Teaching Environmental Engineering Students Ethics, Law and Policy

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Abstract

Most conventional introductory courses on *environmental engineering* are offered as core or electives courses within chemical or civil engineering departments, with the primary focus usually being on the description and analysis of pollutant generation and transport in water, air, and soil. There is a concomitant discussion and analysis of the physical, chemical and biological treatment technologies that have been developed for pollution remediation and control. Scant attention, however, is paid to the social, political, economic, and technological, in short *total*, environment within which environmental engineering principles and practices, mediated by legal and regulatory forces, gets implemented. In this paper, I discuss the introduction of ethics, environmental policy and environmental regulatory issues into a regular introductory environmental engineering course. This is accomplished by beginning the course with a discussion of environmental ethics, followed by a general introduction to concepts in environmental law, focusing on what have become part of accepted legal practice, or have become evolving legal issues. Within the context of environmental regulations and the evolution of environmental laws, the broad range of situations that fall under the wide brushstroke of *environmental justice* are reviewed, analyzed and discussed. For engineering students, this is an exciting introduction to the social context of the science and engineering of the environment. Course materials include contemporary and historical readings followed by discussion and analysis, and also include general surveys of data, where applicable and available. Some specific case studies are included as well, time permitting. The material is covered in lecture/discussion mode, which permits the incorporation of brief introductions to environmental technologies and options, many suggested by the students themselves. With such a contextualization of environmental engineering practice, students are better primed for, and more receptive to, an introduction to the principles and technologies of environmental engineering.

I. Introduction

As awareness of the importance of environmental issues grows, and as students begin to demand

and require training and education in this area, universities around the world have seen the incorporation of environmental issues into courses across the curriculum (1). In most chemical engineering departments it is now common to find an elective course offered to students, usually in their junior or senior year, that covers topics in the general area of environmental engineering. These courses are taught by faculty whose primary research interests are in the environmental field. The texts that are used often come from civil engineering (2-6) because civil engineers were the first to explicitly deal with environmental issues through the field of sanitary engineering. These textbooks, and other like them, typically begin the study of environmental engineering with a focus on hydrology, water purification and use, and waste water treatment. Subsequent sections broaden the coverage to include air quality, air pollution and control, and solid waste treatment. Some texts also include chapters on noise pollution and its control, hazardous waste treatment and management, and nuclear and radiation pollution. The latter three pollution problems are usually not treated in any depth because these courses are generally limited to one semester's duration which is insufficient for coverage of *all* types of pollution.

Syllabi for a one-semester courses usually follow a broad outline as shown in Table 1 below.

Table 1: Typical Course Topic Outline for A General Environmental Engineering Elective

Section I: Hydrology and Water Treatment
Section II: Water Pollution and Waste Water Treatment
Section III: Air Pollution and Control
Section IV: Municipal and Solid Waste Treatment
Section V: Hazardous Waste Treatment
Section VI: Case Studies of Environmental Remediation

As the topics outlined illustrate, the focus of typical environmental engineering elective courses is treatment technology. Because of the vast number of contaminated sites that exist within the United States and the world, treatment of contaminated media will continue to occupy technological and human resources for the foreseeable future. It is not surprising, then, that the underlying theme is pollution treatment and control, especially since this has been the tenor of the response of industry, government and society in general to the pollution problem[1]. Beginning with pollution and its causes, characterization and description, the course focus is rapidly shifted to pollution remediation. The goal, *as it should be for a chemical engineering elective*, is primarily to equip students with the tools to extend their knowledge of unit operation and process technology[2]

1 More recently, pollution prevention (see, for example, U.S. Environmental Protection Agency, Proceedings of Pollution Prevention Symposium, November 1997, Washington D.C.) has become the buzz word in the environmental arena, and the focus of much of the research has shifted to process modifications and green chemistry (see, for example, National Academy of Science, 2nd Annual Green Chemistry and Engineering Conference, July 1998, Washington, DC) for the prevention of pollution at the outset, rather then the belated end-of-pipe technologies that can only control and remediate extant pollution.

2 That the student already possesses core chemical engineering knowledge suggests that this course be offered either to juniors or seniors.

to the treatment and remediation of pollution in various media including water, air and soil. Although "Green Chemistry" concepts are introduced through case studies of process changes that have resulted in significant reductions in adverse environmental emissions, detailed coverage is beyond the scope of a traditional environmental engineering elective.

