Student and Instructor Experiences with a Seminar Course on Engineering and Social Justice

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Abstract

The purpose of this practice paper is to document the design and delivery of a seminar course on engineering and social justice. Mainstream engineering culture views engineering work as purely technical and independent of the subjectivities of the practitioners and the sociopolitical context in which engineering work is performed. Engineering students are often unaware of how engineering intersects with aspects of social justice due to the way they learn engineering. As a result, they develop an apathy toward social and ethical considerations. To address this issue, the authors of this paper designed a one-credit elective course. This course was offered to students pursuing engineering and engineering technology degrees at the Rochester Institute of Technology. This paper documents in detail the design and delivery of the course along with student and instructor reflections of the experience. Student experiences are captured through the journal they maintain over the course of the semester. Instructor experiences are captured through the self-reflection of the authors and documentation of their perceptions of the successes and challenges in running this course. We feel that the course was well received by students and allowed them an opportunity to critically reflect on the role of engineers and their own education as future professionals.

1. Introduction

Discussions of social justice in engineering education have gained momentum over the past few decades, notably resulting in the nascent Equity, Culture and Social Justice (ECSJ) division of the American Society of Engineering Education (ASEE). Changes to the ABET outcomes required for accreditation since 2000 have also increased the emphasis on professional ethics, consideration of wellbeing, and attention to global, economic, environmental, and societal contexts in engineering education, which has led to the development of new curricular content around ethics and contemporary issues. Yet compared with other initiatives such as increasing training in engineering design processes, development of entrepreneurial thinking, and undergraduate research opportunities, the inclusion of justice issues into the undergraduate curriculum has been slow [1], and still remains obscure for students [2].

The challenges are, in large part, cultural. Mainstream engineering culture views our discipline as depoliticized and purely technical, and thus free of bias [2], [3]. Any injustices are explained away by a false sense of meritocracy, an idea that people get what they personally merit, rather than seeing injustice as a consequence of technological design, bias or larger systemic issues [2]. Faculty who been trained immersed in this culture, tend to normalize the mainstream values and lack training and comfort in integrating social justice issues in their courses [4]. And students who have interest in social justice often feel they must leave it at the door of their engineering classes [2].

As a result, students are often unaware of how engineering intersects with social justice [3]. And even when they are aware, it becomes less important to students over the course of their careers [2]. Prior scholarship has highlighted a narrow technical focus and a general disinterest

among engineering students toward societal issues. In a review of the literature on engineering ethics education, Martin et al. [5] found that students are generally disinterested and disengaged in considering ethical and social implications of engineering work. Highlighting students' beliefs toward social and ethical issues, in a survey of more than 1000 engineering students in Australia, Stappenbelt [6] found that about a third believed that it is unrealistic to expect ethical behavior from engineers. Benham and colleagues [7] in their study found that while undergraduate aerospace engineering students recognized macro-ethics issues related to the aerospace industry and the potential for unethical practices in aerospace companies, a majority held these issues separate from the work of engineers, agreeing that "social and political issues are tangential to engineers' work" and "technology can't be good or bad in itself" (p. 3).

The risks inherent in the omission of social justice considerations in engineering education and the profession are paramount. Historically, the profession has been closely linked with militarism and imperialism and strong connections remain embedded in the culture and curriculum of engineers. The first ever formal training program for engineers in the US began at the West Point Military Academy and funding for military research still dominates research dollars [8]. The Department of Defense is likely the largest employer of engineers in the world [9]. While it is not straightforward to calculate this number, some studies have estimated it to be between 8% and 40% [10]. New technologies such as robotics, drones, artificial intelligence, and satellite technologies bring additional risk for misuse in war, surveillance, communications, and policing [11], [12]. At the same time, extraction of resources to support technology dissemination and the associated pollution still disproportionately impact marginalized communities and destroy the natural environment while the benefits of technology accrue unequally [13].

Students' attitude toward societal concerns influences professional practice. This attitude forms a part of students' engineering identity [14]. When these students join the professional practice, they influence the nature of the profession. Thus, students with a disinterest in issues of social justice can lead to a workforce that is disengaged with the social and ethical considerations of their work. Riley [13] notes that this disregard for social aspects prevents the engineers from engaging in social justice work.

