Work-In-Progress: Integration of Inclusivity Activity in Civil Engineering Materials Course

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Abstract—

The objective of the paper is to present a work-in-progress effort in integrating an inclusivity component in a civil engineering materials course. Civil Engineering Materials is a required junior level 2- credit course with a lab on aggregates, cement, cement concrete and asphalt, and hot mix asphalt. There were 72 students in the class with 24 groups of three members each. In fall 2017, the instructor introduced an activity in half of the number of groups compared the testing standard of construction materials between two states within the US and the other half compared the testing standards between a state in the US and a different country. The objective of this activity was to expose half of the cohort of students to practices in different countries and evaluate the impact of exposing this activity on the social attitudes. The course has a two 75-minute lecture slot, and one 150 min slot for laboratory. The instructor was supported by four lab assistants. However, the students meet for the laboratory only four to five times a semester. The students were required to do the following as part of this activity: 1) Submit a one-page summary about the comparison between states within US or between US and other country within the first four weeks of classes; 2) Meet with each lab assistant to discuss the progress four weeks after the topic was approved; 3) Give a final presentation for 20 minutes, including 5 minute during the last week of class during the lab period. All the lab assistants viewed all the presentations and graded based on Oral Communication, Visual Communication, Professionalism, Technical Content, and overall organization.

Keywords—inclusive pedagogy, diversity in curriculum, critical thinking skills, learning in global context

I. INTRODUCTION

The National Science Foundation awarded the Civil and Environmental Engineering (CEE) Department at Rowan University with a grant to increase the population of underrepresented minorities (URM) and underserved communities within the department. One of the ways in which the CEE department is attempting to increase retention is by inclusive curriculum reform. Inclusive curriculum can help underrepresented students find alignment within their field [1]. While curriculum reform may present challenges to faculty, there are simple ways to introduce inclusive assignments that can complement technical course materials. One way to develop inclusive content is through the use of global scenarios [1]. Using global scenarios help students apply their technical knowledge to a context that is culturally different from their own and exploring global contexts are supported by accreditation and disciplinary institutions [2-4]. The use of global scenarios help students broaden their perception of how engineering can be applied to different contexts [2]. This work-in-progress paper is meant to showcase how one particular class used the opportunity to develop an inclusive assignment in a technical course. The class was given an opportunity to apply the same technical knowledge to both a familiar domestic setting and a global setting. This paper will show how taking concepts in global engineering helped develop a means for having a technical basis in making an inclusive course.

II. DEVELOPMENT OF STUDENT ASSIGNMENT

A. Background information

Global competency in engineering is in demand for our field and our students should have some preparation for engaging in a global community. The Accreditation Board for Engineering and Technology which is responsible for the accreditation of engineering programs across the United States has counted global engineering as an important aspect in engineering education. ABET states that engineering programs must demonstrate that students are able to understand the impact of engineering solutions in a global context [3]. The American Society of Civil Engineers which

978-1-5386-1174-6/18/$31.00 ©2018 IEEE

serves as the governing body for Civil Engineers has added global engineering to its Body of Knowledge as well [4]. Within these standards, there is a recognition that more skills are needed to succeed as an engineer in the present day.

To be deemed globally competent a student must be able to identify cultural differences in order to compete in a global setting, collaborate across cultures, and effectively participate in interactive settings in other countries [5]. It has been suggested that an international experience is not essential for the development of certain global engineering skills, but rather infusing global themes into engineering technical classes can be enough to develop better global engineers [2,6]. In Downey's *What is Global Engineering Education For?*, we see a collection of experiences from a variety of engineering faculty that create and develop programs and institutes for global engineering [6]. Each contributing author recognizes the importance of developing globally competent engineering students because they see an essential link to engineering education and the importance of having engineers who are able to perform on a global market. These competencies that an engineering student should have along with his or her technical and professional skills that are developed within the university [8]. It has been suggested that some of the global engineering competencies should include awareness of global political and societal issues, understanding of multicultural issues, and the ability to apply engineering solutions in a global context [8]. Global engineers have such proficiency that in an idealized setting a truly global engineer can be placed in any culture and situation and function just as normally as he or she would in his or her native culture [6].

The use of global engineering scenarios to teach students can be viewed as an inclusive practice. Inclusive practices can include a variety of approaches. Global scenarios can be considered inclusive because of how they can be used to focus on nonwestern examples and it enables students to think outside of their cultural norms [1]. Global scenarios can even be used by students to explore cultural settings that they would like to work in at some point in their future careers. By using the approach of developing more global minded students, an engineering faculty member can develop a more inclusive atmosphere within their class. The following assignment is one particular approach to including global scenarios.