There are several forces driving the incorporation of ethical and social issues into such an engineering elective. First, new program accreditation criteria (7) require the inclusion of teaching ethics in the curriculum, particularly in providing a broad understanding of ethical responsibility. Criteria in ABET 2000 also require demonstration of "…broad education necessary to understand the impact of engineering solutions in a global/societal context." Second, since regulations, policies and laws often form an interactive triad of factors that guide the development of environmental remediation technologies, students must be educated about these environmental laws, including their history and impact on policy making. Third, there is now a great deal of evidence to suggest (8,9) that communities of color and lower income communities experience adverse environmental impacts to a much greater extent than white and/or affluent communities. This outcome has come to be known variously as environmental injustice or, more harshly, racism. Because of the severity of this inequity, students in courses on environmental engineering must be educated and informed about this issue, especially in Historically Black Colleges and University's (HBCU's, such as Howard University) and Minority Academic Institutions (MAI's). The goal must be to empower them to bring their technical skills and professional abilities to bear on this injustice that may be occurring in their own backyards.

Table 2: Course Outline for Environmental Engineering Elective Incorporating Ethics

Section I: Introduction: Environmental Ethics, Regulations and Policy
Section II: Environmental Justice and Environmental Equity
Section III: Water Treatment, Waste Water Treatment, Water Pollution Control
Section IV: Air Pollution, Control and Treatment
Section V: Solid Waste Management: Collection, Treatment and Disposal
Section VI: Hazardous Waste Management
Section VII: Environmental Remediation Case Studies

Table 2 presents a very general outline of the topic structure for the environmental engineering elective course as it was offered the past two elective cycles in our department. The remainder of this paper will detail the way that the three issues of environmental ethics, environmental justice, and environmental law and policy have been integrated into this environmental engineering elective course. This course has now been offered twice over the past four years to students. More frequent offerings were requested by our students, many of whom felt the course was ideally suited to their professional interests. However, the small size of Howard's Chemical Engineering faculty and our curricular structure for elective offerings only permitted the offering of the course every other year.

II. Environmental Ethics

Environmental ethics is paid scant attention in many of the texts available for introductory

environmental engineering courses (2,4,5, 10). However, a few texts do briefly introduce the topic (3) and some focus a good deal of attention on the subject (11). In a more specific monograph, Gunn and Vesilind (12) cover environmental ethics for engineers in much greater detail; introductory chapters from this important monograph are used as readings. The readings, assigned prior to the lecture period, then provide the basis for classroom discussions.

For a topic of this nature, especially in the context of an engineering elective, the discussion always spans a broad spectrum of issues. The instructor provided focus with directed questions, for example what constitutes an ethical person? Lively discussion was facilitated by formal introduction of various types of ethical systems, ranging from hedonism to socialism. The discussion was then steered towards engineering (why does an engineer need ethics?) and the environment (what constitutes an environmental ethic?), and wrapped up by outlining the poles in the environmental ethics spectrum.

III. Environmental Law and Policy

Environmental regulations form the basis for the development of remediation and clean-up technologies. Before most texts discuss the various environmental treatment technologies in different media, introductory chapter(s) usually begin with an outline of environmental regulations and legislation. In this course, we utilize those components specifically focused on environmental legislation and its history. This approach to outlining the development of environmental regulations demonstrates to the student the growth of scientific understanding and how that growing understanding has an impact on legislation.

Although some texts only provide a brief treatment of environmental legislation, others provide a more detailed historical perspective, as well as specifics of legislation pertaining to each of the different media. This perspective shows how changes in legislation have occurred as understanding of adverse environmental effects has grown. For example, Vesilind et al (11) shows the development of legislation on water quality, starting with common law (based on precedents) through the riparian and first-use doctrines, and ending with statutory law as legislated by elected bodies and based on scientifically established water quality standards. The course uses case studies to explain the relevant environmental laws and highlight the details of their application and enforcement. In explaining the development of statutory law, the Water Quality Act of 1965, the Federal Water Pollution Control Act of 1972, and the Amendments to the Clean Water Act of 1977 are all covered. Changes in legislation clearly demonstrate how developments in science and technology have provided the rationale for legislative action.

This historical approach to legislative developments was maintained in discussing air pollution legislation because we found students were most receptive to this format. The laws governing the discharge of gaseous emissions were outlined, showing the evolution from simple tort and property law to complex statutory regulations. The impact of scientific understanding of pollution on societal actions was discussed, showing how air pollution legislation initially targeted particulate emissions from industry, yet completely ignored the automobile as a major source.

Only after it was established scientifically by Haagen-Smith that automobiles emitted a major fraction of air pollution was automobile exhaust regulated and legislated (13). This kind of historical example underscores the dialectic between the development of legislation and the advance of scientific and technological understanding. This discussion is then followed by coverage of the Clean Air Acts of 1963 and 1967 and the Amendments and Modifications thereto in 1970, 1990 and 1994, again in the context of increasing societal awareness of environmental hazards posed by human activity.

