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Collaborative Environmental Science Courses: Bridging between Undergraduate Research into Energy Issues in Malaysia and the United States

ARTICLE

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ABSTRACT

With support from the EnviroLab Asia initiative at the Claremont Colleges, I redeveloped my Environmental Chemistry course for undergraduates to focus on environmental issues in Asia. I collaborated with a colleague from the Universiti Kebangsaan Malaysia (UKM) who was teaching a similar course for master's-level students in Bangi, Malaysia. Our students worked on projects together comparing different aspects of renewable energy in the two countries. At the end of the semester, my students traveled to UKM for a symposium with my colleague's students and continued working on their research projects to turn them into publishable papers. The Claremont Colleges students greatly benefited from both the academic and cultural learning that occurred during our travel. I am currently developing a network of faculty at universities in Asia-Pacific Economic Cooperation (APEC) economies who have their students work on data-gathering and/or analysis projects that can be useful for policymaking by the APEC Energy Working Group.

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For the spring 2018 semester, I received a course redevelopment grant for my upper-division Environmental Chemistry (CHEM139) course from the Claremont Colleges EnviroLab Asia initiative, which is funded by the Henry Luce Foundation. This allowed me to add a focus on environmental chemistry issues in Asia to the course and to co-teach the undergraduate class with Dr. Norasikin Ahmad Ludin, a colleague at the Universiti Kebangsaan Malaysia (UKM). The Claremont Colleges are a consortium of seven colleges located in Claremont, California, consisting of Pomona College, Scripps College, Claremont McKenna College, Harvey Mudd College, Pitzer College, Claremont Graduate University, and Keck Graduate Institute, whereas UKM is a large research university located in Bangi, Malaysia. Dr. Norasikin's research focus is on cutting-edge solar energy technology and renewable energy policy, and she also taught a master's-level course on the philosophy, policy, and issues in energy to graduate students during the fall 2018 semester. Our interests overlap, as I study energy policy and air quality chemistry. Our wide range of combined expertise allowed us to advise students on a range of renewable energy research topics. Students from both institutions collaborated on research projects throughout the semester, communicating mostly through Google Docs, WhatsApp, and email. In the end, each group of students produced an innovative paper that compared renewable energy issues in Malaysia and the United States.

Although my focus was on developing international collaborative undergraduate pedagogy, I see this project as the first step in a larger arc. I am working on building a network of Asia-Pacific Economic Cooperation (APEC) university faculty who will teach collaborative courses in which students can use real-world data collection and analysis to help inform APEC Energy Working Group (EWG) policies. APEC is a regional economic forum comprised of twenty-one member economies across the Asia-Pacific. The goal of the forum is to encourage greater prosperity for the people in the region "by promoting balanced, inclusive, sustainable, innovative and secure growth and by accelerating regional economic integration" (APEC 2018). My contribution to these goals will come in the form of convening internationally integrated research networks.

The origins of this project derive from my work as a Jefferson Science Fellow at the US Department of State in the Office of Economic Policy at the Bureau of East Asian and Pacific Affairs during the 2016–17 academic year. I was a foreign affairs officer focused on energy, science, and technology for the APEC region. My work concentrated on energy issues within APEC and included participation in EWG meetings, particularly on the implementation of renewable energy and energy efficiency policies to lower greenhouse gas emissions and help prevent the impacts of global climate change. I also organized a workshop in Kuala Lumpur, Malaysia, for APEC and Association of South East Asian Nations (ASEAN) countries on the life-cycle costs of clean energy. The workshop included discussions about the health and environmental benefits of renewable energy. After working with APEC EWG delegates and colleagues from the US Department of State and US Department of Energy on a range of science policy issues, I realized that there was a key challenge facing EWG delegates: they work on many initiatives, but lack time for the data gathering and analysis necessary to make data-driven policy decisions. As an academic with experience working in APEC, I know that these countries have excellent research universities that could fill this need. I have been working to develop a network of universities in APEC economies that can support and inform regional energy/environmental policy development and support EWG delegates. An important objective of this network is to develop problem-based science/environmental policy classes that connect students, researchers, and policymakers and address regional environmental challenges. I received a grant from APEC to organize a workshop to bring university faculty and energy policymakers together to start developing the network and identify interesting renewable energy and energy efficiency projects for us to work on. The workshop was planned for summer 2020, but has been rescheduled for June or July 2021.

