
Enhancing STEM Education with a Global and Interdisciplinary Perspective: Developing and Teaching a Course on Global Water Challenges through an International Collaboration

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Abstract: Typical engineering curriculum focuses mainly on the technical content, concentrating on the theory, applications, problems and solutions only related to US and the students are typically trained to develop solutions utilizing the available technology without considering global and cross-cultural perspectives. However, the challenges we face locally resonate with other nations' challenges, and the solutions would be best created through collaboration and exchange. Global water challenges are complex and multifaceted, affecting millions of people worldwide. Access to clean water and sanitation practices vary widely across the globe, with some locations facing severe shortages, while others are dealing with problems related to contamination and pollution. Climate change, population growth, urbanization, and failing infrastructure further add to these challenges. Solving global water challenges requires a multi-disciplinary approach, addressing social, economic, political, and environmental factors. Collaboration across disciplines, countries and institutions is essential to promoting sustainable and equitable water resource and quality management practices. As instructors, it our duty to prepare our students for the future challenges, as well as equipping them with technical, communication and global competence skills to give them the ability practice their profession in a global setting and to develop novel and timely solutions. In order to address the gap in providing the students with a global perspective and to expose them to other cultures, a course was developed and taught along with an institution in Central Asia. The syllabus and course topics were developed through soliciting input from the students from both institutions. Course activities were designed to enhance the communication between the students, information exchange and collaboration on projects. The details of the course and the lessons learned are presented in this paper.

Why a Global Perspectives Course?

With the goal of training globally and culturally aware STEM students, and the financial support provided by the American Councils for International Education, a collaboration was established between a US and Central Asia institution. Virtual meetings were held between the faculty at both institutions to create an understating for the expectations related to the course content and the desired course outcomes to be achieved by both institutions. Once the details were ironed out, the US team visited the Central Asia institution along with three students to collectively create the course syllabus and course activities. The faculty and students from both institutions held meetings in tandem (in person) and at the end of the planning process, everyone came together to discuss the preferences and needs by all students and faculty.

The two main objectives throughout this process were to establish a working collaboration with participating faculty and to successfully teach a global exposure course to provide students the opportunity to engage in multi-cultural and multi-disciplinary communication and collaboration while becoming aware of global and cross-cultural approaches to water crises and sanitation. Access to clean water and sanitation practices varies widely across the globe and the students are typically trained to develop solutions utilizing the available technology at hand without much consideration of global and cross-cultural perspectives on handling such challenges. The cultural and diverse viewpoints of the people affected by water challenges are often overlooked, leading to suboptimal solutions. Faculty from both institutions deemed it essential to recognize the cultural differences in handling these challenges, including varying regulations and enforcement, as well as economical and technical competencies of the nations involved. These concerns were specifically addressed through specific course content and activities.

A unique feature of this effort was developing and delivering a virtual course that allowed students to participate from anywhere, expanding the reach of the course. This course provided the students with an affordable access to international communication and collaboration experiences, global learning and research opportunities, and a chance to develop themselves as global engineering and science leaders. The course development and instruction may be utilized as a model for a truly global classroom and may allow faculty in other fields to adopt a similar approach to tackle global challenges in their field. The course content, instructional materials, and learning activities can be transferable to many other institutions, allowing this effort to achieve goals beyond the original proposed activities. Additionally, the course is aimed to be a catalyst for modernizing curriculum while infusing it with cultural competency and socio-environmental justice. Finally, this course addressed a crucial need for globally aware STEM students and collaboration between higher education institutions.

Training the Future Engineers and Scientist to Face Global Water Challenges

Course Description: The interconnected world creates the necessity and urgency for the engineers and scientists to be able to recognize the global challenges we face regarding water availability and quality, and to be able to work with international partners and develop solutions for societies with different cultures. This course provides a foundation to develop cross-cultural competence in the engineering and environmental sciences fields, considering social, political, economic and technological differences in areas such as water resource management, water quality management, water/wastewater treatment, environmental justice, sustainability and ethics. As a student in the course, you will interact with students and professors from the partner institutions in Central Asia.

