Online Ethics Center
FOR ENGINEERING AND SCIENCE

Using the Web for Teaching Engineering Ethics Across the Curriculum

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Description

This essay discusses a different approach to the untrained instructor problem-the development of a web-based co-instructor. The web resources described in this paper have as their primary goal assisting engineering faculty in the College of Engineering at the University of Michigan teach and assuming some of the work of teaching engineering ethics across the curriculum. This paper describes a program that was never actually implemented.

Body

World Wide Web (WWW) resources for engineering ethics have grown significantly over the past few years. Sites mounted at Case Western Reserve University, Texas A&M, Illinois Institute of Technology, North Carolina State University and other universities with engineering ethics programs, as well as sites maintained by engineering societies, such as the National Society of Professional Engineers,

provide easy access to cases, articles, newsletters, codes of ethics, related links and more . For the experienced teacher, these sites provide convenient, up-to-date materials for bringing ethics into the classroom.

Four years ago, the College of Engineering at the University of Michigan made the decision to teach ethics "across the curriculum," along with technical communication, teamwork skills, and environmental issues. Teaching engineering ethics "across the curriculum" raises a difficult pedagogical problem-the problem of the "untrained" instructor. To embed ethics in and across a curriculum rather than teaching it in one or a few specific courses requires that faculty who have little or no experience teaching ethics accept responsibility for doing so.

The problem of the untrained teacher has most commonly been addressed through instruction. Over the past decade, workshops, seminars, and training programs, both local and national, have been organized in an effort to prepare engineering faculty to teach engineering ethics [2-12]. This paper discusses a different approach to the "untrained" instructor problem-the development of a web-based co-instructor. The web resources described in this paper have as their primary goal assisting engineering faculty in the College of Engineering at the University of Michigan teach and assuming some of the work of teaching engineering ethics across the curriculum.

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Objectives and Community

The plan for teaching ethics across the curriculum being developed at the University of Michigan sets three goals, which are addressed in four different settings [Steneck, [1999] #168]. The three goals are providing students with:

- an understanding of the complex inter-relationships between technological development and the welfare of individuals, society, and the environment (technology and society)
- an understanding of the professional nature of engineering and of the responsibilities associated with a professional career (engineering and society)
- the ability to analyze situations that raise questions about and to articulate reasoned ways to respond to problems associated with professional dilemmas

(ethical reasoning).

The settings are:

- a first year, introduction to engineering course, taught to all students
- beginning department or major courses, which are usually taken in the second year
- engineering science courses and technical courses, taken during the second through fourth years
- engineering design courses, usually taken in the third or fourth year

This plan is simple in design, but complex in implementation.

Complexity arises from the fact that ethics instruction in our new curriculum needs to take place in many different settings. We currently teach five different introductory courses each term, with enrollments of about 100 students per section. Students then select from about a dozen majors, which, as noted above, will include ethics in at least three different courses. This gives at a minimum 40 different settings for teaching ethics, each of which has particular needs and engages students, roughly 4000 total, at different stages in their education.

Initially I turned to the Web as a convenient way bring unity and coherence to our curriculum. Over time, the reasons for using the Web in instruction have been refined to include its capacity to provide:

- a unified program presence, in the absence of a core ethics faculty or a program office
- a common set of resources that students can consult during their years at Michigan
- resources and guidance for the engineering faculty who will be introducing ethics into their courses
- some actual teaching in the form of directed assignments and interactive case studies

Our target audience, however, has remained the same: students and faculty in the College of Engineering at the University of Michigan.

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Technology

Anyone who has gone through the process of mounting a complex website knows that the selection of technology is crucial, both software and hardware. I made some wrong decisions along the way, which I have included in this discussion of technology for the benefit of anyone facing a similar situation.

Server

I knew when I began web development that I wanted the site to be interactive, which in turn required scripting. As I will describe shortly, we will track students' responses to questions and give them selective feedback. Websites maintained by the University of Michigan are limited to standard scripts. This, at least, was I was initially told. Therefore, on the recommendation of our computer staff and with support from the University, I purchased a server, which was maintained and backed by our Computer-Aided Engineering Network (CAEN), but not part of the umich.edu system. This was wrong decision number one.

Having a separate server made it difficult to make use of the University's Kerberos system, which I needed to restrict access to University of Michigan engineering students and faculty. We looked very briefly at maintaining our own user directory, but there is no practical way to track the status of students apart from their computer accounts. Therefore, I have since moved the site to the University of Michigan network and use two locations: one for site development and one for the active website. Staff at our Information Technology Division (ITD) review the scripting on the development site before it is moved to the active site.

