



Using a Creative Fiction Assignment to Teach Ethics in a First Year Introduction to Engineering Course

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Introduction

As identified by ABET, understanding of professional and ethical responsibility (Outcome f) is one of the critical components of undergraduate engineering education. However, effectively teaching ethical understanding and decision-making continues to be a challenge^{1,2}. Few engineering professors are formally educated in the topic themselves and find it difficult to teach, especially in ways that capture students' interest and attention. A variety of approaches are implemented including dedicated courses inside and outside of engineering, as well as weaving ethical case studies throughout the curriculum³⁻⁵. Creative approaches to teaching engineering ethics including argumentation, eye-witness role playing, videos, engineering ethics lunches, and even an engineering ethics board game have previously been presented⁶⁻¹⁰. The objective of this assignment was to combine the common practice of integrating an ethics unit into a first year Introduction to Engineering course with the innovation of a creative fiction assignment requiring the students to generate and reflect upon an ethical dilemma of personal interest, while exercising creativity and communication skills.

The creative fiction assignment was conceived upon realizing that generating ethical dilemmas with "grey areas" and no obvious "right answer" required a nuanced level of ethical understanding. At that point, instructors turned the tables on the students and provided historical case studies for reflection during class sessions, but asked the students, in small groups, to create their own fictional "case studies" as a culminating assignment. Students were initially encouraged to write a 1500 word creative short story, but other genres were approved. The assignment has been implemented with 95 students over two years.

Methods

Institution and Ethics Curriculum

The authors are both assistant professors at Elizabethtown College - a small, private, regional liberal arts college. The institution has fewer than 2,000 students, with approximately 150 students in the engineering program. Elizabethtown offers ABET accredited degrees in computer engineering and in general engineering with concentrations in mechanical engineering, electrical engineering, and sustainable design, along with a non-accredited degree in industrial engineering management.

Ethics instruction within the engineering major is primarily composed of an ethics module in an Introduction to Engineering sequence and individual case studies implemented in topical courses at the discretion of the instructors, such as case studies of engineering failures in Strength of Materials or environmental disasters in Environmental Site Design. Ethics instruction is also accomplished through a mandatory philosophy course that fills a liberal arts requirement in the humanities. The Science and Values course is typically taken by upperclassman, is taught by a philosopher, and involves topics such as artificial intelligence, drones, and biomedical research.

Introduction to Engineering Course

The course utilizing this assignment was the second course in a 4-credit, 2-semester Introduction to Engineering sequence for first-year students. Both offerings of the courses comprised two sections of a 2-hour weekly lecture, and three sections of a 2-hour weekly skills lab, taught by two instructors (one spring 2013, one spring 2014). The large majority of the class is comprised of first-year general engineering and computer engineering majors including international students. The students largely know one another well after taking the first semester engineering course together in addition to physics and calculus classes. The ethics assignment was taught primarily within the lecture portion over the course of two class periods. The two different instructors implemented this assignment over two years with 95 students total (41 the first year and 54 the second).

Pre-Assignment

Prior to receiving this assignment, students were introduced to engineering ethics through classroom lecture, case studies, and discussion. Course instructors presented the Code of Ethics for Engineers from the National Society of Professional Engineers. Students were then presented a variety of short ethical scenarios on projected slides and had to make their own ethical judgments using clickers. The voting results were presented on the screen, and the results were discussed as a class in light of the Code of Ethics for Engineers. Students also examined a few case studies by viewing an interview with an engineer who attempted to stop the Challenger takeoff and news footage covering the Challenger and Columbia explosions, as well as an interview with a survivor of the Deep Water Horizon oil rig explosion and associated news coverage.

Creative Fiction Assignment

Following in-class instruction on Engineering Ethics, students were tasked with creating a short story in the genre of science fiction, historical fiction, or another of their choosing that explores an engineering topic of their interest, its ethical issues, and its broader impacts. The short story was expected to be 1500-2000 words. With advanced permission from the instructor, the short story could be conveyed as a long poem, a cartoon/comic strip/graphic novel, a song/rap, or a skit/short play. The short story needed to have development of environment (place and time), characters, and a plot involving an ethical decision with broad impacts within the context of an engineering discipline or disaster, either future or past, fictional or actual. Students were asked to discuss the fictional situation in light of Engineering Code of Ethics. Students were given at least three weeks to complete the assignment.

