

Development of Inclusive Freshmen Engineering Assignments

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Abstract

At Rowan University, freshmen engineering students take an introductory course in the fundamentals of engineering. In this course, students learn the fundamentals of engineering that they will use for years to come. Beyond helpful tools such as CAD and other computer software, the course offers students a chance to explore other topics relevant to engineering. This includes, disciplinary boundaries of engineering, engineering ethics, and the design process. While these topics can be given a cursory lecture, there exists opportunities to expand on these themes and topics. Given practices of inclusive classrooms, a faculty member can create engaging ways to have students explore these topics and encourage the development of good research skills and critical thinking. Inclusive practices can include practices such as decentralizing western examples in engineering, showcasing underrepresented engineers, allowing students to draw connections with their personal lives, enabling different styles of learning, and allowing students to teach themselves. This paper will showcase three such assignments and explore the development, rationale, and results for each as well as how inclusivity is used for each assignment. One assignment allows students to investigate the disciplinary divisions of engineering, allowing students to have the chance to educate one another on the history and nature of engineering disciplines as well as showcase unique individuals that have made some contributions to engineering. Another assignment allows students to explore the design process by comparing engineering design to the design methods used by non-engineering fields. This will allow students to see how design is used across the world and how it can enable cross-disciplinary work. The final assignment involves students exploring ethical, moral, and social issues in engineering through the use of movies that highlight actual events in engineering. The use of visual media to reflect issues in engineering can help engage more visual and reflective students and allows all students to observe the direct implications of ethics to engineering and how it affects society. This paper can be used to stimulate the development and elaboration of other assignments that have similar qualities and objectives.

Introduction

At Rowan University, all freshmen engineering students have to take part in a unique course known as Freshmen Course. This course belongs to a series of courses that is unique to the University's engineering program. In this course, faculty are given freedom to initiate their own projects within the sections they are teaching. In this case, the author instructs a given section of Freshmen Course. Within that course, three assignments are given that help students explore engineering and its intersections with society. These intersections can include interdisciplinary work, race, gender, class, ethics, and anything that can have potential impact within a society. This paper goes over the initial attempt to have these assignments integrated within the students' experience within Freshmen Course.

Motivations

These assignments were developed as a means to create more inclusive materials for freshmen students in Freshmen Course. In Riley and Claris's work on inclusive practices, they encourage faculty to expand students' understanding of what engineering is and make

connections on how it is socially relevant. [1] The author believed it was a good challenge to incorporate some of these suggestions into Freshmen Course. Two major examples that Riley and Claris discusses is de-centering western civilization and showcasing different kinds of engineers, particularly those who are underrepresented. Riley and Claris also mention how students should see the social implications of engineering so that engineering students can develop some critical thinking about what they do and how it affects others. [1] Other engineering educators have echoed similar issues. Hosoda has written about how native Hawaiian culture integrate science within itself and notes that all scientists should be aware of how science behaves in a cultural context. [2] Gluckman also noted that teaching engineering ethics through cultural contexts can enrich student learning. [3] The author developed three assignments that could help satisfy these requirements. Across the assignments, the student will explore historical and global backgrounds of engineering and who gets to engage in those fields of engineering and design. The intent is to allow students to think about how engineering has evolved over time and how the field impacts the world around them. These assignments are grounded in real people and events so that students can make relations between what they see and experience to what they are researching. These assignments are also further aligned with the materials taught in Freshmen Course so students feel that they are not just doing busy work but are exploring another facet of the materials they have in class. This paper intends to show how each assignment was structured for their initial use in Freshmen Course.

Assignment Overview

These three assignments are intended for a first-year level course, known as Freshmen Course. At Rowan University, Freshmen Course is the first in a series of similar courses where students are able to work on a variety of projects where they get to apply concepts they have learned in their technical courses. These courses are a special feature within Rowan University. In Freshmen Course the students are given access to a webbook that provides them a variety of lessons including an introduction to engineering and design, ethics, MATLAB, statistics, communication and other essential skills. The three assignments are paired with specific chapters in the webbook and they help reinforce concepts of research and communication that are also presented in the webbook. These assignments are intended to be presentations based on research that the students will conduct in teams. Each assignment will get 3-4 weeks for the students to complete and each team will get 15-20 minutes of presentation time with 5 minutes of questioning. The lab session for Freshmen Course offers a total of 165 minutes for all student teams to present without feeling rushed. This paper will now describe how each assignment is implemented. Since these are presentations, the students are encouraged to be as visual as possible. The heavy use of images and gifs are encouraged and students are also told how to properly cite written and media sources within the presentations.

Assignment 1

In this assignment, students are allowed to self-select into teams to research individual engineering disciplines and contributing engineers. This activity is intended to help create alignment to an engineering field and to foster mutual understanding between different engineering majors. Within the Freshmen Course, this assignment is used in conjunction to the

introductory webbook chapters explaining the essence of engineering and introducing the different disciplines. Since this assignment is an exploration of different disciplines, students' majors do not have to be aligned with the discipline they are researching. For Rowan University, Civil, Mechanical, Chemical, Electrical, and Biomedical Engineering are the disciplines that are used for students to research. For this assignment students are expected to cover the following:

1. Origins of engineering discipline
 - a. When and where did discipline start?
 - b. Who are considered founders?
 - i. What was their socioeconomic status?
 - ii. What was their profession?
 - iii. What did they share in common?
 - c. What is the organization in charge of the discipline and when did they start?
2. Current implications
 - a. Are there any sub-disciplines?
 - b. What are common applications that we encounter every day?
 - c. What are current challenges being undertaken by the discipline?
 - i. Can they relate to the NAE Grand Challenges?
3. Underrepresented Engineers
 - a. Investigate up to four engineers that are underrepresented based on their race/gender/sexuality/class/interdisciplinary work.
 - i. What have these engineers accomplished?
 - ii. What are intersections these engineers have with non-engineering elements?

