

2006-1997: INTRODUCTION OF CONTEMPORARY ENGINEERING ETHICS ISSUES IN A FRESHMAN ENGINEERING COURSE

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Student Presentations on Contemporary Engineering Ethics Issues in an Introductory Freshman Engineering Course

Abstract

This paper presents summary of changes that were introduced in “ethics” instruction in a freshman year introductory engineering course at Virginia Tech. While ethics is 10% of the course content, substantial changes were made to the course curriculum in fall 2005 so that 1200 students could be better engaged in learning ethics material. Parts of these changes are attributed to an NSF supported department-level reform (DLR) project. Traditionally, ethics instruction in the course included reading assignments and video presentations. However, this year, a presentation assignment was developed for the course’s 32-seat workshops. Groups of 3 to 6 students were assigned one of eight recent topics: 1) levee construction in New Orleans 2) looting and government response in New Orleans 3) debris removal in New Orleans 4) contamination issues in New Orleans 5) rebuilding New Orleans 6) Asian tsunami of December 2004 7) San Francisco and earthquake preparedness and 8) Galveston and hurricanes. For each topic, groups were given instructions regarding subjects and questions to address. During a workshop period, each team was allowed 6 minutes to present and 2 minutes to answer questions. The main goals of this assignment were to increase freshmen students’ engagement in technical communication and teamwork and to boost awareness of current events and ethics. Surveys revealed students’ opinions and showed that the changes to how ethics is taught at Virginia Tech is well-received by many students.

1.0 Background

At Virginia Tech, all engineering freshmen enter as General Engineering (GE) students and are transferred to a degree-granting department when they have successfully completed a required set of courses. The GE program is conducted by the faculty in the Department of Engineering Education (EngE). A number of EngE faculty, including Lo and Lohani, have been collaborating with faculty members in other engineering departments and the school of education to undertake reformulation of the GE program using a spiral curriculum approach¹. This effort is part of a department-level reform (DLR) project from the NSF. One of the spiraling themes relates to “ethics.” The intended approach is to cover general ethics related topics reflecting contemporary engineering issues in the GE program and include discipline specific “ethics” issues in upper level courses. Faculty members from the Biological Systems Engineering (BSE) department are participating in this DLR project and are working with EngE faculty to reformulate the curriculum of the bioprocess option within the BSE using spiral approach. A companion paper gives brief description of BSE related new “ethics” topics that have been developed to serve the proposed spiral approach.² The present paper presents a brief summary of “ethics” related changes that have been introduced in an introductory engineering course that is a part of the GE program.

2.0 Engineering Exploration (ENGE1024)

One of the required courses in the GE program is ENGE 1024, Engineering Exploration, which is taken by about 1500 students annually. Twelve hundred of the 1500 students take the course during the fall semester. In spring 2005, Lo and Lohani took the lead in piloting a new format for EngE1024 involving one 50-minute lesson, team taught by Lo and Lohani, in a 120-seat classroom followed by one 110-minute workshop, taught by graduate teaching assistants (GTAs), in a 30-seat classroom each week. The graduate students were assisted by undergraduate teaching assistants (UTAs) in grading work and conducting hands-on activities. The principal reasons for initiating this major change are to: i) allow additional time to students to become engaged in more hands on activities during the workshop period, ii) create teaching opportunities to graduate students, iii) give students the opportunity to present and to become aware of contemporary engineering issues, and iv) collect/analyze data for conducting engineering education research. Lo and Lohani co-taught two sections (~160 students in each) of ENGE1024 in fall 2005. Details of fall 2005 implementation can be seen in a companion paper³.

The current ENGE 1024 course description is: “Introduction to the profession and the College of Engineering; foundation material in: problem definition, solution and presentation; design, including hands-on realization working in teams; modeling and visual representation of abstract and physical objects; scientific computation; algorithm development, computer implementation and application; documentation; ethics; professionalism”.⁴ Coverage of ethics in the GE program is meant to be an introduction to engineering ethics, with engineering students receiving additional ethics training in their upperclassman courses. Traditionally, ethics instruction in EngE1024 consisted primarily of a video, readings from a text, and discussions based on the video and assigned text. For several years, the freshmen students watched the National Institute for Engineering Ethics’ Gilbane Gold, which provided a fictitious example of key ethical concepts such as public safety and whistle blowing.