What contributes to this attitude among engineering students is what Cech [2] calls a "culture of disengagement". She highlights that as students move through their engineering degrees, their beliefs about public welfare issues (comprising ethical responsibilities, an understanding of how machines are used, consequences of technology, and social consciousness) decline. She attributes this decline to an underemphasis of engineering programs on policy implications, and ethical and social issues. This finding, however, also points to the possibility of turning students' apathy into engagement through curricular changes. For example, Agrawal and Heydenrych [15] note how a community-driven course project helped students more critically consider the impact of engineering developments on the health and welfare of community members. At a larger scale, Cech and Finneli [16] show that engineering students who received training pertaining to public welfare responsibilities in engineering classes are more likely to have an expansive understanding of these responsibilities in their workplace.

Our work is an attempt to help engineering students be more aware of how engineering intersects with issues of social justice, and at the same time, weaken the technical-social dualism

that is perpetuated by the culture of disengagement in engineering education. To this end, the authors of this paper designed and delivered a one-credit seminar course offered as an elective in the College of Engineering and the College of Engineering Technology at Rochester Institute of Technology. The following sections describe our positionality in conducting this work, and the design and delivery of this course along with reflections from students and the instructors.

2. Authors' Positionalities

The positionalities of the authors of this paper are derived from our passion for including more social justice-focused curricula in engineering. We firmly believe that engineering students need to become more aware of the intersection between engineering and social justice and incorporating relevant content in their curricula is one approach to achieve this goal. While we are aware that there is no single complete definition of social justice, our beliefs on this issue closely align with Riley's: "the struggle to end different kinds of oppression, to create economic equality, to uphold human rights or dignity, and to restore right relationships among all people and the environment" (p. 4).

Author Agrawal is currently working as an Assistant Professor at Rochester Institute of Technology. Born and brought up in India, he has previously worked in different academic roles in South Africa and India. Being an immigrant who is perceived as a person of color in the US, he has experienced different aspects of advantages and disadvantages based on his caste, class, gender, ethnic, sexual, and immigrant identities. His past research has focused on exploring the possibilities of equity-centered (more specifically decolonizing) engineering curricula. His goal in running this seminar course was to increase students' awareness of how engineering and social justice are related and, in the process, learn from students and other scholars new ways of understanding this issue.

Author Brownell's (Principal Lecturer, Rochester Institute of Technology) perspective is informed by her small town, Polish-American, working class upbringing as well as a decade working with community groups in northern Haiti on ecological sanitation projects. As a white, cisgender, straight-presenting, US trained engineering professor with the associated privileges afforded and potential biases, she is working to learn from colleagues and students holding other intersectional identities about their experience of engineering culture in an effort to expand both its welcome and self-critique. Her motivation for creating the class was to create space for discussion, reflection, and peer to peer co-learning around engineering and social justice issues - something that would have helped her thrive as a female engineering student.

3. Course Description

Following a faculty learning circle on Engineering and Social Justice in Spring 2024, the authors proposed a one-credit Special Topics course to be taken as an elective. While the course was open to all undergraduate students at the university, the primary target audience was students enrolled in the College of Engineering and the College of Engineering Technology. The course was co-instructed by the two authors of this paper. For both of us, designing and delivering this course was a voluntary contribution to the university in addition to our standard workload.

The course was titled "Engineering and Social Justice Learning Circle," and was advertised through academic advisors, email, and physical and electronic flyers. The syllabus described the class as "a learning group guided by critical pedagogy where everyone is both a learner and a teacher as we explore how social justice and engineering are interwoven." After the drop-add period, we had nine students registered and one who asked to sit in on the course without registering, making a total of ten. Nine of these students attended in-person and, in the interest of increasing the inclusivity of the offering, one was facilitated to join through the on-line platform Zoom. One student later withdrew midway through the semester citing personal reasons.

In the Freirean [17] style, the course was designed to start with what the students already knew about the intersection of engineering and social justice, then expose them (along with the instructors) to additional topics, and finally allow them to choose the direction of further individual and group exploration. The class culminated in a group project where they were tasked to collectively create something to share back to the larger university community.