The purpose behind this assignment is for students to have a basic understanding of how engineering developed into disciplines and to provide an opportunity for students to be exposed to engineers and engineering artifacts that they can identify with. It is important for students to understand how their discipline affects the day-to-day lives of people. In order to explore underrepresented engineers, the students can be given a list of discipline-specific engineers that can help guide them to think about who they can investigate.

Assignment 2

In this assignment, students are allowed to self-select into teams to research individual designer showcased on a given episode of Abstract, a documentary series on design offered by Netflix. This activity is intended to help explore how design is used by other fields and to foster mutual understanding between different design fields. This assignment is used in conjunction to the introductory webbook chapters explaining the engineering design process. For this assignment students are assigned a given episode from the list below:

1. Ep. 2 Tinker Hatfield: Footwear Design
2. Ep. 4 Bjarke Ingels: Architectural Design
3. Ep. 5 Ralph Gilles: Automotive Design
4. Ep. 6 Paula Scher: Graphic Design
5. Ep. 7 Ilse Crawford: Interior Design

Students are made aware that these featured designers are real people that have accomplished a variety of achievements in their professional lives and therefore students are expected to explore these designers in greater depth than what is offered by the documentary. As with the previous assignment, the students are expected to cover the following:

1. Abstract Episode
 - a. Who is featured?
 - i. Describe the person's life background.
 - ii. How did they determine their profession?
 - b. How does their field use design?
2. Compare and contrast
 - a. How do you define engineering design?
 - b. What is the difference between engineering design and the design used in your episode of Abstract?
 - c. What are the similarities between engineering design and the design used in your assigned episode?

The webbook that the students use shows engineering as a ten-step procedure that is quasi-linear. Having students explore how different designers use design as a tool can help students see that there are multiple ways to design and that there are some commonalities between them. Another aspect the students get to explore, is how each designer was influenced by their life events to engage in design fields. Again this was encouraged by Riley and Claris so that students can feel aligned and involved in their field.

Assignment 3

The third assignment is offered in the Spring semester of Freshmen Course. The reason behind this is that Freshmen Course covers multiple aspects of engineering ethics and the societal impacts of engineering in the Spring semester within the webbook and other course projects. That enables this assignment to offer more alignment with course materials. Much like the second assignment, this allows students to watch a movie that covers an aspect of a historical event that occurred within the realm of engineering. Students are told that they are expected to do research into the events and people that are covered by the movie. This helps students find more grounded, factual material to build their presentations. The movies assigned are the following:

1. The Wind Rises
2. Hidden Figures
3. An Unreasonable Man
4. Flash of Genius
5. Erin Brockovich
6. Underwater Dreams

These movies were selected because they all offer some intersection between engineering and a non-engineering aspect of life. Specifically students are asked to investigate the ethical, moral, and societal implications of their movie. Some of these non-engineering implications include,

nationalism, consumer rights and advocacy, intellectual property, and social inequality. Each student team is asked to cover the following:

1. Explore the historical context of the movie.
 - a. What is the context of the movie?
 - b. What is the historical accuracy of the movie?
2. Engineering in the movie
 - a. How is engineering depicted in the movie?
 - i. What is the predominant field shown in the movie?
 - b. Who are the engineers depicted in the movie?
 - i. What are their lives like?
 - c. What counts as engineering in the movie?
3. What implications for engineering in the movie?
 - a. Are there racial/gender/SES/political intersections?
 - b. What are the ethical/moral/social implications of engineering in the movie?

This is intended to help students understand that engineers and their engineering projects have direct impacts to society and to people who interact daily with engineered systems. Students also get an opportunity to once again explore, who is allowed to engage in engineering work and how their work is valued. Again this is done to build the students' capacity to see social relevance in engineering.

Assessment and Future Considerations

These presentations are graded based on how well the students cover the required information and how well they handle questions based on their presented work. Students did need some practice to develop a more visually stimulating presentation. Extra guidance was offered during class that allowed students to see how to integrate visuals effectively in their presentations. Initial student responses to these assignments were positive. Some students verbally remarked how relieved they were that they were not writing more reports and that they got an opportunity to be creative in their presentations. Other student's remarked on how they enjoyed discovering something that they never knew before about engineering and design. For future development, these assignments will require some form of capturing student data on what they understood from the experience that can be used to further develop these presentations. Since these assignments are an initial attempt to include more inclusive practices into Freshmen Course, the following year, the author intends to initiate a form of reflective assessment into each assignment. A reflection is a good tool for assessment since it engages different kinds of learners and can help students further unpack their experiences. [1,4] Reflections help students engage in their own development and given Kolb's model of learning, reflections are an essential step to further developing a students' understanding of engineering. [5] Given this positive initiation, formalizing assessment is the next logical step to make these learning experiences more meaningful to students.

References

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