The first step I took in building such an extensive network was to start with a simpler approach and see if a prototype pilot model worked. This meant working together with a professor in another country on a collaborative course to determine the strengths and weaknesses of co-teaching with someone across the world. During this pilot course in the fall of 2018, Malaysian and US students worked on five different projects. These ranged from studying the implementation of green buildings in Kuala Lumpur in comparison with Los Angeles to examining the potential environmental benefits of blending ethanol into gasoline in Malaysia and the United States. My faculty colleague and I realized partway through the course that the analysis that the students were doing was sophisticated and would be of considerable interest to the wider academic community, so we started brainstorming ways that the students could work together to turn their project papers into peer-reviewed work. In addition, we thought it would be good if the students could present their research findings to each other and to the broader UKM community. My students and I received funding from two sources to support this work: (1) an EnviroLab Asia Mini-lab grant to support student-faculty collaborative research and (2) funding from Claremont McKenna, Pitzer, and Scripps Colleges to encourage student presentations at professional meetings. In May 2018, five students and I traveled to Bangi, Malaysia, to present student research

findings at a symposium at UKM and work with their collaborators on their research projects.

The Solar Energy Research Institute (SERI), which is part of UKM, hosted a symposium for me and my students on May 15 and 16, 2018 (***Figure 1***). Faculty from SERI presented about the research they are doing and described their educational program for the Claremont Colleges students. I introduced the UKM community to the Claremont Colleges and talked about the benefit of a liberal arts education. A foreign service officer from the US embassy in Kuala Lumpur joined us as well. She shared information about US energy policy and how it relates to Malaysia. She also shared different opportunities for US students to come back to Malaysia and for Malaysian students and faculty to travel to the US to continue collaborations, mostly through the Fulbright program. During the symposium, we visited the Solar Park, the Advanced Silicon Laboratory, and the Advanced Organic Solar Cell Laboratory. These are all great resources on the UKM campus that allowed Claremont Colleges students to learn about the cutting-edge research scientists do at UKM.

Students from both schools gave talks about their research, including the following talks from the Claremont Colleges students:

- Two juniors from Claremont McKenna College: "Energy, Economics, & Environment for Industry 4.0".
- Junior from Pitzer College: "Environmental Benefits for Blending Ethanol into Gasoline for Kuala Lumpur, Malaysia and Los Angeles, United States".
- One senior and one junior from Scripps College: "Environmental Impact from Renewable Energy Technologies System".

Following the conference, the Claremont Colleges students spent two days working with their collaborators at UKM to turn their research papers into peer-reviewed papers (***Figure 2***). The students worked with Dr. Norasikin and myself to come up with a target journal and outline for each paper. The plan was for students to continue working on the papers over the summer for submission during the fall 2018 semester to relevant journals. Currently we have one paper being prepared and are planning to submit the manuscript at the end of this academic year. A few of our students, both in Claremont and Malaysia, graduated and lost focus on the papers, but we are hopeful that at least one of the papers will be published. After communicating electronically all semester, it was exciting to see the groups meet together for the first time in person. They had great discussions not only about their projects but also about life in the US and Malaysia and their interests outside of school. One of the Claremont McKenna College undergraduates remarked that "for our group research projects, it was so valuable to meet with our collaborator, a graduate student in Malaysia, face-to-face and work on our paper together." One of the Scripps College students agreed with this evaluation of the benefits for the US cohort of undergraduates:

> [I]n collaborating with students in Malaysia, we didn't have communication further than a few emails and work on a Google doc. Collaborating in person offered clarity and ideas that would not have been possible via email. We completely reorganized our paper based off of in person collaboration.

