

ENGINEERING

ETHICS

EDUCATION **STUDY**
ETHICAL

STUDENTS

ASSIGNMENT **METHOD** **ISSUES** **TEACHING** **COURSES** **STUDIES** **CASE** **CLASS** **SOCIETY** **MANY** **STUDIES**

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Engineering Ethics Education

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Introduction

Due to the impact of their work on society, engineers have an ethical responsibility for its safety and welfare. Although codes of ethics, such as the BMES code of ethics, and industry exposure are invaluable in guiding ethical behavior, universities have the potential to provide students with effective frameworks for identifying and navigating ethical situations. Yet many engineers graduate with a lack of awareness in ethics. Two ways ethics education can be incorporated in a university curriculum are through required courses or integrated in courses across the curriculum. Most programs do not have the resources to offer stand-alone courses to all students, thus they must utilize an across-the-curriculum model. However, these efforts are hindered by a lack of resources for instructors of technical courses.

Purpose

The goal of this handbook is to aid instructors in incorporating ethics into an engineering curriculum in an effective and engaging manner. It contains necessary information and resources for implementing case study based ethics assignments. The two focused on are the Point-Counterpoint strategy and the Analysis Method strategy, both developed from research and best practice in the fields of ethics education and engineering. The following pages cover the uses of cases studies and the development of these learning strategies. Further, the learning outcomes and requirements for these strategies are covered. Finally, the guide to implementing these strategies and the resource needed are given.

Preface:

The following work stems from a student project at Worcester Polytechnic Institute. This project is found as a report as an Interactive Qualifying Project. The title of the project is Ethics in Engineering Education.

Learning Outcomes and Requirements**Which strategy works best?**

Each of these learning strategies allow for different outcomes from students and have different requirements and situations where they function most efficiently. The question of which works best is entirely based on what outcome is desired for the students and the abilities of the environment they are implemented in. Depending on the desired outcomes and limitations of implementation, these strategies can be decided between.

Learning Outcomes**Point-Counterpoint**

The learning outcomes for students in the point counter point strategy are to learn about how to think about an ethical issue and how to create reason based supporting arguments. The focus of the strategy is for the students to learn about one ethical issue, through arguing for both sides to its solution and discussion it with other students. Through doing this the students will learn about the presented ethical issue and how to think about an ethical issue. Students will not have to rely only on their bias and feelings, and instead allow them to expand their viewpoint on the issue.

Analysis Method

The learning outcomes for students in the analysis method are to learn how to break down complex sets of many ethical issues and analyze them for solutions. The focus of the strategy is for students to approach a case study of multiple ethical issues, similar to how they will face problems in their career. Through doing this, the students will learn about the presented complex set of ethical issues and the skills of ethical issue analysis that their future career will require.

Strategy Uses and Requirements

Point/Counterpoint

- Requires only a small amount of introduction time in or outside of class
- Student work is short
- Debate can be done between 20 to 60 minutes
- Each implementation of the strategy works with one ethical issue from the examined case study
- Focuses on teaching basic ethical issue thinking process

Analysis Method

- Requires only a small amount of introduction time in or outside of class
- Student work is long, depending on number of issues examined in case study
- Debate can be done between 20 to 60 minutes, depending on number of ethical issues examined
- Each implementation of the strategy works with one case study of multiple ethical issues
- Focuses on students understanding an entire situation of many ethical issues and teaching ethical issue analysis skills

Strategy Implementation Guides

Point/Counterpoint

Goal of the assignment:

Inspire familiarity with an ethical issue presented in a case study. This will be useful in teaching the benefits of being unbiased in analysis and discussion of ethical issues. Students will develop a skill of looking at both sides of an argument, helping them be more open-minded. For this assignment, an issue will be presented and the students are required to create a supporting

argument for both sides as to how to solve the issue.