B. Method set up for the assignment

Civil Engineering Materials (CEM) is a two credit hour course that is offered in the Fall semester of the third year within the CEE department. This course is a required course for Civil Engineering students and it covers the fundamental concepts of aggregates, cement, cement concrete and asphalt, and hot mix asphalt. This class had a lab component that was used to introduce the project to students and gave them time to ask questions and develop their work. There were 72 students in the class with 24 groups of three members each. The group project assignment for the year 2017 was designed to provide an open ended problem to students. The motivation behind it was to enable students to critically compare and contrast standards in materials. Students would have a greater understanding into the role of standards and their use. For this project, half the student groups were asked to select a country that was not Canada or in Europe to compare standards or compare standards used in their home state with another state in the US. Students were encouraged to perform some in-depth investigation of their region to find the issues that are specific to their region. It also enables students to single out why certain standards are different. For the student teams that focused on international standards, they were encouraged them to explore the social elements that influenced the use of the standards. Technical specifications due to weather and geographic location can be seen by students as common issues regardless of the location of their region. However, social considerations from policy issues provide some opportunity for the students to link their technical understanding to different social contexts. After collecting information on the standards, students then developed a presentation to showcase their research. This project helps develop an inclusive atmosphere because it enables students to research a context that they are unfamiliar with and it helps develop their global competency by being able to apply their own knowledge to different contexts.

C. What students developed

Towards the end of the semester, students have developed their projects and present them to the entire class for evaluation. Each team presented a twenty minute presentation to each other within their lab periods. The faculty for the course were present to observe the presentations and evaluate them. The domestic teams had presentations that were technically oriented. For example one team compared New Jersey's concrete standards with the standards used in Florida. The major distinction was that the standards were more focused on wind related issues. Another team compared one set of standards to California with an intense focus on reinforcement for earthquakes. The domestic student teams made notice that their standards changed from state-to-state based on weather and geological issues. Only one team considered bringing up how standards were influenced by state legislature and tax policy.

The student teams that compared US and international standards recognized that there were more elements that helped influence international standards. These teams attempted to address the following issues: 1) socio-economic factor; 2) political conditions; 3) general constructing practices; 4) loads and weathers. They demonstrated a deeper understanding about broader range of issues and how they directly or indirectly impact standard. One team noticed that in Brazil, the corporation in construction practices and politics were so wide spread, that it was common for standards to be ignored and for certain key politicians and construction workers would receive bribes in order for buildings to be erected without regard to standards. Another team noticed that

Tanzania used British standards and concluded that as a former British colony it made sense that Tanzanians would reuse British standards due to their shared experience. However that team also noticed that the highways in Tanzania were overdesigned since they didn't have the same conditions that the British had. Another team noticed that Japan made one of the most stringent standards around concrete and asphalt due to their issues with earthquakes.

Despite the lessons learned by students, this project provided them certain challenges. The parameters for this project was intentionally kept broad to provide flexibility to the students. Some students were lost as to how they should approach the social issues with relation to the international standards. The faculty kept the project as open-ended as possible for the students to not feel limited in what they could discuss. Another issue arose when students had trouble locating international standards. Some students had to scour the internet to find out where the standards existed for free, public access. These two major hurdles created a lot of confusion among the students and needed significant more guidance during the semester.

III. Discussion and Future work

The Fall 2017 was a pilot effort that will allow the faculty in charge of the course to do a more detailed evaluation of the impact of the inclusivity activity in Fall 2018. In that semester, we will have two independent sections of CE Materials, one of the sections will have the inclusivity activity, and other will not. This will allow faculty to conduct assessment by course evaluations to see if there is any significant difference in students' experiences and understandings. Also the faculty will include reflections to the project, such as: 1. What do you know about engineering regulations such as the ones set by the American Association of State Highway and Transportation Officials?; 2) What are your thoughts about the application and implication of regulations in the US and around the globe?; 3) What do you believe are the qualities and knowledge needed to practice engineering domestically and abroad?; and 4) Of these qualities and knowledge, which do you believe you possess and which do you believe require development? The reflection is another inclusive activity that can engage students in critical thought [1]. The purpose of the reflection is again to gauge how the project affected the students' abilities to think broadly and to think in a global and social sense. After this experience the faculty will also seek to collect as many international standards as possible for the students to have access to as well as give students a defined list of issues to explore so that they feel more guided. While this project presented some challenges, the students pulled through in finding how standards are shaped by where they are applied and the faculty will continue to provide students with projects that enable them to think as broadly as possible.

The use of reflection to evaluate the assignment can also be extended to measure what the students' thoughts on diversity. Prompts can assess if students equate diversity with global issues or whether they view themselves as being represented in these situations. Reflections can also be given to see if students believe that they are able to work in situations where the culture is different from their own. This can expand the instructors' awareness of whether the students are understanding how diversity can play a role in engineering in a technically and professionally relevant way. When the instructors analyze the reflections, they can use coding framework as suggested by Chabon and Wilkerson [9], where reflections have increasing levels of depth. In that particular model, students can offer a shallow description of what they learn and increase their depth of understanding by demonstrating empathy, critical analysis and meta-cognition. This framework can be used to see how deep students are understanding concepts in diversity and other social contexts and the instructors are able to evaluate how they can alter the assignment to better address those concepts.

Acknowledgment

This material is based upon work supported by the National Science Foundation (NSF) under IUSE/PFE-RED Grant No. 1632053. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.

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