Creating and Measuring an Awareness of Professional Ethics

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Abstract

This paper presents an approach for creating in students an awareness of the ethical responsibilities of practicing engineers. Using a case study in professional ethics, students in a junior-level mechanical engineering design course are given two consecutive writing assignments which are the basis for four classroom discussion periods that focus on student responses to the case study. The student assignments are in addition to, and do not necessarily commingle with, the technical content of the course. The results are that the percentage of students with an understanding of ethical responsibility increases from 45% to 68% after these assignments. This approach is readily implemented by an individual instructor and can be part of a comprehensive effort to teach ethics across the curriculum. The approach should be considered an introductory component of an ethics instruction strategy where the learning objective is awareness rather than mastery.

I. Introduction

Engineering educators are obliged to introduce their students to the precepts of professional ethics. This obligation has been codified in the ABET Engineering Criteria 2000 which states, under Criterion 3(f), that “engineering programs must demonstrate that their graduates have an understanding of professional and ethical responsibility.”

In response to this need, educators can adopt a number of strategies. Among them are the following, paraphrased from Alenskis:

- A stand-alone course in ethics.
- An ethics component in a stand-alone course in professionalism.
- An ethics component in a senior project, thesis, or capstone course.
- Integration of ethics across the curriculum.
- Commingling ethics instruction in technical courses.

Each approach has advantages and disadvantages (reference 2 cites studies that investigate each of these approaches). As Alenskis states, “The issue is often how to present ethics as an important aspect of the technical profession, without hindering the learning of more technical matters.” It becomes increasingly difficult for faculty to devote time to ethics instruction given that state legislatures are imposing lower credit-hour caps on baccalaureate degrees. Another diffi-
In this paper, the author presents an approach for creating in students an awareness of the ethical responsibilities of practicing engineers as a component of a technical course, but without commingling with the technical content of the course. This approach is readily implemented by an individual instructor and so it both answers the question “What can one person do?” and avoids the issues involved with large-scale institutional efforts.

II. Method

Professional ethics data from two offerings of a single course taught by the author in Spring and Fall 1999 are included in this study. The course is MEEN 440 Mechanism Design and Analysis, a required junior-level design course in Mechanical Engineering at North Carolina A&T State University. The same case study was used in both classes. The total number of students is 43. The basic dilemma of this case study is whether or not a principal of a consulting engineering firm should violate the letter of her contract with a client in order to make known to the public the existence of a possible hazard to public safety. The potential hazard is real, but its extent is unknown. Disclosure could cost the engineer her client, future business, and a breach of contract lawsuit. Nondisclosure could result in serious injury to a bystander.

On the first day of class, students are assigned to read this case study, taken from the “Applied Ethics in Professional Practice” webpage maintained by the College of Engineering at the University of Washington. To paraphrase the website, the case studies are taken from actual practice and names and locations are altered to obscure the participants’ identities. Several (in this case, 15) solutions to the ethical dilemma are suggested. Not all of these solutions are necessarily ethical, but may represent reactions commonly found in professional practice. After reading the case study outside of class, students must select the solution they consider to be the most ethical and write a thoughtful justification of their response. This essay is two pages or less, it is graded on the coherence of the writing and the use of supporting arguments—not on the proper application of professional ethics—and is due usually in less than a week. This assignment gets the class working on a task that is important to our learning objectives even before we’ve started covering technical material.

The day the essays are turned in, the instructor facilitates a discussion of the answers students selected. The discussion period begins with a think-pair-share exercise on the topic “What ethical guidelines did your partner consider in reaching a solution?” The instructor uses the students responses to this exercise to develop a general discussion lasting about 20 minutes with the purpose of airing as broad a spectrum as possible of candidate guidelines to ethical decision making. The instructor makes no value judgements and gives no hints regarding the “correct” answer to the case study.

