”Drugs, Alcohol, Joblessness, and Lifestyle”: Engineering Students’ Perceptions of Homelessness and Implications for Social Justice Education

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My name is Bryce Fledderman and I am a senior at the University of San Diego. I am majoring in Integrated Engineering with an emphasis in Sustainability. I am also a student-athlete at the university who plays football. I started doing research with Dr. Mejia in August and am very excited to work on my first paper.

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Abstract

This paper describes how engineering students in a lower division user-centered design course framed issues of homelessness within an engineering context. We focused on the issue of homelessness as the context for the course’s design project because it is one of the largest social justice issues impacting the area where the University of the Borderland (pseudonym) is located. The goal was to determine how the project influenced students’ perceptions of homelessness and the role of engineers in this social justice issue. Results indicated that students tend to frame issues of homelessness in simplistic terms aligned with deficit perspectives (e.g., inadequacies of the home) and meritocratic ideologies. These results suggest that engineering educators that seek to address issues of social justice need to first deconstruct the complexity of social issues and the nuances involved in technical work. Decoding complex social issues is important in order for students to see themselves as agentic actors that can contribute to social justice through engineering design.

Introduction

Social contexts in engineering are often seen as tangential to problem solving, thus exacerbating the problematic ways in which engineering problems are framed as decoupled from society and social justice. Yet, most engineering educators in the US are familiar with the student outcomes set forth by the Accreditation Board for Engineering and Technology (ABET), which, in its most recent manifestation, cunningly integrates societal context and professional skills throughout its technical objectives. The new ABET Student Outcomes 1-7 render engineering programs unable to decouple technical skills from what are commonly (and often disdainfully) referred to as “soft skills.” Our program, and specifically the course discussed in this study, embrace the integration of the liberal arts into engineering and purposefully frame technical engineering content by its broader social context, as well as take a humanistic approach to engineering by orienting the core of our program around social justice [1, 2].

Much of the literature tying engineering education to human or societal context stems from the field of Science, Technology, and Society (STS) and Engineering Studies, which emphasizes that science, technology, and engineering are not objective and isolated; rather the creation of new knowledge and technology are influenced by society, politics, and culture, and these technologies in turn will have impacts on society [3]. This area of work has led to research that examines how integrating socio-technical thinking in the engineering classroom can develop more holistic engineers capable of working in both the social and technical dimensions of contextualized, open-ended problems [4].

This study was conducted within the context of a User-Centered Design course, which uses an STS framing to expose lower-division students to engineering as a sociotechnical discipline—

that engineering is inherently political, and that we must understand our own stances as individuals in conjunction with considering social impacts of our engineering [1]. In keeping with the university mission, all graduates must complete two courses with the diversity, inclusion, and social justice (DISJ) university core flag, which seeks to help students develop critical self-reflection and the ability to analyze the complexities of social constructions in everyday life. As a result of our campus environment, our version of User-Centered Design has evolved to be unique in its objective to cover topics including justice, power, intersectionality, and privilege and oppression. Students take this course in their second or third semester of college as a requirement of our engineering program, which also fulfills the university's lower-level DISJ graduation requirement.

We argue that before interventions can be implemented in the classroom, it is important to analyze how students interpret social justice issues in the context of engineering. In this paper, we explore engineering students' perceptions of homelessness before and after extensive in-class activities on the topic of homelessness, and the implications of these perceptions on engineering education. We focused on the issue of homelessness as it is one of the largest social justice issues impacting the area where the University of the Borderland (pseudonym) is located, which presented an opportunity to teach our students about social issues within an engineering context.