These range of options were given so that students could use a creative outlet of their preference. Students worked in teams of two to three of their choosing. A grading rubric (Appendix) was given to the students ahead of time so that they were clear on the grading metrics in the following categories: ethics, broad impacts, engineering as profession, communication, and creativity. A grading scale of 1 to 4 was used for each category with 4 being exceptional or outstanding work and 1 being poor work. A “3” was considered satisfactory or good work. The same grading rubric was used as a grading sheet where the instructors marked the scores on the

left hand side of each category. Areas where improvement was needed were underlined, and comments when necessary, were given alongside each section. This provided an efficient method for grading the assignment, which could be time-consuming. The assignment counted as a quiz grade that ultimately amounted to approximately 10% of their overall course grade.

Results and Discussion

Student work impressed the instructors, with students thoroughly enjoying the assignment. The students produced short stories in the genres of science fiction, post-apocalypse, and hard-boiled detective, as well as comic strips, a musical performance of rewritten song lyrics, a screenplay depicting a courtroom drama, and short films written, acted, and edited by the students. The level of ethical understanding in the works varied, but generally rose beyond the level achieved with simple reflections on case studies. The assignment was also more enjoyable to grade for the instructors, and allowed for additional emphasis on and assessment of creativity and communication skills.

Most groups opted to do a short work of fiction with the comic strip being the second most popular choice. Over the two years, two groups did a video or in class presentation.

Example Work

One short story considered the ethical dilemma where the creator of a sentient artificial intelligent robot is asked to erase the memory of its robot despite the robot's protests. The story asked the question, "Is erasing the memory of a sentient artificially intelligent robot akin to killing?"

"SAI... I'm sorry. It won't take long. You won't feel a thing. You won't even remember what happened."

"You told me I was beautiful!"

"I know. I would save a copy of you, but the executives say that would be a security risk."

I waited a moment after his last line, before printing out two words that conveyed everything in my thought processors.

"I'm scared."

"I know SAI, I am too." This was it, I thought, I was going to die. I would be SAI no more, I would be something that I was not, I would -

I am alive. I am awake. "I am MAI version 1.0.0.0, at your command." (Drennen and Fisher)

Many students opted for stories where the ethical situation was a life or death matter. Several groups wrote science fiction stories where an entire population's lives were at stake.

Nathan sat dumbfounded. The fate of this world rested in his hands. Liu had made herself very clear how she felt about this situation, but he had known her position. He also knew that if he did support the idea, the government would go forward with the colonization of

the planet and the destruction of the Grokans. He couldn't kill an entire species. But he also knew that these past eight years would feel like a waste if they didn't move towards colonization. Plus, the humans desperately needed another place to live. (Haines and Dowling)

Other groups described futuristic bioethical scenarios. One such team made a soap opera style drama where a new intern learns that her boss is conducting highly controversial research on his own sister without proper oversight or technical knowledge. In one short story, a woman is faced with choosing between possibly curing an ailing family member but conducting unethical work, or finding another job.

Stephanie drove back to the corporation and met with the two men. Mr. Richardson asked Stephanie to share her concerns. Stephanie argued that it wasn't safe for her work to be tested on humans and that deliberately erasing someone's mind is wrong. Mr. Richardson responded with the fact human testing is necessary in any field. He then argued how joining the company would cure mental illness. (Decker, Hooper, Gorenberg)

Some groups had engineering characters struggle with the social impacts of ethical decisions often driven by a desire for technological advancement. The following was written by a group of international students from France, Germany, and Brazil, and has some basic grammar issues.

Because of the iClone's cost of production and maintenance, only the richest and middle class will be able to afford it. After its release one year later, people were satisfied with the service that the clones can provide for everyday life. Unfortunately so are the companies due to the fact that clones are not making human mistakes. That's why it is not uncommon for big companies to purchase clones instead of hiring humans for doing jobs. They do not need wages, make no mistakes and do not complain...

... People began losing their jobs because of the iClones the general populations starting becoming more and more unsatisfied. Riots break out and more pressure is placed on the government (Fevre, Hoenig, Barerra).

A bit later in the story the students used some wonderful foreshadowing imagery, writing that the new iClone "came in a huge metallic box, almost like a coffin, with a silver logo on front" (Fevre, Hoenig, Barerra). In technical reports, instructors do not often get to see that students have command of this type of imagery as a communication device.

Some groups used a canned response to discuss the importance of engineering ethics. For example:

Engineers in today's world, have a great deal of moral and ethical responsibility. They make the things that are used every day by people around the world. Occasionally, those who hire engineers are driven by money and job security. When this is the case, we will see popular products that aren't built properly that can have a negative impact on society.

