AC 2011-207: INTEGRATING CONTEMPORARY ENVIRONMENTAL ISSUES IN AN INTRODUCTORY ENVIRONMENTAL ENGINEERING COURSE

Mahbub Uddin, Trinity University

Dr. Mahbub Uddin is a professor of Engineering Science and the Chair of the Entrepreneurship Program at Trinity University. He led Trinity University to establish the Center for Entrepreneurship and Entrepreneurship program. He is a pioneer in integration of entrepreneurship, nanotechnology and six-sigma into the undergraduate engineering education. He has published extensively in areas of his expertise and in education. Dr. Uddin is an active member of AIChE and ASEE. His honors include: DOW Chemical, Outstanding Young Faculty Award, New Engineering Educators Excellence Award, ASEE, Outstanding New Engineering Educators Award, NEEE, Dr. and Mrs. Z. T. Scott Faculty Fellowship Award for Outstanding Achievement in Teaching and Advising, Trinity University, and Fellow, American Society for Engineering Education.

Integrating Contemporary Environmental Issues in an Introductory Environmental Engineering Course

Abstract

This paper discusses the strategies, experiences, assessment, and outcomes of integrating contemporary environmental issues in an introductory environmental engineering course. Environmental engineers and scientists need to constantly be aware of contemporary environmental issues. Therefore, it is absolutely essential that our students develop a culture of reading newspapers, journals, and government/industry publications on a regular basis to become aware of the contemporary environmental issues and be prepared to discuss and debate these issues. In an introductory environmental engineering course each student is required to report on seven articles that he or she read from a variety of sources such as local/national newspapers, environmental journals, internet, etc. Students need to submit a brief summary of the environmental news along with the source to the entire class as soon as they read about it. Students also give a five minutes presentation and conduct class discussion/debate on a contemporary environmental issue as soon as it appears as a news item. Students maintain a portfolio/journal of all the articles on contemporary environmental issues they read over the semester. At the end of the semester each student is required to submit his/her portfolio of seven articles along with his/her reflections and assessment of each articles. In addition, students conduct environmental caucuses similar to town hall meetings, and write two term papers on contemporary environmental issues.

Course Overview

The Fundamentals of Environmental Engineering course is intended for sophomore /junior engineering students at Trinity University[1]. This course is also open for science students. This course is designed to introduce student basic knowledge and skills necessary to understand the nature of environmental problems, raise awareness and concerns for contemporary environmental issues, identification of sources for environmental pollutions, design and analysis of the current technologies for environmental pollution control. The objectives of this course are as follows:

a) To understand the principles of Chemistry and Microbiology used in environmental engineering.
b) To perform preliminary design and analysis of treatment processes for water and air pollutions and hazardous waste.
c) To recognize and understand contemporary environmental issues.
d) To understand professional and ethical responsibility for protecting the environment.
e) To understand the impact of engineering solutions from environmental viewpoints.

Topics covered in this course are divided in following categories (each class period lasts 50 minutes):

I. Introduction to Environmental Engineering: the nature and scope of environmental problems, water-air-land interactions, engineering and environmental ethics, public awareness, education, individual and societal responsibilities for protecting the environment.(3 class periods)

II. Chemistry and Microbiology in Environmental Engineering: methods of expressing concentrations, stoichiometry, material balance, chemical equilibrium, solutions and solubility, pH, acid-base reactions, the carbonate system, gas laws, gas-liquid transfer, reaction kinetics, types of reactors, reaction rates, principles of biochemical reactor design, fundamentals of microbiology, bacteria, growth and death of bacteria.(5 class periods)

III. Water and Water Pollution: water resources, physical and chemical characteristics of water, sources of pollutants, water quality standards and parameters, biochemical and chemical oxygen demands, assessment of water quality, government regulations, Clean Water Act, water treatment processes.(3 class periods)

IV. Waste water and Treatment Processes: sources contaminants, physical and chemical and biological characteristics, the effect of oxygen-demanding wastes on rivers, waste water treatment processes, primary, secondary and advanced treatments, fundamentals of biological treatments, design and analysis of selective waste water treatment unit operations: Sedimentation basin, Filters, activated sludge reactors.(10 class periods)