Theoretical Foundations

In engineering, the universalized narrative of problem solving, applying science and math, and making things [5] has instituted the idea that technical aspects may have a significantly higher value than the social contexts in which engineering occurs. Engineering classes teach students how to solve close-ended and decontextualized problems, resulting in engineering graduates often not understanding the larger context of their work [6]. Jesiek and colleagues [7] argued that "this mismatch between the technical focus of the curriculum and the sociotechnical complexity of actual engineering work means that students are often unprepared for the reality of engineering practice" (p. 1). Jesiek and colleagues [7] also suggest that many people they interviewed about how much technical work was needed for their upcoming jobs but still had to go through a "boot" camp to learn the specificity of their job for that specific company. Even through these, the engineers had to engage with other engineers and senior colleagues to learn to prove that the social side is just as vital. Examples of people they interviewed discussing how much of the technical work needed for their upcoming jobs still needed to be done through boot camps or learning from that specific company but in order to complete these, they had to engage with other engineers and senior colleagues to learn. The importance of social relationships and an understanding of social issues is extremely valuable for the development of engineering students. Unfortunately, engineering programs emphasize the technical content so intensely that most engineering students do not get the opportunity to work with social issues thus never creating that awareness.

The focus on technical aspects of engineering, and the perception that engineering work is objective, has also led engineering students to think about the profession as apolitical [8, 9].

This depoliticization frames engineering as a technical space where the social and political sides are tangential to engineering decision-making. Cech argued that students' conceptualization of engineering as apolitical has also created issues related to disengagement with social causes, particularly those related to justice [8]. Engineering students learn early through professional socialization - in part due to the pedagogical approaches used in the classroom - that justice issues are "social" and "political" and thus irrelevant to engineering practice. Cech's study described how engineers found themselves in uncomfortable situations and unable to discuss social or justice issues with colleagues [9]. Engineers faced being ostracized if they expressed emotions or care for such issues. Some participants in Cech's study indicated that they wished they would have learned and talked more about the consequences of these technological advances and the problems that led to why our world is in its current and past form [8]. As indicated in other studies [10], engineering is oftentimes perceived and portrayed as a profession where one must be emotionless and apolitical. Godfrey and Parker [11] also regarded them to be expected to be numerate, self-reliant and not emotionally demonstrative.

Often engineers think about engineering problems in terms of building or creating a solution [5], and sometimes these conceptualizations lead to engineers framing engineering as a field dedicated to "help" others [10, 12]. The issue of homelessness is not exempt from this particular framing. While this perspective of helping others is not ill intended, a more critical analysis must be done to help students examine the perspectives and attitudes they bring forth when working on these types of issues. One study involving 10th and 12th graders was tasked with designing a temporary housing unit for individuals that experienced homelessness [13]. Students analyzed heat loss through insulation and the amount of heat released by the individuals staying inside of these temporary units. While students successfully completed the analysis, it is not clear to what extent the students critically examined how the problem was framed, or what the factors that lead to homelessness were. The students were not asked about how or why people experience homelessness or whether these temporary housing units would result in a permanent and sustainable solution to homelessness. We point to this study because these approaches to engineering design (i.e., strong focus on technical aspects and detaching ourselves from any responsibility we may bear) have continued to permeate throughout K-16 education. In order to change these notions about social issues, we must reaffirm the importance of critical perspectives in education early on.

Some current research has tried to provide a more critical and action-based approach to problems related to homelessness. Pocock [14] discussed how we need to address the realities of homelessness taking a more critical stance. It is important to consider several solutions, such as low cost public bathrooms and improved cost of living scenarios, which could potentially ameliorate some issues related to homelessness [14]. Pocock [14] also argues that students cannot just be taught heat transfer principles, but they need to incorporate real life critical perspectives into the problems they are trying to address, including homelessness. These problems are complex and we cannot continue to essentialize or simplify problems. Once students start connecting different engineering concepts and applying them to frame problems in a more holistic way, then they may be able to bridge this gap we have created between the

technical and social aspects of engineering. This paper seeks to understand what the perceptions of students to issues of homelessness are given that the location where they attend school is affected by it. As we continue to provide more opportunities for students to become more critically conscious [15], it is also important to understand how students conceptualize social issues we are asking them to address.

