For WSU, the structure of having to think about cost analysis in a rigorous way early in the course caused the students to be noticeably better at thinking about costs involved in process design compared to prior years. It is interesting to contemplate that a well-structured collaboration may not only aid in workforce development, but also help students meet new peers that they would not otherwise have met in the context of a course within the department, and thereby contribute to their wanting to engage more in group meetings.

Conclusion

Our first COIL endeavor demonstrated promise as a fruitful international learning opportunity. Students had meaningful, valued engagement with peers in another country without having to travel abroad. The designed COIL was created as part of a collaboration between the American University of Ras Al Khaimah (AURAK) in Ras al Khaimah, United Arab Emirates, and Wayne State University in Detroit, Michigan, USA. The COIL's goal was to improve students' critical thinking skills through a unique online teaching environment with students from a variety of backgrounds. The COIL approach provided a practical way to prepare students for diverse cultural work settings that are likely in their professional futures. It also assisted in the satisfaction of academic program goals at each of the two universities. Furthermore, COIL assisted us as faculty in modeling lessons that promote intercultural compassion and empathy, as well as maximizing the functionality of online learning approaches.

COIL gives students the opportunity to communicate, work together, share ideas, and enrich their educational experience. Through COIL, students can also develop intercultural awareness, discipline-specific content knowledge, and communication and teamwork abilities that are important for students to learn within an engineering education context. These experiences allow engineering educators around the world to work together to foster students' appreciation of the global context in which they work. They also require educators to be aware of potential challenges that students may face and to aid in addressing them. For example, in this COIL collaboration, although both student groups used English as a common language, the different proficiency levels between the Wayne State and AURAK students caused some communication difficulties. The groups were also not matched in terms of the number of AURAK versus Wayne State students in each group due to the class sizes, which could pose challenges for having personal interactions. As the instructors of this COIL run future versions of the program, we will take these challenges into account to improve the experience for students.

References

Appiah-Kubi, P., & Annan, E. (2020). A review of a collaborative online international learning. *International Journal of Engineering Pedagogy*, *10*(1), 109–124. https://doi.org/10.3991/ijep.v10i1.11678

Asojo, A. O., Kartoshkina, Y., Jaiyeoba, B., & Amole, D. (2019). Multicultural learning and experiences in design through collaborative online international learning (COIL) framework. *Journal of Teaching and Learning with Technology*, *8*(1), 5–16. https://doi.org/10.14434/jotlt.v8i1.26748

de Castro, A. B., Dyba, N., Cortez, E. D., & Pe Benito, G. G. (2019). Collaborative online international learning to prepare students for multicultural work environments. *Nurse Educator*, *44*(4), E1–E5. https://doi.org/10.1097/NNE.0000000000000609

Guth, S., & Rubin, J. (2015). How to get started with COIL. In A. S. Moore & S. Simon (Eds.), *Globally networked teaching in the humanities* (pp. 40–57). Routledge.

King de Ramirez, C. (2021). Global citizenship education through collaborative online international learning in the Borderlands: A case of the Arizona–Sonora megaregion. *Journal of Studies in International Education*, *25*(1), 83–99. https://doi.org/10.1177/1028315319888886

Marcillo-Gómez, M., & Desilus, B. (2016). Collaborative online international learning experience in practice opportunities and challenges. *Journal of technology management & innovation*, *11*(1), 30–35. https://dx.doi.org/10.4067/S0718-27242016000100005

Munoz-Escalona, P., Cassier de Crespo, Z., Olivares Marin, M., & Dunn, M. (2022). Collaborative online international learning: A way to develop students' engineering capabilities and awareness to become global citizens. *International Journal of Mechanical Engineering Education*, *50*(1), 89–104. https://doi.org/10.1177/0306419020934100

Rubin, J. (2015). Faculty guide for collaborative online international learning course development. SUNY COIL Center. http://www.ufic.ufl.edu/UAP/Forms/COIL_guide.pdf