V. Air Pollutions: criteria and non criteria pollutants, sources and health effects, emission standards, indoor air pollution, global warming: causes, effects and solutions. Clean Air Act, pollution control, design and analysis of air pollution control equipments: gravity settlers, baghouses, cyclones, scrubbers, electrostatic precipitators, absorbers, adsorbers, and combustors.(7 class periods)

VI. Hazardous Waste: definition and identification of hazardous waste, regulations and management, hazardous waste treatment processes.(4 class periods)

VII. Contemporary Environmental Issues: problem recognition, analysis of environmental impacts and probable solutions, individual and societal responsibilities.(10 class periods)

Contemporary Environmental Issues

The primary learning objectives of this topic is to develop student's awareness and literacy on a broad range of contemporary environmental issues pollution to policies that can harmfully affect the health, survival, or activities of human or other living organisms in this planet[2,3,4]. To achieve this objective we adopted the following strategies:

1. Develop Environmental Information Literacy: Students are required to read local/national newspapers, environmental journals, internet, etc. on a regular basis and identify issues that might have local or global environmental impact. Students share their reading with a short summary of the environmental news and literature citations with all the students in the class including the instructor. Students maintain a portfolio/journal of all the articles on contemporary environmental issues they read over the semester. At the end of the

semester each student is required to submit his/her portfolio of seven articles along with his/her reflections and assessment of each articles.

2. Analysis and Evaluation of Environmental Issues: Once in every week one student give a short presentation in the class regarding an environmental issue he or she read recently. The rest of the class must then analyze, and evaluate the environmental impacts. Each student is required to write a technical report (2800-3000 words) on a contemporary environmental problem of their interest.
3. Developing Consensus on Environmental Problems: Students conduct environmental caucuses in the evening (similar to town hall meeting) to debate on environmental issues, their importance's and impacts. Students are told that there is very limited funding available and only four projects will be funded for further study. After debating the issues they then develop a consensus and align themselves in four different environmental projects of their top interests. Each group then submits a formal written report on their environmental projects. The major thrust of this report is to provide a thorough analysis of the environmental problem, its impact and recommendations for corrective actions.
4. Making a Difference through Individual Actions: In the reflection Journal/Portfolio each student is required to report on what actions he or she would take personally that might contribute towards the solution of the stated environmental problem.

The Fundamentals of Environmental Engineering is an elective course in our curriculum geared for sophomore/junior engineering students. The class size is limited to 20 students. In spring 2010, eighteen students enrolled in this course. About 24% of this course is devoted to the study of Contemporary Environmental Issues. Each student read about 125 articles appearing in varieties of local/national news papers, environmental journals and conference proceedings (within two years of publication), internet news papers and other online mediums. These articles cover a broad range of topics such as air and water pollutions in United States, Europe, China, India, Pakistan, Bangladesh, Africa and South America, Global Warming, climate change, water crisis in Africa, oil and hazardous chemical spills, dumping municipal and electronic waste in developing countries, environmental impacts of coal power plants, effect of pesticides on agricultural land, effect of planting genetically modified seeds, biodiversity, environmental impacts of burning fossil fuels and power plants, unforeseen environmental effect of renewable energy, population growth and consumerism, violations of government regulations, politics and environmental policies, etc. These readings provide students a broad, comprehensive and balanced prospective of the contemporary environmental issues.

Assessment of Learning Outcome

Thirty five percent of the overall semester grade is based on the learning outcome of contemporary environmental issues. The assessment rubrics for the contemporary environmental issues are given in Table 1 and 2. Rubric No. 1 is used to assess the class presentation and the portfolio. To assess the term papers both rubric No. 1 and 2 are used[5, 6]. A sample format for the portfolio is included in Table 3. The grading breakdown for the entire course is given below[7]:

Homework	10%
Case Studies on Contemporary Environmental Issues	15%
Class Presentation 5%	
Portfolio 10%	
Two Term Papers on Contemporary Environmental Issues	20%
Two Exams (2X15)	30%
Final Exam	25%
	100%