Methodology

Context of the Study

In order to understand undergraduate engineering students' perceptions of homelessness, we incorporated an engineering design project focused on homelessness into a *User-Centered Design* course at our university. This paper focuses on the projects assigned in the fall semester of 2019 and the spring semester of 2020. These two projects were both centered around homelessness, but differed in their scope due to the COVID-19 pandemic during the 2020 spring semester. During the Fall 2019 semester, students enrolled in the course were asked to design a solar water heater for a mobile shower unit intended to provide services to individuals experiencing homelessness [2]. A full description of this project, example student work, and a discussion of student perceptions of the project can be found in previous work published by the authors of this paper [2]. During the COVID-19 crisis in the Spring of 2020, students were asked to identify an unmet user need related to the pandemic affecting individuals experiencing homelessness. Throughout the project in both semesters, we partnered with a local homelessness advocacy group called Think Dignity to ensure student projects were grounded in real-life issues. The project in both semesters required students to perform background research on the issue of homelessness and to attend a talk from a guest speaker from Think Dignity. With these activities, we tried to ensure that students were focused not just on their technical solutions, but that they also understood the underlying causes of homelessness and the roles engineers should play in solving such a complex sociotechnical problem.

Data collection & analysis

All work described in this paper was reviewed and approved by the University of San Diego's Institutional Review Board. All data analyzed in the present study originated from students who willingly consented to be included in this research. In both semesters, students completed four open-ended questions before and after the project. In this study, the open-ended questions were intended to gather data related to students' perceptions of homelessness and the role of engineers in this social justice issue, rather than to identify a "right" or "wrong" answer to each guiding prompt. The four prompts were:

- Q7. What are the major reasons why people are or become homeless?
- Q8. What is the role of engineering in mitigating or addressing homelessness?
- Q9. In what ways does engineering ameliorate or exacerbate homelessness?
- Q10. What would be a potential solution for homelessness?

A total of 105 students responded to the open-ended questions over the two semesters. The pre- and post-responses were analyzed following a deductive coding approach where a priori

codes (Table 1) were initially applied and data was systematically reviewed to refine the coding scheme [16]. These a priori codes were collected from previous research on attitudes, mindsets and discourses in engineering [8-10, 17, 18]. Each of the four datasets (Fall 2019 pre, Fall 2019 post, Spring 2020 pre, and Spring 2020 post) were independently analyzed by separate coders. Following this initial coding, the authors reviewed all datasets to ensure consistent coding was employed. Any disagreements in coding assignment were discussed and a final consensus was arrived upon before data analysis began. Once all datasets were coded and finalized, we examined the data for common themes using NVivo (QSR International). Data was then aggregated into themes [16, 19].

Table 1: A priori codes used to analyze student responses to the open-ended questions

Codes	Description
Technical	Participant provides descriptions to demonstrate or describe technological affinity, interdependence, or importance (i.e., artifacts, machinery, optimization, efficiency, cost effectiveness, etc.) with an obvious lack of sociotechnical considerations.
Sociotechnical	Participant provides descriptions to demonstrate or describe social affinity, interdependence, or importance (i.e., society, communities, individuals).
Meritocracy	The idea of meritocracy is that people receive reward based on merit – that they earned reward through their actions. The corollary of this claim is that people without reward earned their lack of reward, or otherwise did something to deserve that.
Counternarrative to meritocracy	Acknowledge that there is something wrong with the system. In addition to the system not working, unfortunate circumstances may originate the problem (e.g., not born into privilege, bad luck, etc.).
Inherent deficits	These indicate that there is something inadequate with the individual (e.g., lack of family and friend support, Drug addiction, mental illness, lack of money, lack of jobs)
Social Responsibility	Creates a counternarrative to the purely technical work of engineers.
Artifacts	Participant indicates that technological artifacts are asocial, apolitical and neutral. Disregards inherently political aspects embedded in artifacts.
Decision-making	Participant indicates that social and political dimensions are artificially separated from—rather than recognized as inherently intrinsic to—engineering practices. Objectivity is never contested.

