

Learning and Teaching Ethics in Engineering: Preparing Engineering Faculty to Teach Ethics

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Abstract

Through assessment processes recently put into place, many engineering departments at Penn State identified a need to enhance the ethics components of their curricula. To support departments in their enhancement processes, the College of Engineering worked with the College of the Liberal Arts to create a faculty development program to prepare engineering faculty to teach ethics, entitled, "Learning and Teaching Ethics in Engineering." The program was designed to allow engineering faculty to gain some background in ethics and to develop ethics activities for their courses and methods for assessing them. This paper provides a description of the program, a summary of the learning objectives, instructional approaches, assessment methods developed by the participants, and a summary of the assessments of the effectiveness of the program.

Introduction

Over the past several years, departments in the College of Engineering have designed and implemented assessment and feedback processes to improve their curricula as required by the ABET accreditation criteria. Through these processes, many departments identified a need to improve the ethics components of their curricula. Various options to address this need were considered by the Faculty Advisory Board of the Leonhard Center for the Enhancement of Engineering Education, and a faculty taskforce on the ethical, societal, and global aspects of engineering education at Penn State. Together the Faculty Advisory Board and the Taskforce considered different sets of learning objectives for ethics education and possible options for achieving those objectives. However, despite considerable effort, the groups could not agree on a set of objectives or on a single approach to ethics education. Ultimately the groups reached the decision that each department should define its own learning objectives related to ethics and select appropriate pedagogical approaches to achieve them.

Although there was a lack of consensus on learning objectives and pedagogical approaches for ethics education, most of the departments did prefer integrating ethics into engineering courses, as opposed to having students take a course in ethics or philosophy. However, this approach raised two important issues: in general, engineering faculty members do not have appropriate knowledge and experience to teach engineering ethics, and they are not comfortable addressing ethics or

engineering ethics. (These two issues have been identified by other Engineering Colleges as they formulated plans for integrating ethics into their curricula, e.g., IIT¹, Towson State² and Oregon Institute of Technology.³) It became clear that if departments were to be successful in integrating ethics into engineering courses, some form of development would be required for most faculty members.

Shortly after the need for a faculty development activity became clear, the College of Engineering and the College of the Liberal Arts received a gift from an Alumnus to start joint activities involving engineering and ethics. This gift explicitly linked the Douglas and Julie Rock Ethics Institute in Liberal Arts and the Leonhard Center. When the Directors of the Institute and Center met to discuss possible joint projects, they quickly decided that a faculty development program to prepare engineering faculty members to teach ethics was the best starting point. A design team was assembled, which consisted of a faculty member from Engineering, a faculty member from Philosophy, the Director of Engineering Instructional Services, and the Directors of the Center and Institute.

The teaming of Philosophy and Engineering in the design and delivery of the program proved to be a key factor in its success. The Philosophy team members brought tremendous depth of knowledge in ethics and long experience in teaching ethics in introductory courses, whereas the Engineering team members contributed experience in introducing ethical topics into their courses and expertise in instructional design. The team members also brought together complementary experience in faculty development workshops on ethics, teaching and learning, and instructional design that led to the successful design for the workshop.

The Faculty Development Program

The first task of the cross-disciplinary design team was to agree upon goals for the program. The goals were:

1. To help participants prepare to teach ethics by introducing them to ethical theory and moral reasoning;
2. To help participants systematically design their ethics-related course activities by introducing them to instructional design methods;
3. To disseminate outcomes of the program throughout the College of Engineering.

The first objective addresses the lack of preparation of engineering faculty, in general, in the area of ethics and engineering ethics. The second objective is motivated by the goal of the Leonhard Center and Engineering Instructional Services to increase the use of instructional design methodologies by engineering faculty members. The third objective is motivated by the desire to “spread the word” that engineering faculty members can successfully teach ethics in their courses, so that others will try it in their courses. The design team also decided upon the title for the program: Learning and Teaching Ethics in Engineering (LTEE).

The overall design of the LTEE program was inspired by the successful workshops that have been run by the Center for the Study of Ethics in the Professions at IIT since 1991.⁴ In those

workshops faculty members come together for one week to learn about ethics and to design course activities. The LTEE program consists of four elements:

- An activity-based, three day workshop;
- A follow-up meeting at which participants present their learning objectives, instructional approaches, and assessment methods, and receive feedback from the group;
- A final meeting at which participants present the results of their work;
- Presentations by participants at their faculty meetings.

The first day of the workshop consists of an introduction to ethics and engineering ethics; a philosophy and an engineering faculty member, who designed this portion of the workshop, facilitated it jointly. The participants are introduced to three moral frameworks: virtue, consequence, and duty-based ethics and some challenges to those frameworks, such as moral relativism, that often arise in classroom discussions, along with a methodology for analyzing ethical problems, and possible issues with codes of ethics. Several activities are incorporated into the day including viewing and discussing an ethics case study from NSPE – Gilbane Gold.⁵

The second day consists of an introduction to instructional design and an initial application of the methodology to design learning objectives for ethics activities; participants are also introduced to taxonomies of learning objectives such as Bloom’s taxonomy of cognitive objectives. The participants are presented with a basic instructional design methodology including writing good learning objectives and linking them to pedagogical approaches and assessment. They also are introduced to examples from the literature of various approaches to integrating ethics into courses and for assessing the quality of student work. In one activity, participants are asked to write learning objectives for their ethics activities and to discuss them with the group; another activity requires them to complete a multiple-choice instrument to determine their ethical ideology.⁶

On the third day, the participants begin with an activity in which they prepared grading methodologies for student essays on ethics. They are then introduced to a website (www.engr.psu.edu/ethics) that was developed to support engineering ethics education at Penn State, so that they can use resources from the site to help them prepare their ethics activities. This comprehensive web site features a listing of on-line case studies that are organized into several different categories, and the cases can be sorted on-line by any category. For the remainder of the day, the participants work on the design of their ethics activities.