Table 1: Assessment Rubric No. 1

	Insufficient **1**	**Effort Noted** **2-4**	**Good Job** **5-7**	**Excellent** **8-10**	**Score and Comments**
Quality of Sources	Sources simply pulled from the web. Selection criteria unclear	Sources out of date, unknown and lacking connection to the course	Recent sources, relatively known, and relevant to the course	Very recent sources , well known and prestigious and appropriate to the course	
Impact of Environmental Issues	Irrelevant environmental issues	Uneven or inadequate presentation of the environmental impacts	Balanced presentation of the environmental impacts	Enlightening presentation drawing audience reactions to the impacts	
Analysis and evaluation of environmental impacts and recommendations for corrective actions	Very little analysis and evaluation of environmental impacts. No recommendation	Unclear analysis of the environmental Impacts. Very little evaluation and recommendation	Good analysis, evaluation and recommendation of most of the environmental impacts	Comprehensive analysis and critical evaluation of all environmental impacts. Excellent recommendations for corrective actions	

Table 2: Assessment Rubric No. 2

	Insufficient **1**	**Effort Noted** **2-4**	**Good Job** **5-7**	**Excellent** **8-10**	**Score and Comments**
Topic Development and Content	Content is vague or irrelevant, reflecting little if any insight regarding topic.	Information provides some support for arguments, but analysis is basic or general, with little insight evident.	Information provides reasonable support for arguments and shows evidence of insights gained.	Clear and balanced use of relevant information facilitates thoughtful and in-depth analysis of the topic.	
Organization and Presentation	The writing is not logically organized, and the reader cannot identify a line of reasoning.	The illogical arrangement and sloppy transitions make it difficult to follow the line of reasoning.	The presentation flows logically for the most part, so the reader can follow the line of reasoning.	The presentation of information is arranged logically and flows smoothly throughout.	
Documentation and Citations	There is no documentation or source citation.	Some information is properly documented, with citations in readable style.	Most information is properly documented, with citations in acceptable style.	Information presented is clearly documented, with citations in correct, consistent style.	
Grammar, Spelling, and Proofreading	Bart Simpson would have done better.	There are numerous grammatical errors. Sentences are long and clumsy. The presentation is wordy or repetitious.	There are some grammatical errors, but most sentence structures are well developed and concise.	Paragraphs, sentences, and word usage have clear, concise purposes. There are few, if any grammatical errors.	

Table 3: Sample copy of a page of Student's Portfolio on Contemporary Environmental Issues

ENGR 2359 Fundamentals of Environmental Engineering Spring 2010

Article 1: Europe Finds Clean Energy in Trash, but U.S. Lags.

1. **Source (please provide literature citation)**

Rosenthal, Elisabeth. "Europe Finds Clean Energy in Trash, but U.S. Lags." *The New York Times*. 12 Apr. 2010. Web. 1 May 2010.
http://www.nytimes.com/2010/04/13/science/earth/13trash.html

2. **Summary of the Article**

Denmark has 29 waste-to-energy plants for a population of 5.5 million compared to 87 plants in US for a population of 300 million people. Waste-to-energy plants have three benefits: generate significant amounts of electricity, reduce the need for landfill sites, and lessen the greenhouse gas emissions. The waste to energy also has other indirect benefits: they reduce the need to transport wastes to the landfill sites further reducing greenhouse gas emissions. Moreover new technology has allowed waste-to-energy plants to become highly clean.

3. **Explain the important issues and environmental impacts**

USA is suffering environmental costs by not utilizing the potential of waste to energy plants. The environmental impact is higher greenhouse gas emissions and loss of cheap electricity.

4. **Recommended actions.**

- Create awareness that waste-to-energy plants do not mean the end of recycling
- Streamline the process of selecting and building the incinerators
- Change public perception by educating them about effective operation of waste to energy plants elsewhere
- Government funding

5. **Based on your analysis/reflection of the environmental impacts what action(s) you would like to take personally that might contribute towards the solution of the stated environmental problem.**

- Study the problem further and understand exactly why waste-to-energy plants have not been build in US despite its benefits
- Convey the knowledge to the friends and locals making them aware of the benefits

- Writing articles in popular newspaper elaborating the benefits of waste-to-energy plants

To measure the learning outcome in the contemporary environmental issues students were also required to complete a survey. A copy of the survey and student feedback is included in Table 4.

Table 4. End of Semester Outcome Survey for Contemporary Environmental Issues

1. As a result of reading many articles for the Fundamentals of Environmental Engineering class, I have learned a great deal about contemporary environmental issues.