Findings

The coded data revealed four themes based on students' perceptions and attitudes toward homelessness: (1) homelessness as the result of inherent deficits, (2) exclusion of social aspects in engineering, (3) persistence of meritocratic ideology, and (4) critical perspectives of social issues. The following sections provide a description of each of the themes that emerged from the coding of the data. Some of the quotes included in these sections are representative of what was observed in the data set.

Homelessness as the result of inherent deficits

Most of the respondents mentioned that individual characteristics are to blame for homelessness. These included factors such as drug abuse, mental health, post-traumatic stress disorder, and illness, among others. When asked to identify the reasons why they believed individuals experience homeless, one student indicated "I think drug addicts often become homeless because they have trouble functioning without drugs." Another student responded, "I think there are a lot of people with mental illness...people sometimes become homeless because they have trouble finding work with a mental illness." These responses also aligned with the perception that individuals who experience homelessness are not adequately prepared to fit into society, or because of their "lack of enthusiasm in life." One student indicated that "The chronically homeless typically have a mental illness paired with drug or alcohol abuse which causes them to have a much harder time getting back into society." Another student argued that "drugs are a big influence as well because they can make people become less motivated and delusional to the point of downward spiraling." These responses were very common among students and seemed to follow the same line of thinking: individuals carry deficits and they are the ones to blame for their own situation.

Other deficits were not necessarily attributed to the individual but referred mostly to the inadequacy of the home including lack of parent involvement, no family support, or domestic violence. This inadequacy of the home was mostly described with the words "carelessness," "life style," "divorce," or "lack of family support" among others. One student responded, "I would make the argument that most homeless people did not have the best upbringing in terms of safety of the area they grew up in and parenting." Another student mentioned that "[t]here are many contributing factors to people becoming homeless, including loss of job, divorce, or getting kicked out of a person's own house."

These deficit perspectives were mostly observed in the pre-surveys administered during both the Fall 2019 and Spring 2020 semesters. However, it was noticed that the number of instances in which students indicated that inherent deficits were to blame for homeless decreased after they completed the project (i.e., after completing the post-survey). These changes in perception are, nonetheless, descriptive of how some students continue to argue that homelessness is directly related to deficiencies or inadequacies of individuals rather than systemic issues (e.g., capitalism, lack of universal healthcare, neoliberalism, racism, etc.).

Exclusion of social aspects in engineering

Data analysis showed that students commented on the idea that engineering is inevitable for progress, and that efficiency and cost determine the success of a solution. Their responses also included some references to how engineering is about improving things, even though those “things” were commonly materialistic such as buildings, tents, or other artifacts. Students rarely mentioned the impact that engineering could have on disrupting systems of oppression that may exacerbate homelessness. Moreover, students rarely indicated the role of engineers in society - either as professionals or citizens. One student responded that addressing issues of homelessness may require “more legislation,” but then disregarded the role an engineer may have in changing current systemic structures by saying, “but I’m an engineer, so I don’t care much for government work.” This quote is representative of a sentiment shared by many students where they did not see themselves as agentic actors - compartmentalizing their identities as engineers and citizens. Some respondents also commented that engineers are not meant to eliminate homelessness. Some students indicated that engineers are not responsible for solving issues of homelessness and that they are influenced by either corporations or politicians that tell them what they should do.