Course Objectives: Upon successful completion of this course students will be able to:

1. describe global water challenges we are currently facing
2. list global water challenges predicted in the upcoming decades
3. compare and contrast regulations around the globe for water sanitation and resource management
4. explain and compare cultural perceptions of clean water and water sanitation across countries
5. compare and contrast available technologies around the globe for water resource management and sanitation
6. illustrate and critique the equity, diversity, social and environmental justice, sustainability applications across countries related to access to clean water

Course outcomes are for the students to:

- recognize the water challenges we are facing globally
- articulate the cultural differences in the approaches to solve water challenges, including discussion of regulations and other constraints that govern the actions
- collaborate with peers from various countries to develop a solution to a water related issue
- adapt to changing cultural expectations, set of challenges, and available technologies as they develop solutions to address water challenges

Assignments and Activities:

- 1- Weekly/bi-weekly discussion prompts: Students will be asked to find research or news articles to add to the content covered in class. They will post written, oral or video submissions. They will need to reply to other students' comments.

- 2- Case studies: Students will pick a problem within a block (eg. Water quality/resource management, drinking water treatment or wastewater treatment) and will compare the approaches and solutions of Central Asia and USA. Discussion of available technologies, regulations and cultural expectations/influence may be included in this analysis.
- 3- Group projects: As indicated on the syllabus, there are two group projects in this course. Students will be paired up with students in another country (groups may have 3-4 students). Building on the case studies they worked on (to provide scaffolding for this assignment and get the students working on the project as early as possible) they will create a short report and a short presentation. All students will be expected to contribute to all parts of this activity. The instructors will assess how the students shared the work, how much they interacted to prepare the report and presentation, who did they seek help from (ideally almost all faculty being involved in the course).
- 4- Reflections: Students will be asked to reflect on their newly gained knowledge and experience throughout the semester. Four reflections essays are planned to be completed.

Course content:

- Introduction to global water challenges
- Environmental Justice under the umbrella of diversity, equity and inclusion
- Introduction to cultural competencies
- Environmental ethics and STEM communication
- Global approaches to water resource management
- Global approaches to water quality management
- Impacts of pollution and climate change on water scarcity and water rights around the globe
- Impacts of pollution and climate change on food security and agriculture around the globe

- Regulations for water sanitation around the globe, Central Asia Stds, EPA, WHO
- Global approaches to drinking water treatment
- Global approaches to drinking water treatment continued
- Global approaches to wastewater treatment
- Global approaches to wastewater treatment continued

Structure of the Course

The course started in person at the home institution at USA. The students were introduced to the environmental justice, social justice and DEIJ concepts before the course went virtual and the students from the Central Asia institution started joining. After the students get a chance to meet and interact with each other, the first main concept that was covered with all students was the cultural competence to lay the groundwork of the expectations and understanding of the global classroom. From then on, every class session would consist of material covered infused with discussion and input from students. The live transcript was enabled for all class period, and the chat was offered as medium to ask questions at all times. The students from Central Asia were encouraged to participate more, when they were allowed to write their questions and replies on the chat. The class sessions were made more interactive through use of collaborative work on Google slides and Jamboard, where students collaboratively worked on topics to provide the answers to the prompts. During each class session students were distributed into breakout groups with specific prompts to discuss among themselves. The instructor(s) would visit the breakout rooms to facilitate the conversation and interaction between the students.

Lessons Learned

- The major challenge in teaching this course synchronously and virtually was the time difference between the locations. In either case, it was an early morning or late evening for

the students. However, the topics and the instructors maintained the interest and engagement through (collaborative) active learning activities.

- Inviting experts and practitioners to cover various topics, as well as teaching with the faculty in Central Asia kept the students engaged and motivated.
- Because of the institutional limitations, not all of the students could get on the course LMS and hence the interactions between the students were mostly limited to class sessions. This also derailed the plans for the discussion threads and out of class interaction between the students. A better plan for LMS is necessary when teaching courses with other institutions.
- The international students needed encouragement to speak up and fully participate in the class, but through this process the students in US recognized the importance of allowing space and time for the students to feel comfortable in such a setting.
- Overall, students reported a very positive experience and noted they gained most of the skills and experience desired by the instructors. This information was collected qualitatively through the reflection paper that was assigned at the end of the semester. Students highlighted the benefit of being able to interact with students and faculty from different countries, and different majors. We believe that this first offering of this course was successful in the outcomes that it anticipated to achieve.