Agree strongly Agree Neutral Disagree Disagree strongly

Student Feedback**:** *16 students strongly agreed and 2 students agreed with the above statement.*

2. In my reading I found the following issues most engaging (mark 1 through 3 for your top choices):

_____ Carbon dioxide emissions

_____ Consumerism

_____ Deforestation

_____ Electronic waste

_____ Environmental policy and climate change

_____ Water consumption and conservation

Other(s):
(You may indicate and rank up to three topics that you found more engaging than those listed above.):

_____

_____

_____

Student Feedback**:** *6 students selected "Environmental policy and climate change" as their top choices, 5 students selected "Consumerism" as their top choices, 3 student selected "Water consumption and conservation" as their top choices, and 2 students selected "Deforestation" as their top choices. The other two topics: "Carbon dioxide emissions" and "Electronic waste" each received one top mark.*

3. In general I learned the most about environmental issues from these sources (rank in order 1 through 5):

_____ Local newspapers

_____ National or international newspapers

_____ Journals

_____ Government or industry publications

_____ News items on the Internet

_____ Other: _____

***Student Feedback*:** *11 students identified "News items on the internet" as their number one source for contemporary environmental issues. 5 students identified "National or international newspapers" and 2 students identified "Government or industry publications" as their top sources.*

4. I plan to stay engaged with contemporary environmental issues in the future in the following ways (mark all that apply to you):

_____ Read articles in newspapers

_____ Read environmental journal articles and/or books

_____ Read news and reports on the Internet

_____ Watch television programming on environmental issues

_____ Discuss issues with friends/family/co-workers

_____ Contribute money or time to support an environmental issue

_____ Contact my elected officials about environmental issues on which they vote or make decisions

_____ Run for elected office myself!

Others:

_____

_____

_____

Student Feedback**:** *All 18 students commented that they plan to stay engaged with contemporary environmental issues in the future by reading articles in newspapers, environmental journals, books, news and reports on the internet and watching television programs on environmental issues. All the students plan to contribute money or time to support environmental causes and discuss environmental issues with friend/family and co-workers. Several students also mentioned that they would make it a priority to stay connected to contemporary environmental issues and plan to monitor changes in environmental policies and laws.*

5. As a result of my increased awareness of environmental issues, I am likely to take action in the future to help resolve environmental problems.

Agree strongly Agree Neutral Disagree Disagree strongly

Student Feedback**:**
15 students strongly agreed and 3 students agreed with the above statement.

6. I found the assignment to read, share report on, and assess articles on contemporary environmental issues to be a valuable part of the Fundamentals of Environmental Engineering course.

Agree strongly Agree Neutral Disagree Disagree strongly

Student Feedback**:** *All 18 students strongly agreed with the above statement.*

Analysis of Student Feedback

Almost 100% of students strongly agreed that the integration of contemporary environmental issues motivated them to learn a great deal about current environmental problems and helped them to understand their ethical, social, cultural, geo-political, technical, economical and governmental prospective. The majority of the students feel that this course also helped them to develop a culture of reading local and national newspapers, government and industry publications, and environmental journals. They would like to continue their reading habits and plan to stay engaged with contemporary environmental issues in the future. They also expressed strong commitment of personal involvement towards finding the solutions of the contemporary environmental problems.

Relationship with ABET Outcomes

The contemporary environmental issues were integrated in the Fundamentals of Environmental Engineering course in the spring 2008 and 2010. Because of extremely positive student's feedback we will continue to offer this course in the future. Since this is an elective course (offered every other year) with limited class size, the Engineering Science department at Trinity University do not feel it would be appropriate to map this course with ABET outcomes. However, the learning outcomes of this course can be easily mapped with ABET Program Outcomes f, g, h, i and j.

Conclusions

Integration of contemporary environmental issues in to a traditional introductory environmental engineering course helps students to develop a culture of reading environmental news regularly. It provides students a broad, comprehensive and balanced prospective of the contemporary environmental issues. Assessment of students work indicate that integration of contemporary environmental issues significantly improves student's competence to analyze and evaluate the impacts of current environmental problems and their solutions from technical, economical, societal, geo-political and global viewpoints. It also raises student's awareness of individual and social responsibilities towards protecting the environment.

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3. Slattery Michel C. (2008) Contemporary Environmental Issues Kendall/Hunt Publishing Company. 2008
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