Online Ethics Center
FOR ENGINEERING AND SCIENCE

Problem-based Learning in a Professional Ethics Course for Undergraduate Engineering Students

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Description

This activity is considered an NAE Exemplar in Engineering Ethics Education and was included in a 2016 report with other exemplary activities. The activity describes a course taught for engineering students at Georgia Tech where students take part in problem-based learning approach, discuss a real-life case study from their own experience or historical case study, and think and discuss possible solutions to questions raise as part of this case.

Body

Exemplary features: Incorporation of ethics into engineering design thinking and engineering projects.

Why it's exemplary: I am in the midst of a long-term project in design research, developing and refining an innovative approach to teaching stand-alone, semester-length courses in practical ethics for students in engineering degree programs at Georgia Tech. The design centers on problem-based learning (PBL): students work together in groups, with guidance from the instructor, to develop, analyze, and respond to complex, open-ended problem situations in professional practice. The goal is for students to envision a range of possible options for responding, then

carefully to consider the ethical implications of each in terms of basic moral values.

Program description: The engineering ethics course fulfills the ethics requirement of many of the undergraduate engineering degree programs at Georgia Tech. Students are mainly third- and fourth-year undergraduate engineering majors. Each section of the course as I teach it is capped at 35 students. The course is offered by the School of Public Policy (SPP) under the Philosophy of Science and Technology (PHIL) designation. In the context of the SPP, instructors have considerable latitude in course design, outcomes, and requirements within broad outlines laid down in the course catalogue, although I am the one faculty member involved in this particular design project and the design is my own. I generally offer a section of engineering ethics every term with the goal of helping students to develop cognitive skills associated with moral imagination.

The learning outcomes of the course all involve developing the capacity to notice, respond to, and think about ethical values in particular, concrete, messy problem situations. A messy problem is one in which there may not be just one correct option or even just one way of understanding the problem. By the end of the term students should demonstrate improved abilities in the following areas:

Contextual Awareness: choose an appropriate scale for framing a problem situation and its implications; identify plausible opportunities for and constraints on choice and action in the situation; and connect opportunities and constraints to wider systems and institutions on which they are conditioned.

Critical Consideration: identify concrete instances of basic ethical values that are (a) in play in and (b) implicated in particular options for action in a problem situation, including values that tell for and against each option.

Theoretical Understanding: organize and connect concrete instances of basic values by appropriate use of theoretical frameworks; use appropriate terminology for each theoretical framework; draw appropriate connections among concepts within theoretical frameworks; and manage the connections among concepts between frameworks.

Three Auxiliary Outcomes: generate a variety of distinct, practicable options for responding to a problem situation, which includes reframing the situation (creativity); organize written work for ease of understanding, using clear and precise language that is accessible to a general audience (communication); and collaborate

effectively with others (collaboration).

Following the PBL model, the course is structured as a kind of apprenticeship; students work together in groups, with guidance from the instructor, to acquire and use the cognitive tools of ethical inquiry and problem solving. The course is divided in three parts, the first part of which is an introduction to the tools themselves: students work from primary and secondary sources in ethics to develop a working understanding of ethical theory as a way of focusing attention on basic values, and they work through a series of short practice exercises to refine that understanding and develop a sense of the steps to be taken in ethical inquiry. In the current version of the course, the ethical theory on offer is Aristotle's virtue ethics, which lends itself quite well to the context of professional practice. While Aristotle was most interested in dispositions of character that contribute to general human flourishing, in terms of the function or characteristic activity of humans as such, I have students consider the function of engineers as professionals and the dispositions of character most appropriate to that role. I also provide the students with scaffolding, which is an important element of the PBL approach. Scaffolding is an artificial structure for focusing students' attention until they have enough experience to focus attention in those same ways on their own. The scaffolding for virtue ethics has students fill in columns picking out aspects of the experience of a situation and the response to it that are especially important for assessing the appropriateness of the response. In each of the remaining two parts of the course, groups work more independently to develop a novel problem situation that might confront a practicing engineer, analyze the context of the situation, develop at least three options for responding to it, and consider the implications of each of those responses. In developing a problem situation, groups essentially write a story in which the protagonist, a practicing engineer, comes face to face with an ethically fraught choice. Groups may adapt their stories from actual cases or from their own experience in co-ops, internships, and labs, or they may create works of fiction based on general understanding of the kinds of situations practicing engineers might face. In any case, stories are to be in the present tense and in the first person, and they should be open-ended and ethically complex, even messy. At the culmination of the project, each group presents the situation and responses to the class in a creative format (often a skit or short video) and facilitates a class discussion of the ethical implications. Each student then writes an "individual consideration," which begins with the problem situation from the student's working group and one of the options from the presentation. The student adds a new option of her or his own devising, then

considers the implications of each option following the outlines of the provided scaffolding, but in paragraph rather than tabular form. The goal of the consideration is to indicate the basic values that are in play in each option, for good or for ill, without coming to conclusions.

Assessment information: Design research proceeds by an ongoing process of making incremental improvements of a course design, accompanied by a more formal assessment using qualitative data, quantitative data, or both. An important first step, though, is to arrive at a course design stable enough to lend itself to repeated rounds of assessment over a period of time. My project has just reached the point of having a stable course design. Significant revisions before the spring 2015 term and additional refinements just before the fall 2015 term have yielded a design that promises to function well for the foreseeable future with relatively minor modifications. This is to say that I have not yet begun the systematic collection of data on the effectiveness of the course design. I can offer some observations, though, that suggest the PBL approach in practical ethics is especially promising and that may provide some basis for the formal assessment still to come. When I started to implement PBL in practical ethics courses in fall 2012, the impact on student engagement was immediate and dramatic, especially compared to my previous lecture-and-discussion approach. Attendance improved markedly, and students were generally active participants in group work. The current design, with its high degree of student control over problem situations and presentation formats, seems even to make the course enjoyable for students. The one learning outcome that has been most elusive has been theoretical understanding, and many of the recent revisions to the course design have been aimed at bringing that more within students' reach. The current term is the first in which I have given over the first third of the course to preparatory readings and exercises, and early signs are promising that students will more quickly gain competence and confidence in using the scaffolding to identify basic values. Anecdote is problematic as evidence for the success of a design, but there have been a number of instances in each term in which I have used PBL when students have written to me or told me that being in my class has begun to change the way they perceive various situations in which they find themselves at school, at work, listening to the news, or even just spending time with friends. They tell me they have started noticing the values that are in play in such situations. They sometimes ask me questions aimed at helping them to clarify the ethical aspects of such situations One student even claimed I had "ruined" things by making it impossible to ignore values in everyday life!

Additional resources:

1. PHIL 3109: Engineering Ethics – Syllabus, fall 2015: https://drive.google.com/file/d/0B1n5fQEuOtUxQldlLUEySURRd1U/view?usp=sharing
2. PHIL 3109: Engineering Ethics – Evaluation Rubric, fall 2015: https://drive.google.com/file/d/0B1n5fQEuOtUxQTNPNGdNSDZIb0E/view?usp=sharing
3. Kirkman, Robert. 2017. "Problem Based Learning in Engineering Ethics Courses." *Interdisciplinary Journal of Problem-Based Learning.* 11(1). https://doi.org/10.7771/1541-5015.1610

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Resource Type

Educational Activity Description

Parent Collection

NAE Exemplars in Engineering Ethics Education

Topics

Case Study Method
Pedagogical Approaches

Discipline(s)

Engineering
Teaching Ethics in STEM