With significant changes to the ENGE1024 course in 2004 and 2005^{3,5}, the teaching of ethics was modified to include a new video, the National Institute for Engineering Ethics’ Incident in Morales, as well as a group presentation assignment on an assigned contemporary issue. Recent events related to hurricanes Katrina and Rita provided important topics that address engineering, engineering ethics, and contemporary issues. Following sections present the details of the new contemporary “ethics” assignments.

3.0 Details of Ethics Presentation Assignment in ENGE1024 in Fall 2005

The main objectives of this assignment were to: research a contemporary engineering ethics related topic, and ii) present the outcome of research to peers to improve in-class presentation skills. For this purpose, students were assigned in teams of 3 to 6 students, so that there was a maximum of eight teams per workshop section. The actual assignment is given in the Appendix. Each team was given instructions to perform research and to prepare necessary PowerPoint slides so that the team could give a 5-6 minute presentation on an ethics-related topic. Each student was expected to talk during the presentation and was notified that each group could expect 1 to 2 minutes of questions following the presentation. All presentations were supposed to occur during a single class period, but some sections required two class periods to finish.

Because the length of the presentations was relatively short, students were warned that they were not expected to go into great detail. However, they were given guidelines for good presentation practice. Because of the logistics of the classroom sizes, students were assigned to give presentations in the workshop portion of the course.

In order to maintain uniformity, GTAs randomly assigned each team one of the following 8 topics: 1) levee construction in New Orleans 2) looting and government response in New Orleans 3) debris removal in New Orleans 4) contamination issues in New Orleans 5) rebuilding New Orleans 6) Asian tsunami of December 2004 7) San Francisco and earthquake preparedness and 8) Galveston and hurricanes. No teams in a single workshop section received the same topic. For these eight assigned topics, students were given sub-topics to address during their presentations, as indicated below.

1. Levee Construction in New Orleans
 - a. Discuss what factors were used to design the original levee system
 - b. Discuss failure of the levees
 - c. Discuss emergency repairs being made to levees, any agency responsible for the levees, and what long term repairs/improvements are under consideration
2. Looting and Government Response in New Orleans
 - a. Discuss looting that occurred during days following Katrina
 - b. Discuss initial police response to looting and how the response to looting changed over time
 - c. Identify two specific looting cases and analyze them using moral theories.
3. Debris Removal in New Orleans
 - a. Discuss general types of debris (i.e., hazardous waste, fallen trees, etc.) that must be removed and concerns with removing each type of debris
 - b. What is currently being done with debris, and what options have been explored to handle debris?
 - c. What factors should be considered to determine order of debris removal? Whose (government, businesses, residences, etc.) debris should be removed first, second, third, etc. and why?
4. Contamination Issues
 - a. Discuss types of contaminants (i.e., animal/human waste, fuel, etc.) and concerns with each type
 - b. Describe current plans to deal with contamination and possible long term effects
 - c. Should residences and buildings be constructed in areas where contamination may exist?
5. Rebuilding New Orleans
 - a. Describe types of local industries in New Orleans and their relative importance on a national and/or international level
 - b. Discuss factors being considered in the reconstruction of the city
 - c. Should New Orleans be rebuilt? Why or why not?
6. Asian Tsunami on December 26, 2004
 - a. Briefly describe what happened during and as a result of the tsunami