Server environment

A fairly large community of users (at least 4,000 with the possibility of peak use periods, such as the end of term) led to the decision to work in the UNIX environment. This was a difficult decision, since I am a committed Mac user who is not UNIX literate. We use Apache server software, which has so far met all needs but also has not been fully tested since we are still in the development stages.

There is no doubt that life would be a great deal simpler if everyone working on this project used the same computing environment. I write and format on a Mac using

Claris Homepage. My web assistant and script developer use PC and UNIX. We exchange and share files through our development server, which means that we seldom meet in person. Exchanging files has not been a problem, although I am sure that others working on the project would like to see me give up my Mac.

Access

A high priority for our site was the capacity to restrict access to UM engineering students and faculty. As noted, this is now done through the Kerberos password system. We are also using "htaccess" to further restrict materials for instructors. Accordingly, anyone trying to access the Responsible Engineering Forum at the University of Michigan, or REF@UM, needs to enter a password. At the present time, guest access is not permitted.

The reasons for restricting access are twofold: First, and most importantly, we are tracking student responses to questions relating to ethics, such as: "would you report another student for cheating?" I want students to be able to answer questions such as this without feeling that the entire world is looking in. Our website is a classroom for students at the University of Michigan, not a forum for public discussion. I may eventually mount a duplicate site so that the public can look in the windows of our virtual classrooms, but it not my plan to allow them to listen to the discussions in the classroom.

The second reason for restricting access is questions about ownership, development costs, and quality control. Many of the pages being developed are experimental. Students are creating some of the case studies. Some of the scripts are being developed by a private consultant who retains ownership. Until the issues these concerns raise are settled, I am reluctant to place all of our material on the web without any restrictions. These are difficult issues that need further discussion.

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Organization and Content

The organization and content of REF@UM are, as mentioned, driven by our program needs. After signing in (fig. 1), readers enter a virtual office with a desk and bulletin board (fig. 2). There are three basic areas or options for browsing:

1. REF@UM, which contains administrative details and links
2. Curriculum 2000, which contains course-related materials
3. National, which is basically a national browsing library with planned links to societies, careers, journals, cases, and news stories.

The development of the site has itself been driven by the phased implementation of our new curriculum, Curriculum 2000, which has not been as orderly as I anticipated. Work is still in progress on most areas and will be for the next year at least. In the remainder of this paper, I will confine my remarks to the second area, the materials being designed to support Curriculum 2000, and to the second through the fourth levels or groups of courses. As noted, our introductory course, Engineering 100, will change next year as will the web materials supporting ethics teaching in this course.

Introductory courses to major.

At some time in their first or second year, students take a basic engineering course that is designed to introduce them to their major field of study. These courses vary considerably from department to department on our campus, with some focused primarily on science while others provide more information on the application of that science. A few introduce students to professional issues; others bring in related topics, such as the relevance of safety considerations, the use of standards in decision making, government regulation, environmental issues, and so on. The one common feature these courses will have when our new curriculum is fully implemented is a common introduction to engineering ethics. The components of this introduction are straightforward, testable, and easily introduced over the Web.

The goal set for this stage in every students' education is to have some fundamental knowledge about the professional field they are planning to enter. Students should be familiar with:

- the engineering societies for their major or field of study
- relevant codes of ethics and related professional standards
- relevant journals and newsletters
- profession-society issues of current interest

To help faculty integrate this information into their courses, we have developed a major-specific database that will allow student to search for societies, codes of ethics, journals, newsletter, cases (discussed below), news stories, and career

information (figs. 3-5). Faculty can use this database to develop lecture materials or as the basis for assignments and tests on professionalism.

Engineering science courses and technical courses.

After their first year, which is driven primarily by the basic sciences, engineering students spend most of their time in engineering science and technical courses. The material in these courses tends to be theoretical and removed from practical considerations, making it difficult for students keep in mind the important links between engineering and technology on the one hand and society and the environment on the other.