In a subsequent class period, the instructor returns the graded papers and discusses issues relating to writing. Students are assigned readings from the Applied Ethics webpage and from the NC State Board of Examiners webpage regarding basic precepts of professional ethics. A second writing assignment is given in which students state their previous solution, outline the reasoning
that supported their previous solution (the purpose here is to promote better writing), indicate a
new solution based on their reading (it can be the same solution as before), and write a new (and
improved) essay in support of their solution. This assignment is due in one week. Papers are
graded on the use of appropriate supporting arguments based on the reading as well as on the
clarity and coherence of the writing. Again, students are not graded on their ethics.

The day these essays are turned in, the instructor facilitates a second think-pair-share exercise on
“Did you change your mind about your solution: why or why not?”, followed by another 20
minute discussion. Again, the instructor makes no value judgements and gives no hints regarding
the “correct” answer to the case study.

The day the instructor returns these graded papers, writing is discussed and the instructor leads a
final discussion concluding with his or her own reasoning about which answer(s) is correct. If the
national survey results from the Applied Ethics webpage are known, these results are shared with
the class. If the survey results are not yet known, the instructor will lead an additional discussion
with the class at the time these results are available.

These assignments and discussion periods are summarized in Table 1. The complete process
spans the first 4 weeks of the semester and consumes about 15-20 minutes of lecture time for
each of the four discussion periods.

<table>
<thead>
<tr>
<th>Class period</th>
<th>Task</th>
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<tbody>
<tr>
<td>first day</td>
<td>Handout first ethics assignment, discuss briefly.</td>
</tr>
<tr>
<td>end of week 1</td>
<td>First writing assignment is due, think-pair-share exercise for 15-20 minutes.</td>
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<tr>
<td>end of week 2</td>
<td>Return graded essays, discuss writing, assign ethics readings and second writing assignment.</td>
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<tr>
<td>end of week 3</td>
<td>Second writing assignment is due, think-pair-share exercise for 15-20 minutes.</td>
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<tr>
<td>end of week 4</td>
<td>Return graded essays, discuss writing, discuss “correct” answers to case study.</td>
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<tr>
<td>end of week 5</td>
<td>First design project is due.</td>
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While this work has been going on, the class has had its usual technical homework and its first
introductory design project assigned. The project is due the week after the conclusion of the eth-
cics assignments. Thus students have had some practice writing, rewriting, and making coherent
arguments before the first technical written and oral presentations are due. This schedule helps
improve the likelihood that reports will be better written than they would have been otherwise.

III. Results

The data for the two classes are combined and compared to the national survey results published
online on the Applied Ethics website.

Figure 1 indicates the percentage of respondents who selected each of the 15 possible solutions
to the ethical dilemma posed in this study. The first bar in each category shows the percentage of
students selecting a particular answer as their first response, before the ethics reading assign-
ments. The second bar shows the percentage after the readings. And the third bar shows the per-
centage of the national survey respondents selecting that particular answer. The same sequence
of three bars is shown for each of the 15 possible responses.
For example, consider survey response number 6. Before the readings, 18% of students in this study selected response 6 as the best solution to the ethical dilemma. After the readings, 24% of students selected response 6. And in the national survey, 23% of respondents selected response 6.

![Percentage of votes for each response](image)

**Fig. 1: Percentage of votes that agree with each of the 15 possible responses.**

For a more telling comparison, the results from the several questions are combined according to whether or not they are consistent with generally accepted standards of professional ethics. In assessing the 15 possible responses, I use the following criteria, taken here from the Rules of Professional Conduct of the North Carolina Board of Examiners for Engineers and Surveyors: “The registrant shall at all times recognize the primary obligation to protect the public in the performance of the professional duties.” (Italics are mine.)

Based on this criterion, responses 6 and 7 are the best of the lot and responses 10 and 11 are acceptable, though flawed. The remaining responses, in my opinion, are deficient. This accounting is fairly consistent with the results of the national survey. Responses 6 and 7 account for 46% of the total (23% each) and responses 10 and 11 account for an additional 22% (11% each). Therefore, I designate responses 6 and 7 “strongly consistent with ethical practice” and responses 10 and 11 “moderately consistent with ethical practice.” All other responses are combined and are designated “inconsistent with ethical practice.”
Figure 2 illustrates the results of combining the results according to this scheme. Again, the first bar in each category shows the student percentage before the readings, the second bar shows the student percentage after the readings, and the third bar shows the national survey percentage.