Implemented Point vs. Counterpoint Example:

A test run of the point counter point method was done in a biomechanics course. Students were given pre-assignment questions before the case study was given to get an idea of their standing on human testing. A case study on a running experiment was given to the students. The case study talked about an athlete who was performing a test where the subject would sprint forward and make a sudden turn afterwards. During one of the trials, the athlete sprained his ankle. The data from the ankle sprain generated different results from what researchers previously thought from data obtained from testing on cadaver ankles. The case study itself did not present ethical issues. However, a scenario was created based on the findings from the article. The students were asked, if they were working for a company and their boss asked them to run the same test to obtain more data to potentially develop a better ankle support to better prevent ankle sprains, would they continue the testing? The ethical issue here is that the researchers intentionally want the subjects to sprain their ankles. After the assignment was completed, a feedback survey was given to students for their ideas on the assignment.

An example of the expected student response can be seen in Appendix C of the full report. This example is based from the biomechanics trial run test of the Point/Counterpoint strategy.

Results of example:

From our results, there were 35 students that said they would continue the testing and 36 students who said they would not. After the assignment, 20% of the students changed their initial decision for the case study. The students liked the point counter point method because it allowed them to see the perspectives from both sides of the argument and analyze the pros and cons of each. This allowed some of the students to strengthen their initial arguments. Some students felt that the discussion was helpful in showing them some points that they did not think of initially.

Assignment Development and Instructions for Educator:

Case Study Criteria:

- Pick a single ethical issue to focus on.
- One that is capable of polarity so it will be useful for discussion. (both sides have a good argument)

Sources for Case Studies:

- Online databases
- Academic articles

- If the article itself does not pose a debatable question, pose one to the students based on the discussion in the article.
- Personal experience in the field

Summary of Assignment:

Assignment steps:

- Find appropriate case study
 - Use case study criteria. Create a summary for the issue presented in the case for students.
- Read Assignment
 - Present Students with assignment summary and assign it for them to read
- View 1 Argument
 - Assign students to decide on which view they find correct and defend it as assignment 1.
- In-class Discussion
 - Hold a discussion and have students discuss their thoughts on chosen solution and discuss argument with other students. Explore other observations and points-of-view for further analysis of the cases' ethical issue.
- Opposite View Argument
 - Assign students to create logical and structured argument to defend the opposite view than the one they originally chose.

*Optional Final Step

- Feedback questions
 - Assign students to answer questions to give context to the assignment, including how useful they thought it was, what they think would have improved it, and how their understanding of the ethical issue and ethics in engineering has changed.

Assignment Guidelines:

In-class Discussion

- Have students express their observations and arguments on the issue
- Add any additional important arguments or points for both sides of the discussion
- Important suggestions:
 - If a majority of the class is defending one side of an argument, you must act as devil's advocate by trying to get more students to switch arguments so that the debate is evenly distributed.
 - Make a list of the argument points for each side so that if any are missed, you can bring them up to students.
 - If the discussion is dying down, try proposing other factors to affect the

debate and enhance participation

- Try to be a mediator, allow students to debate directly with each other
- As students make arguments, write them somewhere so that all students are able to visualize what different arguments are being made

Grading Criteria:

For grading purposes, the main components for a completed assignment:

1. Participation in class discussion
2. Logical arguments in assignment, no right or wrong argument
3. Both student arguments are fully supported

Analysis Method

Goal of assignment:

The goal of this assignment for the students is for them to successfully take a very complex case study, apply this method, and therefore break the issue down into all of its different factors and ethical issues. They should do so in such a manner that the issues can be analyzed, and solutions can be derived, evaluated, chosen, and discussed.

Analysis Method Example

The analysis method was also implemented as a trial run in the same biomechanics course. Students were given a case study and the analysis method to analyze the case study. The case study was about Johnson & Johnson launching a new metal hip implant in Europe because it was rejected by the FDA. However, there were high rates of failure in the implant and the company did not recall the device until after 3 years being on the market, despite warnings from doctors. The main ethical issue in this case study is the amount of regulation that medical devices must have because if more regulation is needed, it will take a lot more time for better medical devices to come onto the market and the cost of them would increase. After the assignment, the students discussed in class their ideas and a feedback survey on the assignment was given at the end.

An example of the expected student response can be seen in Appendix D. This example is based from the biomechanics trial run test of the Analysis Method strategy. In this case, the strategy was simplified, such that the students were required to identify all the ethical issues they could, and then pursue the remaining steps for just one of the issues.