Several weeks after the workshop, the group reconvened so that the participants could present their learning objectives, course activities, and assessment methods. The final portion of the program will occur at the end of the spring semester when the group will reconvene to discuss assessment results from the individual courses and to evaluate the program overall. In addition, all of the participants will give presentations to their faculty colleagues on the results of their work.

Participants in the workshop had to be nominated by their department head; each department was

invited to nominate two members of its faculty. Initially, 14 faculty members from eight departments were nominated; however, three could not participate due to conflicts with the schedule of some of the program activities. The final participant list was 11 faculty members from seven departments. Four departments had two participants, and three departments had one. All participants received one week of summer salary for their participation in the program.

Materials Developed by Participants

The participants quickly embraced the overall instructional design process, and they prepared learning objectives for their ethics activities. Typical learning objectives ranged from knowledge level objectives to analysis and synthesis. Some learning objectives developed by the participants included:

Students will be able to list the three models of ethical thinking and give examples of each.

Students will demonstrate their knowledge of well-known theories of ethics and the NSPE code of ethics by applying them to differentiate between ethical and unethical engineering decisions.

Students will be able to argue convincingly against the statement that ethics is irrelevant because “it’s all relative.”

Students will be able to apply at least one ethical framework in the analysis of an ethical problem.

Students will be able to synthesize knowledge of ethics to generate and evaluate alternative solutions to an open-ended case study.

In their pedagogical approach, many of the participants combined presentation and discussion of moral theories and frameworks for ethical problem solving with case studies. For the introduction of ethical frameworks, several of the participants used the presentation materials from Day 1 of the workshop, while others created their own materials. Some participants chose to use existing cases such as Gilbane Gold, while others drew on their own experience to create the cases. One participant created a case study based upon her work with a physician who is developing a new device to hold breathing and feeding tubes in place on premature infants. Another drew upon his personal experience in which a public interest group applied information from his research inappropriately to construct an argument against an agricultural business.

Most participants worked on a single course, but the team from Civil and Environmental Engineering worked on a two-course sequence – a one-credit seminar on Civil Engineering profession and a capstone course. In the one credit seminar, the students are introduced to the profession of civil engineering and its practice, including social obligations and ethical challenges. The students are also introduced to the three moral frameworks and apply them to simple cases. They then use these frameworks in their senior capstone project.

The potential impact of the LTEE program on students is significant. The participants prepared ethics activities for 14 different courses: 8 senior courses, including capstone courses in CSE and

CEE, 3 required junior level courses, 1 sophomore level course, and 3 first year seminars. These courses enroll approximately 1000 engineering students annually.

Assessment

Assessment of the program includes assessment by participants at the time of the workshop, assessment of the effectiveness of the activities developed by the participants, and analysis of the processes through which the faculty designed and implemented their ethics-related activities, including the effect of their peer group, i.e., the other workshop participants. Feedback was gathered through questionnaires at the end of each day of the workshop; the feedback was very positive. The content and methods used in the workshop appeared to meet the needs of the participants, although they did have some suggestions for improvement of the use of the Gilbane Gold case and also on the discussion of assessment of ethics related activities. Several participants also commented that they had had their approach to teaching profoundly affected by the discussions of instructional design methodologies.

After the workshop, questions were developed by the Leonhard Center and Engineering Instructional Services for assessment of the impact of the planned activities on the students. These questions were used to evaluate newly designed ethics activities in two classes in Mechanical Engineering. The results of the assessment indicate that the activities were effective in raising students' awareness of the importance of ethics to engineers. For example, student responses to questions about their ability to apply ethical frameworks and codes of ethics to analyze ethical problems increased from approximately 2.8/5.0 on the pre-test to 3.7/5.0 on the post-test.

Another part of the assessment plan for these activities is an analysis of the methodologies by which the participants prepared their activities. This assessment is designed around the four frameworks for designing learning environments that are developed and discussed in "How People Learn"⁷ – learner-centered, knowledge-centered, assessment-centered, and community-centered. The intent of this part of the assessment is to understand how the program participants used the knowledge gained in the workshop to develop their course activities. Particular questions of interest include:

- Did the participants use approaches that encompass more than one of the HPL approaches to designing learning environments?
- What was the role of the community, i.e., their faculty peers and other workshop participants, in the process of developing their ethics activities?

This assessment is currently underway, and the results should be available by the end of spring semester.

Summary

The faculty development program to prepare engineering faculty to integrate ethics into their courses appears to have been successful. A key element in that success was the close collaboration of faculty in Engineering and Philosophy, which brought theory and application to

the workshop in a manner that worked well for the participants. Also, the introduction of instructional design methods appeared to be very useful to many of the participants as a design framework for their ethics related activities. Based on the success of this initial offering of the program, it will be offered on a continuing basis until the needs of all of the departments in the College have been met.

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