In each of the three categories, student responses show a trend towards better understanding of professional ethics. Only 33% of students selected a response before the readings and discussions that was strongly consistent with ethical practice. After the readings, this percentage increased to 49%, comparable to the national survey results of 46%.

An additional 12% of students selected a first response that was moderately consistent with ethical practice. After the readings, this percentage increased to 19%, comparable to the national survey results of 22%.

Before the readings, fully 55% of students selected a first response that was inconsistent with ethical practice. After the readings, this percentage dropped to 32%, identical to the national survey results. Another way of looking at this same statistic is that only 45% of students selected a first response that was moderately or strongly consistent with ethical practice. After the readings, this percentage rose to 68%, identical to the national survey results.

**Fig. 2: Percentage of votes that are strongly consistent, moderately consistent, and inconsistent with ethical practice.**
IV. Related result from an ABET outcomes assessment instrument

As part of a new outcomes assessment procedure to satisfy Criterion 3 of EC2000, we asked students this semester (December 99) to rate the effect each course had on their abilities in 32 specific areas. In one question, students were asked, “To what extent did this course contribute to your abilities in understanding ethical responsibility?” Possible answers were “Strong,” “Moderate,” “Weak,” and “Not applicable.” Students discuss these questions in groups of three or four and reach a consensus on each question. These qualitative ratings are converted to numerical ratings—strong (3), moderate (2), weak (1), not applicable (0)—and averages are computed for each category for each course in the undergraduate program.

For the class in this study (MEEN 440), there were 16 respondents in 5 groups. The average response to the ethics question was 3.0, that is, students unanimously agreed that the course strongly contributed to their ability to understand ethical responsibility.

V. Discussion

The student essays provide a sense of the what criteria students used in selecting and justifying their answers. Among the many justifications used, several were regularly cited:

- By reporting the possible public safety hazard to the client, the engineer’s legal obligation was fulfilled.
- By obtaining a hold-harmless agreement from the client, the engineer would not be held liable in the event of an accident.
- The inspection that uncovered the possible hazard was not in the engineer’s contractual scope of work, so she had no obligation to mention it to anyone.

The common theme of these justifications is that a contract defines the full scope of one’s professional ethical obligations. Two conclusions are drawn from this result. First, students generally do not willfully select unethical responses. They believe that the engineer acts ethically if she selects a response that satisfies her legal obligations. Second, these justifications clearly demonstrate the students’ lack of knowledge of professional liability.

VI. Conclusions

Using a case study in professional ethics, students in a junior-level mechanical engineering design course are given two consecutive writing assignments which are the basis for four classroom discussion periods that focus on student responses to the case study. The student assignments are in addition to, and do not necessarily commingle with, the technical content of the course. The results are that the percentage of students with an understanding of ethical responsibility increases from 45% to 68% after these assignments.

The student essays suggest that this increase is not due to an improvement in students’ ethical standards—most of the incorrect justifications were based on an uninformed opinion of the meaning of professional ethics, in this case, the preference of fulfilling contractual obligations to
a client over the professional obligation to promote public safety. A greater number of essays
after the readings cited “public safety” in their justifications. This supports the conclusion that
this set of assignments and discussions generally increased student awareness of professional
ethics. The ABET outcomes assessment measure tells us that the students agree. Note however
that the outcome is increased awareness, not mastery, of ethical responsibility. And these exer-
cises provide students with no formal training in engineering law and liability.

Nearly one third (32%) of students still selected unethical responses after the exercise. An ap-
proach to reducing this percentage is to implement complementary exercises in subsequent
courses in the mechanical engineering program. All students would benefit from the additional
practice in making decisions consistent with professional ethical practice. Thus the exercises in
this study should be considered an introductory component of a program-wide strategy to teach
students the tenets of professional ethics.

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