Results

From the results for the analysis method, there was a 92% response rate from the students even though the assignment was relatively long. Many students wrote 2-3 pages for the assignment which was worth only one percent of the final grade. Also, 79% of the students said that they would definitely keep a copy of the analysis method and use it in the future. The students felt that the analysis method was helpful in organizing their ideas for a more complex case study that can contain multiple ethical issues.

Assignment Development and Instructions for Educator

Case Study Criteria:

- pick a case study with multiple issues
- Issues should have more than one solution and each have pros and cons

Sources for Case Studies:

- Online databases
- Academic articles
 - If the article itself does not pose a debatable question, pose one to the students based on the discussion in the article.
- Personal experience in the field

Summary of Assignment:

Assignment steps:

- Find appropriate case study
 - Use case study criteria. Create a summary or give students original article.
- Introduce Assignment
 - Present students with analysis method and case study (Refer to Appendix B for the Analysis Method Steps). Briefly go over the steps of the analysis method in class
- Analysis Method
 - Have students use the analysis method on the case study given
 - If time is an issue, students can be asked to use the method for only one issue
- In-class Discussion
 - Hold a discussion and have students discuss their thoughts on the issue they picked and their solution for that issue with arguments defending it.

***Optional Final Step**

- Feedback questions

- Assign students to answer questions to give context to the assignment, including how useful they thought it was, what they think would have improved it, and how their understanding of the ethical issue and ethics in engineering has changed.

Grading Criteria:

For grading purposes, the main components for a completed assignment:

1. Participation in-class discussion
2. Logical and complete arguments in assignment, no right or wrong argument
3. All six steps from the analysis method were used and student demonstrated use of all of its guidelines, as appropriate

Assignment Development Resources

Designing and Using Case Studies

A case study can be created from many different sources. Of course, there are case study databases; however, a case study can be from any situation or article that poses interesting issues for analysis. For example, the case study used for assignment one in class was derived from an experiment conducted in a laboratory. The report details the execution of a running test. In one test, an athlete sprained his ankle, and the data, after examination, showed the accepted model for ankle sprains may be incorrect. The researchers found that the ankle sprained differently than previously proposed. From this article, an ethical question was created in which your boss has asked you to continue the experiment with the goal of observing more ankle sprains for increased amounts of data for analysis. This statement introduced an ethical issue and directed the article from a purely academic article into an ethical case study. To see the full case study given to the class, refer to Appendix A.

Case studies can also be found in online databases such as Online Ethics Center or Ethics Education Library. These are just two of many resources found online where case studies on any subject can be found. For very specific classes, it can be difficult to find specific relevant case studies. An example to solve this problem comes from case study assignment 2. The basis for the case study was an article explaining the Depuy ASR metal hip implant. There were major problems with the implant and many ethical issues and debates are presented in this article. This article served as a base to form a case study assignment. With clear instructions to focus on ethical issues, many articles can be seen as case studies. One major key to picking a case study is it needs to be interesting to students, and it cannot be one sided. If the case is non-polarizing and most students choose one side of the argument, it will not be very effective for discussion. However, if the case allows for different views and debate, it will engage students more, and thus the education would be more effective.

Potential Ethical Topics

The following topics can be used in Biomedical Engineering classes as topics for the above stated methods.

Topics for Biomedical Engineering Applications:

- Compassionate care
 - Are drug companies obligated to provide compassionate care?
- FDA regulation
 - Over/Under Regulation?
- Human Testing
 - Knowledge for greater good vs. harm to individual
- Whistle blowing
 - Risk of being ostracized vs. doing the right thing
- Consent
 - How informed do patients need to be of side effects and hazards of experiments?
- Human Cloning
 - Organ Harvesting
- Gene Therapy
 - Effect of giving patients cancer
- Neuroethics
 - Should we allow the manipulation of the human brain and to what extent?
- Authorship
 - Who gets 1st authorship?
- Data Fabrication
 - Is it okay to omit data that will prevent funding even though you know that the data is wrong?

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