Treatment and disposal of solid waste is regulated by laws specific to such waste, beginning with the Resource Conservation and Recovery Act (RCRA, 1976). The impact of technology on environmental policies was discussed in the context of laws dealing with hazardous waste. Superfund (in 1980) and the Superfund Amendments and Reauthorizations (SARA, in 1986) were outlined, with specific focus on how awareness of hazardous wastes and their fate and transport in the environment (influence of science) have affected landfill design, development (technology), as well as landfill regulations through the years.

IV. Environmental Justice

Environmental justice (EJ) is a philosophy of environmental protection that has two major premises. The first premise demands that no single segment of the population bear an unequal share of the national (and international) environmental pollution load. Second, and equally important, environmental justice demands that all segments of the population, across race, socio-economic class, and gender lines, have an equal input into decisions that affect the quality of their environment. In addition, all communities should have an equal say in the development of environmental protection policies and in determining how these policies impact different segments of the population. It follows, then, that environmental racism is racial discrimination in environmental policy-making and the enforcement of regulations and laws (14). The movement for environmental justice has sprung out of a growing body of evidence indicating that people of color, lower income communities and labor groups are disproportionately impacted by toxic chemicals, and that these population groups face far greater risks of exposure to hazardous substances than does the majority community.

Inclusion of environmental justice in the course has a broad set of goals. First, students are informed about the data and research that have lead to findings that certain populations are disproportionately exposed to environmental pollution hazards. Second, the course shows that successful implementation of a pollution prevention program is inherently dependent on no one segment of society bearing an unfair share of environmental degradation. Third, students are shown that it is possible for mainstream and minority environmentalists to work together with activists to achieve environmental justice.

Early on the environmental movement was predominantly white and focused on the preservation of nature for recreational enjoyment rather than on the restoration and remediation of degraded environments. Although societal awareness of pollution as a problematic result of the advances of

industrial society was accepted, nobody really wanted the burden of this pollution in their backyards. Those communities with the education, resources, power, and influence were usually able to keep the pollution out of their environments. In the United States, communities possessing information, financing, technology and political power tend to be white. Lower income and minority communities more likely live in degraded urban or post-industrial environments, and their access to critical resources is limited. Now, community groups fighting environmental health hazards need information to determine whether there is a danger in order to assess and challenge the claims of those who say their isn't a problem, and to educate and to mobilize the community to remedy the situation (15).

This discussion raises the issue of environmental racism (defined using Chavis[14]), which is then further expanded upon with Bullard (8), starting with the first chapters on environmentalism and social justice, and on the politics of place and race. These two chapters introduce the students to how race and racial politics have had an impact on the development of environmental activism and the environmental movement. The inclusion of an environmental agenda within the civil rights movement is described, with particular effort to show how civil rights leaders incorporated demands for remedial environmental action in long-neglected minority communities into their platforms. The case of Warren County, North Carolina demonstrates this discrimination with clarity, and was used as a case study. Showing how prominent civil rights leaders conducted civil disobedience to bring federal attention and remedial resources to bear on the local PCB pollution problem ideally captures the lesson for students on the need for education combined with activism for self-empowerment.

Following this discussion of environmental racism in North Carolina, other examples are discussed. Although examination of the voluminous amount of environmental data requires more than a couple of lecture/discussion hours and is beyond the scope of the course, some excellent summaries are available and should be discussed. A *National Law Journal* (15) survey is one such collection that we have found useful.

V. Assessment

This course has now been offered twice, both in the Spring Semester (1996 and 98). In both instances, the student response to the course was assessed through a feedback questionaire. Students were asked what they liked most about the course, what they liked least, whether the pedagogical format (lecture and lecture-discussion with assignments for both) was beneficial, as well as other comments. Of the few responses received ($n<10$), the predominant sentiment was that the inclusion of Environmental Justice issues and the discussion of environmental ethics brought the field into better perspective for the students. When the course is offered in the future, a more rigorous assessment instrument will be developed that takes into account more specific ABET 2000 criteria.

VI. Conclusion

Recent changes in accreditation requirements and expectations of educational outcomes necessitate the incorporation of ethics issues into the curriculum. As Pfatteicher (18) has noted, teaching engineering ethics and incorporating these issues into current curricula poses several problems, most notably of assessment, i.e. should we assess effectiveness of incorporation of ethics issues into accreditted curricula by the post-graduate ethical behavior of students. Although these are serious concerns, the incorporation of teaching in ethics is not subject to debate (EC2000). This paper demonstrates that incorporating ethics, environmental legislation and environmental justice issues into our elective environmental engineering course can be accomplished. As described in this paper, inclusion of social and ethical topics relevant to the environment at the outset of the course serves to broaden engineering students' perspectives. Further, it serves to enlarge their world-view, provides them with tools to evaluate the impact of technology on their world, and it helps them evaluate their role in this fast changing world. It has been our experience that incorporating these additional but necessary topics does not greatly increase the burden on the faculty, but appears to increase student motivation as well as student participation in their own education.

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