Teaching Environmental Engineering Sustainability and Resiliency in Urban Systems: Simulations and Role Play

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Introduction and Objectives

o UGA has a relatively new Environmental Engineering program encompassing a systems-based approach to engineering problems. The systems approach is not an easy concept for students to grasp, seeing the "bigger picture" is not always readily evident.

o We want the engineer to consider impacts to all systems at the intersection of a problem and solution and be aware of unintended consequences.

o How do engineers design a community (and its components) to be more resilient? In light of acute catastrophic events (e.g., hurricanes and tornados) and chronic events (e.g., climate change), resiliency is becomes even more important.

o These important concepts are taught in ENVE 3320 Environmental Engineering – Urban Systems.

o The objective of this project is to refine the course, which includes role play of engineers and citizens to a more-feedback driven and holistic method of evaluation to acknowledge the student work.

Developmental History of Innovation

o Environmental Engineering – Urban Systems is a core course in our curriculum and the first course students take that exposes them to the concept and design of water, wastewater and solid waste treatment.

o It can help prepare students for the Fundamentals of Engineering exam and gives them a taste of what they might be doing in the "real world".

o Having witnessed the amazing growth of students through teaching senior design through 100% project-based work (four years at the University of New Hampshire), a goal of the course was to add as much project-based concepts as possible to a "regular" lecture-style course.

o The course meets three hours with an additional 3 hour lab weekly; it is a junior level course and typically has 25 students. The first two years of the course, it had only 10 and 9 students, respectively, and the course was taught in the normal lecture-homework style format with a culminating project (writing a US EPA People Prosperity and Planet proposal) that the entire class worked on together.

o As the course grew to 25 students, the curriculum was completely revised to incorporate design projects for each major component and role play activities.

Students create their own scenario to re-develop a community such as this:

The remains of homes in Moore, OK (2013). Photograph by Steve Gooch/AP.

Thinking about sustainability and resiliency, to design these:

And this:

Learning Activities and Materials

o The class begins with lectures for about three weeks about the concepts of green engineering and systems approaches to environmental engineering. In week one, each student is given the demographics of a community. Students create their own story about their community and why the entire community was decimated (typically a catastrophic event) – they are encouraged to be creative and take ownership of the story of their community. Students are required to create a website of the community and publish updates to it the entire semester.

o The goal for the semester is to rebuild the community (in terms of environmental engineering infrastructure). There are three major components to the class after the introductory three weeks, and encompass three design projects: water treatment, wastewater treatment, and solid waste management.

Execution

o Students tour the local water, wastewater and solid waste management facilities (during lab times). Wet-labs designed to illustrate concepts used in treatment design (e.g., flocculation) are conducted.

o The students produce a technical report for each design project. In addition, a mock public meeting is held and presentations are given by the engineers (one third of the class). They prepare a presentation on their design and two other class members are assigned as citizens. Citizens can choose from several roles identified and must ask at least one question of the engineer.

o Currently, the students take the projects very seriously and work on them for many hours outside of class. They do extra research over and above the information given to create as professional a report as possible.

o Grading and providing feedback for 25 reports, three times a semester was challenging. This semester students work in groups of three, providing an additional variable of a group dynamic. Individual group meetings with the instructor can also increase the learning opportunity for the students.

o A more-feedback driven and holistic method of evaluation is needed to acknowledge the work completed for the reports and provide feedback to the students on how to improve. Computer simulations and social media provide other avenues to expand the course concepts and provide evaluation opportunities.

Discussion

o Students have enjoyed the design project work, tours and presentations in class. They report learning well from these and one student recently reported that the class projects helped him to get his job right after graduation.

o However, negative comments included the fact that feedback on the reports was not extensive enough. Feedback from a rubric is not enough and a better, more feedback-driven method of evaluation is needed.

o Students that have done well on the design projects have typically performed well on the exams; but that is not always true.

o Students have reported that after reflection on the design reports and technical presentations, they were really impressed with the work that they completed for the course. The website the students create can be used as a portfolio to show employers (if the students wish to use it in that manner).

Major Issues to Resolve

o Students clearly engage more in the class with the design projects, simulations and role play while working on "real world" issues in the context of a design project after touring operating facilities.

o The engagement and evaluation of the activities still needs to be refined to provide an improved learning experiences for the students.

o Feedback from outside entities could help, but I hope to learn more creative methods of assessment based upon project-based work. I also think that class activities, which in some cases still evolve around lectures, could be improved. I would love to engage with other creative teachers to explore more innovative and creative approaches to accomplish the course learning objectives.

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