- b. Discuss reconstruction that has occurred in affected countries and how the tsunami has impacted warning systems, livelihoods, construction, etc.
 - c. Describe roles that engineers have assumed in assisting with tsunami-relief and reconstruction efforts
7. San Francisco and Earthquakes
- a. Briefly describe what happened during the San Francisco Earthquake of 1906, what changes (i.e., legislative, engineering, etc.) were instituted as a result of the earthquake.
 - b. With recent events in New Orleans, there has been increased emphasis on San Francisco. How prepared is San Francisco to deal with a large earthquake? What is being done to better equip the city to deal with an impending earthquake?
 - c. Discuss advantages and disadvantages to building structures on land created by filling in waterfront with soil. If people are hurt during an earthquake in these landfill areas, who is ultimately responsible?
8. Galveston Hurricane of 1900
- a. Brief description of what happened during the 1900 hurricane and the aftereffects, what changes (i.e., legislative, engineering, etc.) were instituted as a result of the 1900 hurricane, and how technology (communication systems, weather modeling and tracking, etc.) has changed our ability to cope with hurricanes since the early 1900s.
 - b. How prepared is Galveston to deal with a category 5 hurricane? Discuss recent events related to Hurricane Rita.
 - c. During a mandatory evacuation, should residents be forced from their homes if they understand the possible consequences?

Student groups were expected to provide at least three references reflecting their research efforts. It was assumed that students would use the internet for a significant part of their research component and were thus reminded that they would have to discern facts from opinions when using the internet. Also, it was recognized that a group might not be able to come to a single consensus regarding viewpoints. As such, students were informed that a group could present multiple views in this situation. Groups were asked to formulate answers to discussion questions in a well-thought out manner, based on solid reasoning. In addition, they were asked to apply and discuss appropriate moral theories, giving reference to Chapter 2 of their Holtzapple and Reece's Concepts in Engineering⁶ text wherever possible. The authors felt that some topics needed students to provide a historical perspective. Some topics (such as earthquake preparedness) also presented an opportunity for students to explore legislative effects. So, in effect, not all presentation time was designed to concentrate ethics. Students were asked to do more than merely report facts; they needed to reflect on and discuss at least one ethical issue during their group's presentation.

4.0 Assessment

In order to facilitate grading for the GTAs and to give students an understanding of the expectations for the assignment, a grading rubric was distributed to the affected parties. The rubric based grading on the following areas: (1) preparedness to present (2) topic coverage (3) graphical presentation (4) oral presentation (5) ability to present within the assigned time limit

(6) addressing audience's questions (7) references. A significant portion of the grade was based on the presentation itself, to enforce the fact that it was not only ethical content but technical communication that was important. This was one of two formal presentations that students were required to give during their first semester of engineering study. The actual grading rubric is given in the Appendix.

Following the presentations, students were asked to give their opinions on the assignment and the manner to which they prefer to learn ethics. This was done using: i) instant clicker-based questions asked during the lecture, ii) survey questions based on the presentation assignment, and iii) exit survey questions that were asked at the end of semester. Sample responses are given in the sections below.

It is important to note that the data collected is baseline data.

4.1 Clicker-based Feedback

Students were required to purchase and to use eInstruction radio frequency response pads (clickers). Clickers allowed instructors to collect and to discuss immediate feedback. Clicker feedback is based on approximately 100 student responses. These clicker questions were asked towards the end of the semester, after all components of ethics instruction was completed.

Clicker question: How do you prefer to learn ethics?

1. Readings (e.g., case studies from text) (15%)
2. Presentation assignment (e.g., group presentations on contemporary ethics topics) (6%)
3. Video (e.g., Incident at Morales) (36%)
4. Lecture by instructor (4%)
5. Discussion with instructor and classmates (17%)
6. All of the above (11%)

Clicker question: How prepared do you feel to cope with an ethical dilemma in the workplace?

1. Very prepared (34%)
2. Somewhat prepared (46%)
3. Somewhat unprepared (5%)
4. Very unprepared (6%)

4.2 Feedback from student surveys regarding presentation assignment

Feedback from these surveys was based on responses collected from 150 students. Although there were many different responses, below is a sample of the more commonly stated responses.

Question 1 from student survey: Regarding the ethics presentation assignment, what was the most valuable aspect of participating in the assignment?

Learning more than what I had previously heard in the news/feeling more aware (35 responses)

Working in groups (33 responses)

How ethics can be applied to real life situations (25 responses)

Doing research (9 responses)
Practice with public speaking (8 responses)

Question 2 from student survey: What changes do you suggest to improve the ethics presentation assignment?