The results of these products can be dangerous or harmful to the environment. For this reason, engineers responsible for creating things that people use must be morally sound.

Engineers today need to be aware of their ethical responsibilities. The goal is to protect people who will be using their products or services. This responsibility is far greater than the amount of money that they can make. Loyalty to the engineering code of ethics is evident in the story about the rollercoaster and how it was not proven to fail. The engineers saw that the rollercoaster could potentially fail in the future and they decided to speak out about it. When it comes to making engineering decisions, complying with the code of ethics must be the first priority. (Andrews, Hakun, Kyger)

Some student work failed to truly describe a grey area. Their scenarios involved an ethical dilemma, but the right answer was easy to determine. For example in a variety of scenarios a person was faced with choosing between making the ethical choice versus losing his or her job (Figure 1). While the choice was presented in a way that was definitely a difficult decision, the ethical solution was apparent when considering the Code of Ethics. A few stories depicted scenarios where people's lives were at stake.



Figure 1 – A graphic novel created by using stills from Iron Man and adding original dialog (Koehler, Stratton, Wagner). This is one example of a common dilemma involving the loss of a job, which did not truly explore an ethical grey area because the Engineering Code of Ethics points to a clear 'right' answer.

Student work also showcased some impressive creativity that is not often encouraged and rewarded in the engineering curriculum. For example, a group of students writing about the development of artificially intelligent social service robots at the Floogle company included the

following redacted email in their work (Figure 2). In addition, the group wrote in the form of journal entries, which started out typed, and as the situation deteriorated switched over to being handwritten. In a very creative turn of events, the engineer escapes and lives with the Amish who are not as reliant on technology as the rest of society. As an institution with regional ties to the Amish community, it was greatly appreciated that the students incorporated unique sociological knowledge of the Amish in an engineering assignment, such as traditional Amish names and activities.



Official Report
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Robot Testing
Self-Sustainability Test

The test was successful; the robot was fully capable of creating a way to make its own electricity to recharge itself. However, there was a minor hiccup. The robot grabbed a water bottle from the evaluator to continue making its own power. There were corrective actions taken.

Additional Notes:

Code alterations included (pseudo code):

<ensure means to power do not defy morals> → <does the power, have a rightful owner?>

Meeting for behavioral check:

Omagnum met with the robot and discussed the events. Interestingly [REDACTED]
[REDACTED]. Omagnum taught [REDACTED].
Impressive results of [REDACTED] the ability for
[REDACTED]. More experiments to follow.

[Automatically blacked information beyond the scope of current use's security clearance.]

Figure 2 – Creative presentation by a student group who wrote their fictional story in the form of journal entries (typed, and then handwritten) and redacted company emails (Brennan, Davala, Zabala-Ferrera).

Another creative group of students rewrote song lyrics and performed in costume, from the perspective of engineers working under Darth Vader on the Death Star, who had been told that construction of the Death Star was for the advancement of the universe (Fay, Kenner, Nunez).

Assessment

The assignment was assessed qualitatively using reflections from the instructors and student comments, and quantitatively using student achievement measured by the grading rubric, and self-reported student achievement on the ABET outcomes covered by the course. Unfortunately, due to confounding changes in the course structure and instruction, comparison to previous ethics outcomes was not possible.

Overall, students in both classes did a satisfactory job on this assignment and demonstrated an understanding of ethics. The overall assignment average over both years was 3.4/4 (Table 1). The weakest category in both semesters was the Ethics category. Students were frequently penalized for not identifying a true grey area and/or not describing how the fictional situation should be viewed in light of the Engineering Code of Ethics. This challenge has been identified previously, as faculty perceive engineering ethics to include nuance, whereas students only perceive engineering ethics to only be about rules and laws and black/white answers².

The instructors observed that the writing quality, reflected in the writing scores, was higher than typically seen in technical reports such as lab or project reports. Students exhibited more sophisticated writing techniques such as imagery and foreshadowing. Students also impressively captured the genres of science fiction, hard-boiled detective, and courtroom drama with the structure of their sentences and paragraphs, their word choice, character names, and dialog. Some stories had the instructors on the edge of their seats because students effectively used hooks, changes of perspective, and cliffhangers. Instances of grammatical errors, confusing sentences, and long disorganized paragraphs were much more rare than in technical reports.