For the initial few class meetings, we spent time learning about one another and building community. We also brainstormed our understanding of the intersection between engineering and social justice from each of our own understanding using post-it notes. In two groups, the students worked together to sort the post-it notes into categories, sharing their thoughts back to the larger group. Collectively a variety of topics were identified as of interest to the group including sustainability (climate, environmental justice, extraction, pollution, sustainable communities), capitalism/consumerism, engineering for conquest (militarism, policing, colonialism, neocolonialism), human rights and equity of access, people's science, engineering identity and culture, alternate careers, and new ways do engineering (disability justice, queer theories, feminism and antiracism in engineering).

Because the class included students of varying academic levels (1st to 5th year) and a range of personal experience with social justice issues, the readings for the first three weeks were chosen by the instructors to provide everyone with foundational background information for continued discussion. We began with Chapter 3, "Engineering and Social Justice" from Donna Riley's [13] book of the same title, which introduces a variety of justice issues including political viewpoint, class, consumerism, militarism, colonization, racism, sexism, heterosexism, and ableism in relation to the engineering profession. Next, we discussed the banking model of education from *Pedagogy of the Oppressed* [17] and Freire's alternative of popular education to describe the basis for the structure of the course. The third reading was Tonso's [18] paper "Student Engineers and Engineering Identify", which was used to stimulate self-reflection around identity in engineering culture at our university. The remainder of the weeks in the course were reserved for students to sign up to lead a week on a topic of their choice. To this end, they worked with the instructors to choose reading(s) and then led class discussions or activities for the week. The readings were picked from a variety of sources including journal and conference papers, magazine and news articles, policy reports, and webpages of different organizations. The topics that they chose are listed below along with the references for the readings:

- Ethnography in Engineering Design [19], [20]
- Engineering and Imperialism [21], [22]

- History of Engineering Education in the US [23]
- Techno-optimism [24], [25]
- Technology and Human Rights [26]
- Technology in Policing/Abolition [12]
- AI and Labor [27]
- Technology in War [28], [29]
- Technology's role in Palestine [11]
- Humanitarian Engineering [30]

During class time we discussed the topics in relation to our personal experiences and goals for our future endeavors in the engineering profession.

Part of the class time during the final three weeks of the semester was dedicated to developing a class project with the intent of sharing something we learned back to the larger university community. Student-proposed ideas included creating digital posters, holding a teach-in with tables on justice topics, hosting a panel discussion with invited speakers, conducting a survey on ways to use engineering for good, creating a competition, developing a display/activity for our annual campus festival, and writing an article for the school newspaper. Eventually we settled on the idea of creating a 'zine on engineering and social justice which we published and distributed during the spring semester. Each participant, including the instructors, contributed one to two 'zine pages. During our final meeting, all students attended in person for a communal dinner, reflection of the semester, working on the 'zine to finalize its content, and providing course feedback to the instructors. To provide course feedback, students were encouraged to use the starfish method, working individually and in groups to add post-it notes in categories of *keep doing*, *stop doing*, *start doing*, *do more*, and *do less* while the instructors were out of the room.

The assessment of student learning was done in the form of attendance and participation in class discussions, leadership of a class session on a topic of their choice, contribution to the final project, and their reflections on weekly readings. The weekly reflections were submitted by the students in the form of a combined journal at the end of the semester.

4. Student Reflections

As noted, to help students reflect on their understanding of the reading, they were asked to maintain a journal through weekly reflections. The prompt given to them each week remained the same:

> ***In the journal you will document your understanding of the readings, how it relates to your life and surroundings, and how it has shaped (or will shape) your future thoughts or actions.***

In this section we summarize the key aspects of students' reflection using verbatim quotes from their submissions. We obtained IRB approval at Rochester Institute of Technology to use student reflections for this paper. Seven out of nine students course consented for us to use them. These seven students identified with different genders (male, non-binary), races (White, Asian), and were enrolled in different academic years (first to fifth). All of them were pursuing a major

in an engineering or engineering technology discipline. Note that while the reflections were students' own thought based on their everyday experiences, we recognize that the readings provided the direction to students to guide their thoughts.