No changes/ fine as is (29 responses)
Extend presentation time limit (26 responses)
More topics to choose from, not so many on New Orleans (17 responses)
Allow more time for preparation (8 responses)
Do not have presentations due at the same time as other projects (8 responses)
Require that groups address more ethics in presentation (7 responses)
Require that groups specifically address engineering in presentation (6 responses)

Some sample quotes from students are given below:

It helped me understand the actual impact ethics had in the construction of every object in the world.

The topics were real, and the fact that they were not “made up” let the students use morals and good judgment to compete the project.

I learned things about ethics in engineering that can't be learned from defining it during a lecture.

I learned all the different factors I was going to have to deal with. Basically I had no idea how many factors were involved in making ethical decisions.

Longer amounts of time for presentation as there is lots of interesting info!!

Real ethical issues would be nice. These were more like contemporary issues with ethics as an afterthought.

Learn about the problems engineers face w/ the realization that big mistakes are sometimes made.

You get to learn about the morals valued in the real world and how to work with other people in an engineering [project].

Was being able to place ourselves in the situations that occurred and learn about ethics decisions made and what all exactly had to be taken into account to take action.

Learning how to sift thru thousands of useless websites to find the two or three that are useful.

Since we worked with our sustainable design groups, it gave us a chance to work on a different project with the same people. We saw new sides to our group members (new strengths and [weaknesses]).

Ethics may not seem important on paper and a relatively easy idea, but seeing it being considered in a recent event shows how essential the topic is. Knowing something and will be a factor in everyday life provides incentive for further study as well as independent study outside of the classroom in other fields.

4.3 Feedback from Exit Survey

An end of the semester an exit survey was conducted, with responses collected from 900+ students. One of the exit survey questions was: “Has your awareness of professional ethics increased as a result of ENGE 1024?” Figure 1 shows histogram of the responses:

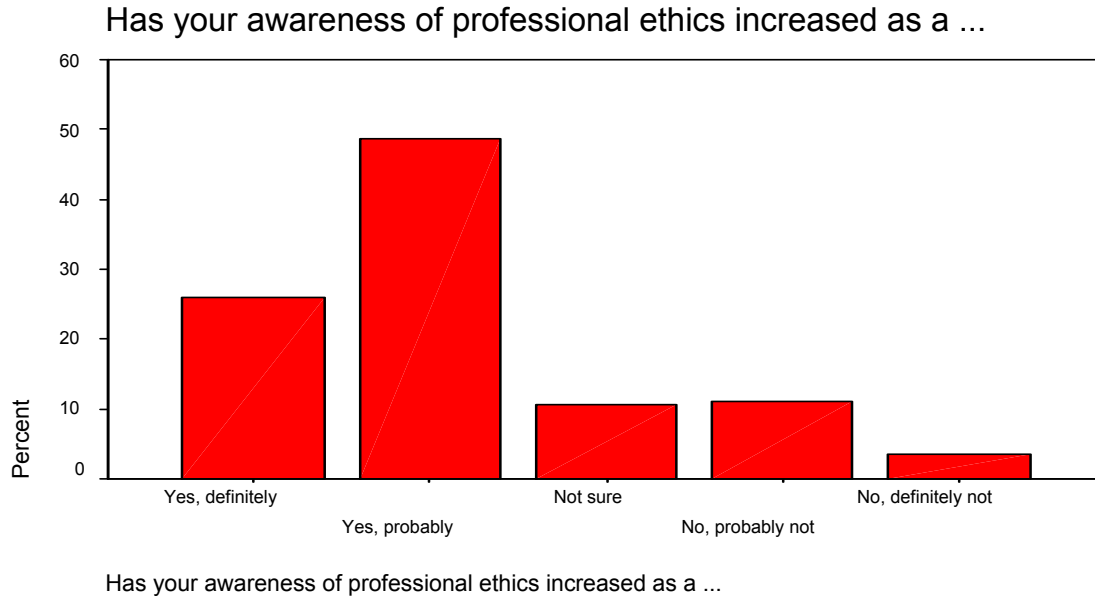


Figure 1: Exit Survey Response to Ethics Related Question

It can be seen in Figure 1 that about 75% students seemed to have made gains from the ethics assignments discussed in this paper. Another ethics related question on “exit survey” was a free response question that read: “What, if anything, did you learn in ENGE 1024 that you didn't expect at the beginning of the semester?” A few sample responses are given below:

I learned a lot concerning ethics and sustainable design which I did not expect to be the primary focus of EngE 1024.

