Incorporating Sustainability into a Bioethics Course – A Case Study

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Work in Progress: Incorporating Sustainability into a Bioethics Course – A Case Study

Introduction

Engineering, as a profession, has ethical obligations to society that go beyond the simple application of technology as learned in science and engineering courses. Bioethics, a required course for bio/biomedical engineering students at our institution, seeks to supplement technological aspects of bio/biomedical engineering by engaging students in an analysis of the effects of bio/biomedical engineering developments on society, focusing on safety of the public as a primary ethical concern.

The motivation for incorporating sustainability as a design value for engineering ethics is that it expands the engineering analysis to consider *social*, *environmental*, and *economic* criteria. This invites engineers to consider the unfamiliar and sometimes open-ended ramifications of how their decisions may impact other systems (e.g., the environment, supply chains, society) at longer time horizons. Moreover, when any of the social, environmental, and/or economic impacts are in conflict, engineers face the ethical challenge of managing tradeoffs.

While the National Academy report envisioned the Engineer of 2020 being able to manage ethics and sustainability [1], researchers have continually used different approaches to understand and refine how teaching ethics and sustainability together could improve student outcomes, considering that teaching ethical reasoning skills for sustainability is rather challenging. For example, Bielefeldt used homework assignments throughout the semester to gauge first-year student attitudes, awareness, and knowledge of sustainability and its ethical imperative [2]. Reid used action research over a four-year process to continually refine their method for teaching ethics and sustainability in engineering [3]; while Spierre et al. took an experiential approach using non-cooperative game theory to better understand the difficulty of acting ethical in difficult situations [4]. More recently Andrade et al. tried to incorporate ethics into a sustainability course using system frameworks, stakeholder value mapping, and empathy building [5], while others have used a discussion and debate approach [6].

In the bioethics course taught at our institution, juniors and seniors are educated on a variety of ethical tools that enable them to analyze fictional and realistic cases. The course is comprised of lectures introducing methodology in analyzing ethical dilemma and determining relevant ethical considerations, and in-class case histories for application purposes. Over a semester (4 months), students are evaluated individually (through responses to weekly discussion forums and completion of an out of class activity), as well as in groups, with a particular focus on the ethical issues developed in a group case project. Upon completion of the course, students are able to *recognize*, *articulate*, and *resolve* ethical issues within the arena of bio/biomedical engineering. As part of a new initiative to deepen student's awareness of the multifaceted nature of bioethical issues, students partaking in the bioethics course during the Spring 2019 offering were asked to incorporate aspects of sustainability in their final project case analysis. The goal behind this initiative was to explicitly introduce the concept of sustainability in order to enable an open-ended exploration of this concept by the students and to evaluate how it affected their analysis

and changed the number of connections they brought to light between *social*, *environmental*, and *economic* factors.

Background & Methods

Sustainability, from the broadest perspective, was defined as a process that *meets the needs of the present without compromising the ability of future generations to meet their own needs* [7, p. 24]. At our institution, *sustainability* is defined as balancing equity, environment, and economics so current and future generations can thrive. Ultimately, from an academic perspective, sustainability often focuses on societal, economical, and environmental impacts and the interplay between these three elements, which are often referred to as the triple bottom line.

For the final project, each group chooses/identifies a case for analysis. Cases can be drawn from student experiences; an ethical dilemma that has affected someone they might know; be a hypothetical case based upon a situation that has ethical ramifications that students find interesting; or an in-depth exploration of a historical case with dubious ethical justification. Students are asked to utilize methodologies, such as utilitarian approach, discussed in class to develop a resolution (recommendation) for their case. Each group presents their case in class and then documents their case for final evaluation. Evaluations, which are all administered by the course instructor, are conducted in three dimensions: *quality and flow of presentation*; *indications of significance*; and choice and application of *methods of moral reasoning*. Prior to group presentations, students are provided a detailed breakdown of each dimension. The *quality and flow of presentation* dimension looks to see if the presentation flow smoothly so that the main argument or gist of the case could be easily followed, specifically: were the main points clearly identified and smoothly ordered? were the case study and proposed analysis adequately represented by the main points? and were the arguments cohesive and appropriate? The *indications of significance* dimension is about relevance of the ethical dilemma posed in the case study, particularly, was the problem clearly explained and properly put into context? Finally, the *methods of moral reasoning* dimension concerns the choice and methods employed in the case analysis, specifically: were the methods of moral reasoning clearly identified and explained? and were the approaches appropriate to the problem, issue, or questions identified?

During the Spring 2019 offering of the bioethics course, forty-one students were enrolled, resulting in eight groups/projects. A lecture was dedicated to instruction about sustainability issues prior to final project selection and preparation. As part of their final project instructions, students were provided with prompts to help them identify sustainability impacts in their respective cases. Specifically, the following prompts were shared:

- Are there direct and/or indirect *social implications* of your case's outcomes at scale and over the long term?
- Are there direct and/or indirect *economic implications* of your case's outcomes at scale and over the long term?
- Are there direct and/or indirect *environmental implications* of your case's outcomes at scale and over the long term?

Furthermore, and to stimulate engagement, students were presented with an example – *for a medical product choosing a one-time use option for distribution may reduce costs, reduce the*

risks for the end user in terms of contamination but, detrimental to the environment – of how conflicts arise within the triple bottom line and asked which of the presented options should be prioritized?

While students' selected case studies focused on bio/biomedical engineering ethical dilemmas, we hypothesized that using the triple bottom line sustainability framework (i.e., the triple bottom line of social, environment and economic) for a bioethics course would improve the ability for students to recognize and articulate tensions and tradeoffs between other design values as well. More specifically, we hypothesized that students would identify and consider more ethical dimensions in their final projects with the sustainability framework than without.

Results & Discussion

A qualitative comparison between Spring 2018 (without sustainability framework) and Spring 2019 (with sustainability framework) cases was conducted to gain insight into the effect of incorporating sustainability in bioethics on the number and types of dilemmas that students recognize and articulate. Two datasets (~30,000 phrases and words each) were derived from student submissions while removing references. Similar to Spring 2019, there were eight groups/projects during Spring 2018. The datasets were compared for the prevalence of words and phrases. Table 1 highlights the percentage of teams in each cohort that included relevant sustainability terms.

Table 1. Percentage of teams in 2018 and 2019 that included relevant sustainability terms in their evaluations.

	2018 (%teams included terms)	2019 (%teams included terms)
Sustainability	0%	100%
Social	38%	100%
Environment	0%	50%
Economic	10%	100%

Directly and/or indirectly every case study allowed the students to consider multiple sustainability criteria. In Spring 2019, there was a significant increase in the consideration of social, environmental, and economic factors on ethical dilemmas compared to the 2018 cohort. While all groups in the 2019 cohort were able to use sustainability to identify additional factors that shaped the ethical dilemma, only half of the groups were able to discuss environmental factors. In evaluating the types of projects one factor that can often separate them may be the extent to which a project lends itself to account for indirect environmental impacts (e.g., resource consumption, raw material extraction, transportation, water use, energy use, environmental emissions). While the difference could be attributed to the nature of the project, it could also be that students' familiarity with social, economic, and environmental impacts varies from individual to individual.

In summary, the sustainability triple bottom framework expanded students' critical thinking of bioethics, however, not all aspects of sustainability may play pronounced roles in each of the ethical dilemmas that bio/biomedical engineers face. Based on this preliminary analysis, the

instructors acknowledge that specific bio/biomedical examples could be developed to highlight scenarios when each of the sustainability factors would play a significant or negligible role in a bioethical dilemma.

References

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