4.1 Intersection of personal identities with engineering

Guided by the reading on engineer identity [18], students assessed and attempted to situate their own identities within the engineering culture that they saw around them and experienced. For example, Taylor[1] reflected on how both female professors and students were perceived in an engineering class:

> *Female professors are often unjustly described as "annoying", "bitchy", or "angry", while female students often have to adjust how they outwardly present themselves to be taken seriously; "too much" of a feminine gender expression is seen as at-odds with the identity of the engineer, while "too little" may take on some level of perceived queerness. Being an engineer is a performance for many, which (drawing from my own experiences) makes learning to act a prerequisite to productive academic engagement.*

It is particularly important to note in Taylor's reflection the need for performing a certain way to be able to fit into the engineering culture. While Taylor continually thought of their performative act, Sasha noted how they choose to not think too much about their own performance despite being cognizant that their identities do not align with those of a typical engineering student.

> *I tend not to think about my engineer performance, but know that I definitely exhibit one as my identity does not mesh well with the typical engineering student.*

For Andrey, juxtaposing identity with the engineering culture was eye opening as it made him realize that being an engineer is not just about gaining the skills required for the profession. Rather, it is an interplay between one's own perception of the self and others' perceptions of them. And these perceptions are shaped by one's experiences both in and out of the class in a circular fashion.

> *One thing that really stood out to me was her point that being an engineer isn't just about grades or technical skills—it's also about how we see ourselves and how others perceive us within our teams and classes. It reminded me that so much of what shapes us as engineers happens outside the classroom, in group projects, conversations, and even the culture of engineering itself.*

4.2 Education of engineers

The various readings that students completed during the seminar course also helped students contemplate their own education as engineers and their own role in the learning process. For example, advocating for more community-centered approaches to engineering work, Casper reflected:

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[1] Pseudonyms were assigned to each student.

If engineers want to work in the humanitarian space, they need to keep the community in mind, whether its people or resources…. I don't think that shift in mindset would be any more difficult for an engineer to adjust to, the difficult part would be building the expertise in the various considerations…if these concepts were added more into school then it wouldn't be as difficult to socialize later.

It is particularly to note that in this excerpt, Casper critiques the current engineering education by noting that it does not focus on the community aspect, which leads to professionals not considering it as a valued requirement in their work. Along similar lines, Taylor notes how engineering curricula should help students situate the historical and current professional practices within the exiting social realities. This will help students become more critical of the profession and eventually push for adopting an approach centered on social justice.

A push for colleges to include courses which explicitly contextualize the current and historical practice of engineering with social issues may help engineering move away from its violent colonial and military roots. But, within our current economic and political contexts, any decolonization process within engineering can only go so far without the simultaneous deconstruction of underlying structures of oppression.

As can be seen in the excerpt, Taylor is also a bit pessimistic about engineering adopting a social justice approach within the current sociopolitical and economic contexts.

In addition to reflecting on the engineering curricula, the readings also prompted students to reflect on their own role in the learning process. As Rafa noted:

In the future I would like to be more conscious and active in my learning. Whether it is through fostering team dynamics or participating in actively engaging and listening to other members. I would like to encourage critical thinking, so we can collectively transform our realities rather than simply adapt to them.

As can be seen, the course readings helped Rafa recognize that not only he is an active participant in his learning process but also there is knowledge in others' life experiences.

4.3 Role as future engineers

While students considered the different reimaginations of the engineering curricula and their own roles in the learning process, the class discussions and the course readings also helped them rethink the role of future engineers and the engineering profession. As Rafa exemplified this though process in his reflection:

Whether it is in group projects, work, or other initiatives, I usually have these predefined ideas about the process towards a solution, like an algorithm or something. This reading [on carefully conducting user research] was a powerful reminder to start with people instead of the actual problems. By trying to understand others and asking the right questions, we can move toward solutions that work.

Commenting on the link between military and engineering developments, Novak noted:

> *I came to the conclusion that military driven research is not the way to go because it primarily focuses on developing weapons which the world does not need more of.*

Andrey expressed frustration over the fact that the social and human impact of engineering work are overlooked due to an overemphasis on the technical aspects. As a result, he found it difficult to align his passion for humanitarian engineering with the current engineering culture of valuing technical advancements over anything else. He stated:

> *Sometimes, it feels like there's this quiet pressure to focus only on the technical side of things and ignore the bigger, more worldly picture, like the human impact of our work. That's frustrating for me because I'm passionate about using engineering for humanitarian purposes, and I think those priorities should matter more.*

For Dominic, learning about the racial bias in technological development and use was an eye opener. While he did not articulate a possible way forward, this new learning definitely disrupted his prior notions about the apparent neutrality of engineering innovations.