I learned that ethics played a major part of then engineering field.

I didn't expect to learn the ethics behind Engineering at all. However, I did enjoy reading about incidents and how they can be prevented.

I didn't expect to learn about professional ethics at the beginning of the semester. I learnt about the ethical obligations that engineers as professionals have towards society.

I feel like I can work with people better than I used to and can deal with juggling numerous tasks all at once.

I didn't expect to learn about ethics in engineering. The sustainability design project took me by surprise as well.

I learned a lot about working in groups. This is something that I didn't think would be covered but I found to be very useful.

The way to be a better team player when first thrown into an environment where you do not know anyone!

Ethics materials covered was very helpful for me, since it is very important issue when I start working in the industry.

I didn't really expect to learn anything so I wasn't surprised.

I kind of feel like this class was a waste of my time.

The importance of ethics in engineering, the role of teamwork and being able to solve problems.

I didn't expect to learn about ethics in engineering, which came as a pleasant surprise.

That engineers face so many ethical dilemmas in their work.

I learned that engineering was a lot more than just building stuff. It turns out to be a good engineer, one has to understand ethics, economics and more.

I [didn't] think it would make us do so many [PowerPoint presentations] like the ethics one.

Most of those seemed like wastes of our time.

5.0 Future Work

Future work will include modifications to the existing presentation assignment as well as continuation of data collection and analysis. For some of the eight presentation topics, it was suggested that the ethical aspect needed to be more explicit. For example, for levee construction, students might benefit from address tradeoffs between cost and public safety.

Performing statistical analyses of the data collected as part of the assessment process. The data collected will be used as baseline data for ongoing studies. These studies include monitoring ethical training of students who progress through the Biological Systems Engineering program at Virginia Tech in the next few years and comparison studies to future ENGE1024 populations.

6.0 Summary

This paper presents a summary of changes that were introduced to incorporate contemporary ethics issues in an introductory engineering course. Student responses indicate that students appreciated learning more about a contemporary issue, having a team experience, seeing ethics in a real life situation, and getting to engage in public speaking. To improve the presentation assignment, student feedback indicates that preparation time should be increased, the amount of time to present should be increased, and more topics should be made available. Based on feedback from students, it can be concluded that contemporary issues based engineering ethical issues can be an effective method to impart basic ethics instruction to students.

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Appendix

Actual assignment given to students:

ETHICS PRESENTATIONS

Recent events related to hurricanes Katrina and Rita provide important topics that address engineering, engineering ethics, and contemporary issues.

Your group is to do the research and preparation necessary PowerPoint slides to give a 5-6 minute presentation on an ethics-related topic. Each student is expected to talk during the presentation. At the end of the six minute limit, your GTA will stop your presentation if necessary. Expect 1-2 minutes of questions following the presentation.

Your GTA will assign your team one of the 8 topics listed below. Your group's PowerPoint presentation should address the subjects/questions outlined under your group's assigned topic. Some of these topics address complex issues; you are not expected to go into great detail. Remember that you only have a maximum of 6 minutes. Please make sure your group has its presentation on one group member's computer and also on a flash stick (in case the computer malfunctions).

Good presentation practice suggests that each slide (except for the introduction and references slides) should take you at least 1 minute to cover; this means that you should have no more than

8 slides total. Your group is required to have at least three references; these references should be listed on the final slide of your PowerPoint presentation. Note that many of the Web sites may be presented information from a particular point of view; your group's task will be to discern facts from the opinions as necessary.