In addition, the Claremont students were able to think about the actual implementation of renewable energy in Malaysia once they observed the flora and fauna of the country. The Scripps College students had worked on a project focused on wind and solar energy. One of them commented that:

Figure 1 *Left:* Junior from Pitzer College gives presentation on blending ethanol into gasoline; *right:* symposium participants listen to a presentation by the students from Claremont McKenna College on the environmental impacts of "Industry 4.0." Industry 4.0 is considered the fourth Industrial Revolution, in which interconnectivity, machine learning, automation, and real-time data are used for advanced manufacturing and also the development of smart cities (all photographs in this article courtesy of the author).

> [W]hen we saw the micro-wind turbine I got to see in person that micro-wind is a viable option in Malaysia instead of just reading studies that it could be, because it was spinning most of the time. I also noticed how much dense forest there was in Malaysia, and it made me think about the viability of solar energy because vast solar fields would require cutting down jungle.

Although the Claremont students had learned quite a bit about renewable energy in Malaysia and the US during their semester in class and by working on their projects, they had not learned much about Malaysian culture. Therefore, Dr. Norasikin and her students took us somewhere new each day to teach us about Malaysian history, culture, and the environment (***Figure 3***). We visited the federal government center in Putrajaya and toured the National Mosque. We also hiked in a rainforest outside of Kuala Lumpur, where we were able to infer what the ecosystem of Kuala Lumpur looked like before development. Dr. Norasikin felt it was important for us to try all kinds of traditional foods, showing us the connection between her environment and the human diet. She invited us to her house to break the fast on the first night of Ramadan. In preparation for the meal, she took us to a Ramadan night market ahead of time so that we could sample traditional treats during dinner. We also toured around Kuala Lumpur one day to see the KL Towers, the Malaysian Cultural History Museum, and hike up to the Batu Caves, a Hindu shrine. The students learned so much more about Malaysian culture from a week on the ground in Malaysia than they could have all semester in my class. The students were able to undergo a different type of learning by actually being in the country and experiencing it. Building relationships with Malay students, seeing the land, and eating traditional foods provided an authentic and experiential learning opportunity for the Claremont students. Several of the students mentioned to me that they were thankful for the opportunity to learn more about Malaysian culture by visiting different cultural sites and interacting with Malaysian students and professors. A student from Pitzer College felt that this experiential learning complemented the classroom work he had done, enhancing his understanding of the environmental issues in Malaysia:

> I found that this collaborative work and travel to Malaysia was an incredible cultural and

Figure 2 *Above left*: Pitzer College and UKM students collaborating on research papers and projects; *above right*: Professor Norsikin with Claremont McKenna College and UKM students; *below left*: Scripps College and UKM students; *below right*: a group visiting the UKM solar park.

> academic experience. This experience throughout the semester, as well as this opportunity at the beginning of the summer, gave me a much greater understanding of some of the advantages and challenges of working with collaborators on a project, especially those from a different culture with a vastly different understanding and viewpoint on the topic.

One striking consequence of cross-cultural and interdisciplinary engagement that EnviroLab Asia has helped generate in my environmental chemistry class is that several of the Claremont students applied for Fulbright fellowships to either do a research project or teach in Malaysia after they graduate. Our interactions with our Malaysian collaborators and our learning more about the history and culture of Malaysia were invaluable for the future work we all plan to do. For example, the senior from Scripps College said:

> [T]his trip has made me really interested in learning about renewable energies and attitudes towards them in different countries. The feasibility of different energy technologies is so dependent on natural resources, policy and public opinion. This trip has made me think more about the possibility of doing work abroad in the future. I have also been thinking about potentially applying for a Fulbright.

One of the students from Claremont McKenna College further commented:

> [T]he trip to Malaysia opened up my eyes to pursuing a career in international environmental policy. After hearing from academics and policymakers at the conference in Kuala Lumpur and presenting on the ability of new technology to help further sustainability efforts, I am much more aware of environmental issues in Malaysia and how the US can collaborate with other countries to promote sustainable development.