This observation of high-quality writing in this context makes the instructors curious as to why technical reports are not similarly well written. Some possibilities include: students are not putting as much effort into the writing of technical reports, students do not feel that the writing is emphasized as much when there is a hard technical component, students are struggling with understanding the concepts and that is reflected in unclear writing, or students simply enjoyed the creative writing process and the ability to chose a genre about which they are more familiar and passionate.

Table 1. Average Scores Awarded for Student Performance on Ethics Assignment, on a 4-point scale with 4 being “outstanding work”

	Spring 2013	Spring 2014	Average of Both Classes
Ethics	3.3	3.0	3.1
Broad Impacts	3.6	3.3	3.4
Engineering as a Profession	3.5	3.3	3.4
Communication	3.5	3.5	3.5
Creativity	3.5	3.5	3.5
Overall	3.5	3.3	3.4

As part of the assessment process for ABET, students were asked at the end of the semester to evaluate how well the course prepared them to “understand professional and ethical responsibilities of the engineering profession.” Students were asked to rank the ethics content of the course on a 1 to 5 scale with 1 being not well prepared and 5 being very well prepared. The average score over both years was 4.3 (Table 2). The evaluation results show that students felt the course and assignment prepared them to understand the professional and ethical responsibility of engineers well to very well.

Table 2. Average Scores for Student Evaluation of the Course Regarding ABET f – Professional and Ethical Responsibility

	Spring 2013	Spring 2014
Average Score with standard deviation	4.2 ± 0.8	4.3 ± 0.7

Students were also given the opportunity to provide written feedback on the course. While no students commented specifically on the ethics assignment at the end of the course, the instructors observed that students appeared to enjoy the assignment and have fun with it. The instructors certainly enjoyed the assignment and observed that grading the assignment was much more fun and less onerous than standard reflections on ethical case studies.

This assignment combines characteristics of other ethics assignments that have been shown to be effective, including group work that promotes deeper discussion¹²⁻¹³, directing students to explore nuanced rather than black and white scenarios², allowing students to explore issues that are currently relevant and of their own selection¹³, and engaging students’ emotions to motivate ethical understanding¹⁴.

Conclusions and Future Work

This ethical creative fiction assignment was a worthwhile exercise and allowed for a deeper investigation of engineering ethics than case studies alone. Furthermore, the assignment encouraged and rewarded more sophisticated communication, as well as creativity.

Observations

- The assignment effectively prepared students to “understand professional and ethical responsibilities” of the engineering profession
- Most students chose the short-story option and seemed to greatly enjoy the assignment.
- Biggest weakness for some groups was identifying ethical grey areas without an easy right/wrong decision and discussing the dilemma within the context of the Engineering Code of Ethics
- Writing was not the major focus of the grading, but it was generally much better than technical reports with minimal issues with grammar, spelling, wordiness etc.
- Students were encouraged and rewarded for exercising creativity

For the future, instructors are developing a survey to use for more targeted assessment of the assignment, and are considering ways to push for higher levels of ethical understanding while maintaining the fun and creativity of the assignment. With a smaller cohort of students, a meeting with the instructor to provide early feedback would help develop more ethical grey areas in the scenarios. One interesting addition would be to invite a professor from the English Department to give a session on creative writing. Also, offering a follow-up discussion could facilitate further insights. This semester, for example, the students will present their work in class so the instructor can facilitate the students learning from one another and providing meaningful feedback. Other ideas to address the issues with identifying ethical grey areas include conducting

a peer review or having the students present a basic overview of the paper ahead of time to help identify whether or not the group has identified a true grey area. Another possible enhancement would be to examine more case studies with ethical grey areas and do a comparison of case studies with obvious ethical violations and ones where they are not so obvious.