If your group cannot come to an agreement about the response to certain questions, your group may present multiple views.

Answers to discussion questions should be well-thought out and based on solid reasoning. You should apply and discuss appropriate moral theories (see Chapter 2 of your Hotzapple text) wherever possible.

Deliverables during workshop:

1. Group presentation addressing above requirements
2. Hardcopy of your group's PowerPoint presentation (max. of 8 slides)
3. Cover/grading sheet (at end of this document)

Topics:

1. Levee Construction in New Orleans

- a. Discuss what factors were used to design the original levee system
- b. Discuss failure of the levees
- c. Discuss emergency repairs being made to levees, any agency responsible for the levees, and what long term repairs/improvements are under consideration

2. Looting and Government Response in New Orleans

- a. Discuss looting that occurred during days following Katrina
- b. Discuss initial police response to looting and how the response to looting changed over time
- c. Identify two specific looting cases and analyze them using moral theories.

3. Debris Removal in New Orleans

- a. Discuss general types of debris (i.e., hazardous waste, fallen trees, etc.) that must be removed and concerns with removing each type of debris
- b. What is currently being done with debris, and what options have been explored to handle debris?
- c. What factors should be considered to determine order of debris removal? Whose (government, businesses, residences, etc.) debris should be removed first, second, third, etc. and why?

4. Contamination Issues

- a. Discuss types of contaminants (i.e., animal/human waste, fuel, etc.) and concerns with each type
- b. Describe current plans to deal with contamination and possible long term effects
- c. Should residences and buildings be constructed in areas where contamination may exist?

5. Rebuilding New Orleans

- a. Describe types of local industries in New Orleans and their relative importance on a national and/or international level
- b. Discuss factors being considered in the reconstruction of the city
- c. Should New Orleans be rebuilt? Why or why not?

6. Asian Tsunami on December 26, 2004

- a. Briefly describe what happened during and as a result of the tsunami
- b. Discuss reconstruction that has occurred in affected countries and how the tsunami has impacted warning systems, livelihoods, construction, etc.
- c. Describe roles that engineers have assumed in assisting with tsunami-relief and reconstruction efforts

7. San Francisco and Earthquakes

- a. Briefly describe what happened during the San Francisco Earthquake of 1906, what changes (i.e., legislative, engineering, etc.) were instituted as a result of the earthquake.
- b. With recent events in New Orleans, there has been increased emphasis on San Francisco. How prepared is San Francisco to deal with a large earthquake? What is being done to better equip the city to deal with an impending earthquake?
- c. Discuss advantages and disadvantages to building structures on land created by filling in waterfront with soil. If people are hurt during an earthquake in these landfill areas, who is ultimately responsible?

8. Galveston Hurricane of 1900

- a. Brief description of what happened during the 1900 hurricane and the aftereffects, what changes (i.e., legislative, engineering, etc.) were instituted as a result of the 1900 hurricane, and how technology (communication systems, weather modeling and tracking, etc.) has changed our ability to cope with hurricanes since the early 1900s.
- b. How prepared is Galveston to deal with a category 5 hurricane? Discuss recent events related to Hurricane Rita.
- c. During a mandatory evacuation, should residents be forced from their homes if they understand the possible consequences?

Copy of Grading Rubric

Ethics Presentations
Grading Sheet

Names of group members: _____

Day and Date: _____

GTA: _____

Presentation	Description	Points	Comments
-Preparedness (10 pts)	Group was prepared to present on time		
-Topic coverage (20 pts)	Group addressed subjects and questions for their assigned topic.		
-Graphic Presentation (20 pts)	The presentation was clear and well organized. The audience was able to easily follow along, graphics and text supported the topic without being distracting		
-Oral Presentation (20 pts)	Students were clear and addressed the audience, made eye contact and spoke in an audible tone.		
-Time Limit (10 pts)	Students were able to complete their full presentation in 6 minutes.		
-Questions (10 pts)	Students answered the audience's questions adequately, was respectful of the audience.		
-References (10 pts)	Students listed at least three references.		
Total Score	<i>out of 100 points</i>		