> *We know that the potential of tech can contribute positively and negatively to society, but I always thought that the negative part would be war, not racism…. yet we still having the same issues we had in the past [i.e., racism] implemented into the growing technology. This is honestly really confusing to think about.*

5. Instructor Reflections

The *Engineering and Social Justice Learning Circle* course was a one-credit special topics class that did not satisfy any specific curricular requirements for students. We believe this aspect of the course significantly affected the outcomes. This class structure meant that both students and instructors volunteered to participate and engage because of significant personal interest in the topic. Below we provide our own experiences of offering the course along with our assessment of student experiences. Note that this assessment was done generally during informal conversations with students. During our last meeting for the course, we also asked students to provide formal feedback.

Since the course did not clearly "count" toward graduation, the coursework did not always get priority from students in terms of completing the readings and reflections. Some students specifically mentioned in their reflections that they wished they could have put in more time outside of class, citing the demands of their other primary courses. At the same time, we, the instructors, were trying to manage multiple competing priorities. Hence, we also sometimes were stretched to fully support students in choosing weekly discussion topics and helping them lead sessions. As a result, some of the students' reading choices were not directly related to engineering, and some sessions were run as simple reading discussions. In the future, a topical reading list can be developed to help students find articles of interest with enhanced support from faculty to create learning activities. We also found a wide variation in the quality and depth of reflections completed by students. This was partly because of the varying levels of experience

and academic maturity students had in the class. However, we believe we could have also helped students reflect more deeply by asking them to more frequently submit their reflections (as opposed to all submitted together at the semester end).

Despite these challenges, we feel that students seemed to really engage with the final project of collectively designing a 'zine. Everyone contributed one or two thoughtful pages to our 'zine, which was compiled and distributed at the university. The 'zine has led to interest from other students for taking this course in the fall of 2025. In the feedback we received from students, they suggested incorporating more similar projects and activities. Also, in contrast to their out-of-class work, students regularly attended the class meetings, and discussions were robust. They frequently stayed late to continue discussions. Overall, the students liked the once-a-week structure but also felt that class sessions could be longer.

For this first iteration, we ran the class as a low-stakes course to gauge student interest. From the faculty perspective, our biggest challenge was the time commitment in offering this course in addition to our regular teaching schedules. To address this, we will investigate ways to incorporate this course into the general education curriculum or offer it as a professional elective in interdisciplinary engineering. This aspect was also highlighted by students in the formal feedback we collected during our last meeting.

The level of interest and participation of the students during class is nonetheless inspiring. It suggests that a portion of the engineering student body is keen to understand how social justice issues connect to their profession and are willing to put in the effort to learn despite the additional workload for little credit. We believe that the Freirean model was successful. Both students and faculty learned from one another about a topic they felt passionate about exploring, and, even more importantly, it was an enjoyable experience (at least for the authors) for a modest amount of effort.

6. Conclusion

The goal of this paper was to document the design and delivery of a one-credit seminar course on the intersection of engineering and social justice, along with the experiences of the participants (students and instructors) in the course. This course was developed with a goal to help students become more aware of how engineering work has implications for the society and the community. Reflections from students, as presented in the paper, highlight that the course allowed them to critically reflect on the role of engineers, ways of educating future professionals, and their own place within the engineering culture. We, the authors, have also discussed some logistical challenges in offering the course as guideposts for future scholars with similar aims.

Nevertheless, we hope that we have, to some extent, resisted the "culture of disengagement" that leads to faculty and students overlooking the social and ethical impacts of engineering work [2]. As the student reflections suggest, this course helped some to better understand how engineering practices contribute to different forms of discrimination. While for others, the course experience provided a direction for how they should think about their own learning and future professional practice. As prior studies have pointed (e.g., [14], [16]), such

course experiences influence how engineers perform professional work, leading to a change in the nature of the profession.

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