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ENCE 637 “Biological Principles in Environmental Engineering”

Workshop

The “Chesapeake Project” gave the opportunity to get to know other University of Maryland Colleagues that have similar sustainability interests but very different backgrounds and ideas on where and how to apply the ideas and solutions from the workshop. A very important aspect was the interaction with faculty from humanities, business, biology, public health and other disciplines. We most often had shared views on the overall aspects of environmental sustainability, but many personal experiences made the discussions interesting and important in order to find ways to engage our student into critical thinking about environmental sustainability. My background is in environmental microbiology and I am used to think about aspects as water use/reuse, energy and bioremediation in technical terms, where solutions are designed involving microorganisms. However, comments made by other course participants about the intersection of the economics, legislation, public health and social aspects were interesting and are components I plan to incorporate through reading assignments and class discussions. It was also interesting and enriching to discuss different approaches to student learning and engagement and how this varies significantly between natural and the social sciences. In the natural sciences an inaccurate perceptions is often brought forward that it is inefficient and too “relaxed” to involve student discussions about the course material during class time. However, after listening to experiences from other Colleges in the social sciences and humanities, it is clear to me that discussion based class activities with a “Student-centered” format can be very efficient in obtaining the learning objectives in natural science and engineering courses as well. I plan to add class discussion and hands-on activities with the mentality that sometimes “less” is “more”. This will require more preparation and engagement from the students particularly when concepts such as environmental sustainability are introduced that varies from the traditional hard-core quantitative engineering topics. I expect that this transition will take time and effort on all sides, but will be enriching the class interactions and the learning outcomes significantly. The effort and enthusiasm delivered by the presenters at the workshop was greatly appreciated and I found the activities and interactions very helpful.

Course aspects

This course (ENCE 637) is a core course in the environmental engineering graduate course sequence. It has been designed to provide substantial knowledge about the biological processes that are involved in environmental engineering and how they can be applied to obtain goals such as clean drinking water, sanitary conditions via wastewater treatment, energy production via biological processes and bioremediation of Legacy Pollutants and other contaminants present in our surroundings. The history of the environmental engineering field is based on the basic concept of environmental sustainability due to issues with for instance contaminated drinking water due to contamination from sewers (for example Cholera outbreaks in London in the 1880es). Since this time the field of environmental engineering has developed significantly and particularly the knowledge of what used to be “Black Box” solutions. However, many more environmental issues have been brought to our attention and the need for sustainable solutions is more important than ever.

In ENCE 637, we focus a lot on the technical and technological aspects, but make sure to not look at problems and solutions in a vacuum. Environmental sustainability has always been included in the course, but a change in the coming semesters will be a CLEARER and SPECIFIC emphasis on sustainability ad methods such as Life Cycle Assessment (LCA) that in the last decade has been applied to the biological processes of environmental engineering as well and non-biological fields. The basic principles of LCA will be introduced in this course and will be discussed based on two peer-reviewed papers (LCA of biofuels and LCA of energy recovered from wastewater treatment plants) in the first part of the class. This will set the basis for the remainder of the course, where all aspects will be discussed in the light of "Environmental sustainability". Is this solution truly sustainable when all materials and resource flows are considered? In addition, we will discuss how to apply other aspects of sustainability such as social and cultural sustainability, since these topics are very important in order to convince the public and potential specific end-users that the solutions will be acceptable and not ruin a nature reserve or a cultural monument in order to for instance deliver clean drinking water and sanitary conditions to a town. These topics are hard to quantify, but none the less very important to discuss to obtain a long-lasting and sustainable solution.

We will also include the aspects of environmental sustainability in the development of a NSF-style research proposal. Currently, NSF does not require that sustainability is discussed while proposing research. However, we will involve environmental sustainability equally to the currently mandatory topic "Broader impact". By requiring this aspect to be discussed in a proposal the researcher has already taken a big step towards sustainability that will form and inform the proposal content.

Course changes
The title will remain unchanged, but changes have been made to the syllabus and style of teaching after my participation in the "Chesapeake Project"

<u>Course objectives:</u>
The following course objectives have been added:
"After completing this course, you will be able to:
4. Discuss the importance of environmental sustainability in environmental engineering
5. Evaluate environmental sustainability aspects of existing and proposed environmental engineering processes and designs

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<u>Course topics:</u>
These content topics have been added and will be in focus during the Fall 2015 semester:
3. Add a lecture on LCA based and sustainability of environmental engineering solutions - after the "build environment" lectures. Are we using more energy on solving a solution than we recover – by use of microbiology? (Example: Will use of thermal hydrolysis of biosolids from wastewater treatment improve the overall energy consumption in a LCA or will it be a sustainable solution?
10. Include sustainability and Life Cycle Assessment in the broader impact section of the NSF pre-proposal, include a discussion about the environmental sustainability of your

solution/proposal with regards to water, energy or other resources. Are we overall solving problems or causing new ones?

Lectures:
Specific lectures and subsequent discussions of peer-reviewed papers have been added to the syllabus in weeks 6, 10 and 13. This will provide an introduction in week 6 making it possible for the students to include sustainability in their tool box of critical thinking for the rest of the semester. We will return to the topic in week 10 with a more policy focused discussion and hopefully getting support by an experienced guest lecturer. In week 13 we will revisit environmental sustainability in environmental engineering to ensure that the students have obtained a solid foundation and will be able to include the concept of sustainability in the individual research projects taking place outside this course.

Homework:
Homework #5 will include environmental sustainability and life cycle analysis.

Teaching style:
A more student centered and active learning style will be applied in the fall semester. The changes will make the class time more interactive and require that students prepare before class, since lecturing will be minimized to 20 min every time. During this time the main concepts will be reviewed and the importance of these will be highlighted and more detailed perspectives left for discussion.

The lecture material will be made available on Canvas minimum two days before class and the readings are mandatory to ensure an engaged discussion during class. The discussions will be based on peer-reviewed papers, experimental protocols, newspaper articles or specific problems. This will enable discussions that can include many topics such as environmental, social and cultural sustainability; How can the community be involved when the environmental engineering solutions are discussed and implemented? How can you identify stakeholders? How do you communicate with the public?

These topics are not specific to environmental engineering or Biological Principles, but are essential in ensuring that the solutions to environmental problems are designed in a sustainable way, will be cared about by the community while in place and thus will be sustainable for a long time.