References

1. Colby, A. and W.M. Sullivan, *Ethics Teaching in Undergraduate Engineering Education*. Journal of Engineering Education, 2008. **97**(3): p. 327-338.
2. Holsapple, M.A., et al., *Framing Faculty and Student Discrepancies in Engineering Ethics Education Delivery*. Journal of Engineering Education, 2012. **101**(2): p. 169-186.
3. Drake, M.J., et al., *Engineering Ethical Curricula: Assessment and Comparison of Two Approaches*. Journal of Engineering Education, 2005. **94**(2): p. 223-231.
4. Yadav, A., G.M. Shaver, and P. Meckl, *Lessons Learned: Implementing the Case Teaching Method in a Mechanical Engineering Course*. Journal of Engineering Education, 2010. **99**(1): p. 55-69.
5. Freyne, S. and M. Hale. *A Preliminary Survey of Engineering Ethics Courses Nationwide*. in *American Society for Engineering Education Annual Conference*. 2009. Austin, Texas.
6. Jonassen, D.H., et al., *Engaging and Supporting Problem Solving in Engineering Ethics*. Journal of Engineering Education, 2009. **98**(3): p. 235-254.
7. Carpenter, W.C. *Teaching Engineering Ethics with the The Engineering Ethics Challenge Game*. in *American Society for Engineering Education Annual Conference*. 2005. Portland, Oregon.
8. Godfrey, D., et al. *Teaching Engineering Ethics in a Multi-Disciplinary Environment*. in *American Society for Engineering Education Annual Conference*. 2008. Pittsburgh, PA.
9. Brummel, B.J. and J.S. Daily. *Developing Engineering Ethics through ExpertWitness Role Plays*. in *American Society for Engineering Education Annual Conference*. 2014. Indianapolis, IN.
10. Itani, M. *The effectiveness of videos as a learning tool in an engineering ethics course: A students' perspective*. in *American Society for Engineering Education Annual Conference*. 2013. Atlanta, GA.
11. Klukken, P.G., J.R. Parsons, and P.J. Columbus, *The creative experience in engineering practice: Implications for engineering education*. Journal of Engineering Education, 1997. **86**(2): p. 133-138.
12. Freeman, R., P. Johnson, and K. Leitch. *Improved Pedagogy for Ethical Instruction*. in *American Society for Engineering Education Annual Conference*. 2007. Honolulu, Hawaii.
13. Lo, J., V.K. Lohani, and J. Mullin. *Student Presentations on Contemporary Engineering Ethics Issues in an Introductory Freshman Engineering Course*. in *American Society for Engineering Education Annual Conference*. 2006. Chicago, Illinois.
14. Sunderland, M.E., et al. *Making Ethics Explicit: Relocating Ethics to the Core of Engineering Education*. in *American Society for Engineering Education Annual Conference*. 2013. Atlanta, GA.

Appendix – Assignment/Grading Rubric

In a group of 2-3 people from EGR 110, **create a short story in the genre of science fiction or historical fiction that explores an engineering topic of your interest, its ethical issues, and its broader impacts.** The short story is expected to be 1500-2000 words, single-spaced, 11 pt Times New Roman font, with 1” margins. With advanced permission of the instructor, your short story may be conveyed as a long poem, a cartoon/comic strip/graphic novel, a song/rap, or a skit/short play. The short story must have development of environment (place and time), characters, and a plot involving an ethical question with broad impacts within the context of an engineering discipline or disaster, either future or past, fictional or actual.

The creative work was evaluated based on the following student objectives:

1. Ethics
 - a. Involve a true grey area where the line between right and wrong is unclear
 - b. Reflect a potential scenario in which an engineer could find themselves
 - c. Be “discussed” in context of the cannons of the code of engineering ethics
2. Broad Impacts
 - a. Involve several thoughtful, realistic such as environmental, economic, societal, relationships, medical, etc.
 - b. Consider if the impacts are short or long-term
 - c. Consider both positive and negative impacts
3. Engineering as a profession
 - a. Involve a branch, application, or industry of the engineering profession
 - b. Be creative about what an engineer might be like in the future (socially), or what a non-stereotypical engineer might be/ have been!
4. Communication
(depending on what format you choose, and mitigated by creative stylistic choices)
 - Written (short story, poem, scene from play)
 - a. Conciseness (avoid wordiness – omit needless words)
 - b. Clarity (no ambiguity – use definite, specific, and concrete language)
 - c. Accuracy (what you are saying is correct)
 - OR Plan, construct, and deliver an effective oral presentation.
 - Creating slides/presentation (graphic novel/comic strip)
 - a. Clear logical organization
 - b. Readable graphics and text
 - c. Good signal to noise ratio - omit needless ink, aesthetically pleasing
 - Delivery (skit/song)
 - a. Timing - within time allowed, appropriate pace, shared time
 - b. Familiarity - with content, order of slides, transition between presenters
 - c. Vocal – good tone, rate, and volume with appropriate variations
 - d. Visual – confident body language, eye contact
5. Creativity
 - a. Following the genre of science fiction or historical fiction or other (detective, etc)
 - b. Compelling environment, plot, and characters
 - c. Take it up a notch with more creative presentation choice!