Two of the students applied to the Fulbright US Student Program to do research projects, one in Malaysia and the other in India. I am interested in following the trajectories of the students who traveled to Malaysia to see how their experience will impact their path in the future.

Figure 3 *Above left*: Students breaking the fast the first night of Ramadan; *above right*: Prime Minister's Office in Putrajaya; *below left*: Batu Caves; *below right*: rain forest outside of Kuala Lumpur.

This collaborative course has positively impacted my teaching and research trajectory as well. I will work with the APEC EWG to identify data gathering and analysis projects that will be beneficial to them in making data-driven policy decisions. In order to facilitate this project, I applied to the Fulbright Scholar Program to spend ten months at UKM during the 2019–20 academic year, but was, unfortunately, not awarded a fellowship. I did travel to many APEC economies during the fall 2019 semester to meet with university faculty and talk with them about the faculty-policymaker network I am developing. Faculty from Australia, Malaysia, New Zealand, Republic of Korea, Thailand, and Vietnam are all interested in participating in the network and the workshop. Bringing key partners together to discuss best practices for identifying class projects, communicating findings to the APEC EWG, and developing collaborations between faculty at different universities will be critical elements in the next step in moving the development of the aforementioned faculty network forward.

Although teaching a collaborative course was a wonderful experience for both me and the students, there were also some challenges when teaching with a colleague who is halfway across the world. The first such challenge that we encountered was the difference between our academic calendars. The academic year at Claremont Colleges starts in late August and ends in mid-December, whereas at UKM it starts in late September and ends in mid-January. Both Dr. Norasikin and I had to adjust the project schedule to fit into our schedules, which gave the students less time to work together overall on their research papers. Second, Kuala Lumpur is sixteen hours ahead of Claremont. The first time we taught the collaborative course, we both taught on Wednesday mornings in our own time zones, which meant that we had to organize special times in the evening for my class to meet and video conference with the UKM class during their Wednesday morning session. The second time we collaborated, we taught at the same time. The Claremont class was on Tuesday at 7:00 pm and UKM class at 11:00 am on Wednesday so that we could video conference a couple of times a month. Finding a way to video conference that worked for both schools was a challenge too because of the different technological resources each school had. We finally settled on using Zoom, and it seemed to work well. Finally, communication between Dr. Norasikin, myself, and the students in groups was challenging. Email and texting are not always the best ways to communicate because responses can be slow. The students were definitely much more productive on their papers when meeting in person. Overall, the educational enrichment provided by this approach definitely outweighs the challenges though, and I would recommend working on a collaborative class over teaching alone.

During the fall 2018 semester, we brought another colleague, Professor Mili-Ann Tamayao, from the University of the Philippines Diliman, into our collaboration. Dr. Tamayao's research focus is on life-cycle analysis of renewable energy, which expanded the scope of the projects our students could work on. We learned that it was exponentially more difficult for three classes from three countries to collaborate as opposed to just two, but it was a fun learning experience.

Overall, this project has been a regenerative force in my teaching and research efforts. As a Jefferson Science Fellow at the US Department of State during the 2016–17 Academic Year, I chose the office that I worked in for the year based on my research focus in Asia. The Claremont Colleges had received an exploratory grant from the Henry Luce Foundation before I started at the State Department, and I knew that we would be applying for more extensive funding if that was successful. My research focus in the past has been in Kenya and Kazakhstan, so this was a new region of focus for me. One of my goals as a Jefferson Science Fellow has been to bring what I learned at the State Department back to the Claremont Colleges in some way, and the APEC faculty network seems like a wonderful way to accomplish two important goals: (1) to help students do meaningful research in my classes and (2) to choose student research that could in turn help positively impact energy policy in the Asia-Pacific region. The Claremont Colleges EnviroLab Asia program coupled with my fellowship at the State Department to provide an excellent way to change my research focus, provide a unique learning experience for students, and eventually impact energy policy in the Asia-Pacific region.

COMPETING INTERESTS

The author has no competing interests to declare.

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