To help ensure that students do not ignore the social and environmental contexts of engineering while taking engineering science and technical courses, we are developing major-specific interactive cases that can be introduced into any science or technical course that covers material relevant to a particular case. The cases are being designed primarily for self-exploration, not in-class instruction. We are using a "write-your-own-adventure" format, with different types of feedback being provided along the way (fig 6). Some of the feedback is "canned," that is, one pre-written response to a particular selection (fig. 7). Some of the feedback is dynamically generated, such as how all students answering a particular question have responded (fig. 8). To emphasize the importance of the links between engineering science and ethics, the cases include links to technical material as well as quizzes on that material. The selection of a particular decision sometimes leads to questions about the ethics of that decisions, at other times to questions about the science on which the decision is based. [Note. An example case will be linked to this site at a later date.]

Design Courses.

Design courses are where students most directly come face to face with real engineering problems and the professional side of engineering. As others have suggested before, this is therefore an ideal time to explore some of the ethical issues raised by engineering. Ensuring that all design faculty do so is difficult with across-the-curriculum teaching. To help ensure some uniformity in the exploration of ethical issues relating to design projects, I am developing a four-step process (fig 9) that takes design teams through:

1. a cost/benefit-oriented analysis of stakeholders (fig. 10)
2. the articulation of standards used for making decisions about (fig 11)

- technological advance
- economic development
- public health
- public safety
- the environment

1. an analysis of professional obligations based on the NSPE Code of ethics (figs. 12, 13)
2. a review of their project from different ethical perspectives [under development]

As with the other portions of the Curriculum 2000 section, these pages can be used by faculty to develop lecture content or simply assigned to students as self-directed exercises.

Assignments

The four course sections of REF@UM have one common feature: online assignments that can automatically be submitted to different course instructors by email (figs. 14-16). Other forms of online testing and evaluation will be developed at a later date, depending on how much use faculty make of this feature of the site.

Prospects and Problems

Although REF@UM is not yet fully developed, it is already making my life as ethics coordinator for the College of Engineering easier. When I talk with faculty about integrating ethics into their courses, their willingness to cooperate is greater if I can supply materials that are easily adapted, do not take up too much class time, and provide clear ways to assess learning. The College is currently gearing up for its ABET visit this fall, under the new Criteria 2000 [1]. Having a straightforward, three-goals/four-courses plan with linked web resources and evaluation tools makes it easier to explain what we are doing and how we are introducing ethics across the curriculum. As useful as REF@UM has been and promises to be, there remain some significant issues to consider.

High on the list of issues is the time invested in this project. Anyone who has taken on a similar project knows I am sure that they take more time and resources than anticipated. I have a $25,000 teaching grant from the University of Michigan Whitaker Fund to develop this site. I could not have done the work without the grant, and the funds will not see the full site developed. Interactive cases can by themselves take tens of hours to develop. Moreover, even when it is complete, the site will have to be kept current and serviced, making continuing support essential. The University of Michigan is slowly coming to understand that faculty cannot be expected to use the Web for teaching without some support, but the University of Michigan, like every other university, is struggling to keep up with the every-increasing demand for electronic technology.

In the competitive atmosphere for funding on university campuses, demonstrating utility is vitally important. A second important issue, therefore, it finding ways to collect evidence to show that a site such as REF@UM is useful. I should have no problem showing that faculty use the site in teaching, assuming they do, but it will be more difficult to provide evidence of the learning it fosters. Online testing will enable me to demonstrate that some minimum standards are being met, such as basic knowledge about professional societies and codes of ethics, but if the web become our main source of instruction, is it capable of delivering a sophisticated enough understanding of professional ethics to satisfy our obligation to teach professional ethics?

This last question raises one final and interesting ethical dilemma. The electronic database we are developing for REF@UM should enable us to do some sophisticated analyses of students' abilities to confront ethical dilemmas. The login system we are using will make it possible to track individual students and their answers to specific questions. We can therefore design our cases to raise specific questions and then track how well students are able to respond to those questions. This information could be correlated with class year, major, courses taken, and perhaps even parameters such as race and gender. It would be to have students fill out a brief questionnaire on their first visit and then correlate this information with responses to specific, pre-designed questions.

The dilemma here, of course, is whether it is ethical to collect this information without telling students, and if we tell students, will this compromise the learning that takes place through the Web? Can a site such as this be used both to teach and to study teaching? I am not sure and not too concerned since for the present my

main concern is getting the nuts and bolts in place. However, before long the machine will be functional and decisions will have to be made about its use.

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Notes

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Rights

Resource Type

Instructor Materials

Parent Collection

Essays on Ethics Instruction

Topics

Pedagogical Approaches

Discipline(s)

Teaching Ethics in STEM