The responses tended to be very broad, but highlighted the technical aspects of engineering (e.g., logistical, scaling up, efficient, etc.). Engineering was described as a profession that could contribute to providing solutions to homelessness, but they were always conceptualized around the technical aspects (e.g., building, creating, designing, making). Interestingly, when engineering was described as a profession that could contribute to addressing issues of homelessness, it was often framed as self-sufficient and did not involve any other actors. For example, several students responded that the way engineers can ameliorate issues of homelessness is by “building rehab centers” or “designing tents in parking lots.” These responses were indicative of solutions based on the oversimplified idea that individuals experience homelessness because of drug abuse or that all individuals that experience homelessness live on the street. In addition, these responses demonstrate that a majority of the students conceptualized engineering as a field that provides answers and fixes problems, regardless of whether they are technical or non-technical solutions.

Some respondents mentioned how engineers have a social responsibility. Very few instances of the social were found - particularly in the pre-surveys - primarily framed around the need to consider issues of homelessness the responsibility of everyone and to “reject designs of ideas that damage society.” There were some particular cases where students countered this narrative by describing the complexities of homelessness and indicating that engineers alone could not solve these issues. One student responded that “[homelessness] is a deep-rooted issue that cannot be solved through one perspective, it needs to be looked at through different lenses to tackle it from multiple angles.”

Persistence of meritocratic ideology

Meritocracy was one of the salient themes from student responses. For instance, students indicated that people that experience homelessness do so primarily because they are “not making the best decisions,” “not working hard,” and “deciding to be in that situation (bring that to themselves).” One student mentioned that people who experience homelessness are not

equipped to make contributions and one way to support them is to “first stop giving them handouts,” while another student said that society should “make ways for the homeless to contribute to society.” These responses are descriptive of meritocracy and the belief that a social system is in place to reward individuals based on their capabilities, hard work, and merits, rather than the consequence of the system we have created where policies and structures are not designed with everyone in mind.

When the students were asked to describe one potential solution for homelessness, they continued to align with meritocratic ideology. Sometimes their responses made the government responsible for issues related to homelessness (e.g., “free handouts,” “government housing”) - making the assumption that the government properly responds to homelessness - but in the end made the individuals themselves responsible for their own situation. One student provided the following example,

I think that government housing makes matters worse because there are many homeless people who do not wish to get on their feet. This ruins government housing because they take advantage of a way to get themselves on their feet. There are people who use this for good, to help progress themselves, but I do not think this is generally the case.

As the statement indicates, there was the perception that people who experience homelessness take advantage of the government and only a few plan on progressing. Similarly to the previous student response, some students also mentioned that “some people are homeless by choice,” where the discourse of “choice” was used to explain or justify continued inequalities in our society. In some instances, students combined meritocracy and deficit perspectives when explaining homelessness. One student mentioned that “[w]hile society isn’t as accepting to drug addicts it partially the fault of the user.” This type of rhetoric presents homelessness as the result of the inadequacy of individuals to gain certain skills and using those skills adequately.

Although several students indicated that homelessness is a complicated problem that requires collaborative work to solve it and indicated that a failed system was to blame for the problem, many students continued to rely on the myth of meritocracy and “choice” to either claim that individuals decide to be in that situation or not get out if it. As one student put it, “[p]eople have the opportunity to make their own decisions in life to put themselves where they are. Sure some things are out of their power BUT 90 percent of people can do something about it.”

When asked about how engineers could ameliorate issues of homelessness, some students did not see engineering as a field that could provide solutions. In those instances where students provided some suggestions, they did not see themselves as agentic actors or promoted the idea that overcoming homelessness requires hard work, skills or commitment. In other cases, the students opted for the design of affordable housing, for example, but rarely mentioned that challenging the system was necessary - emphasizing simplistic technical approaches to a complex issue. One student indicated that,

The role of engineering is to help them in the way they'll accept it. Some of them don't want help because they choose to be homeless. But those that don't, we should create affordable housing or allowing them to not spend on things we can provide them with, like clean water or clothes.

Critical perspectives of social issues

Several students, particularly in the post-survey responses, provided more critical analysis of the causes of homelessness. Some of their counternarratives included a focus on the role of stigma, inadequate policies, capitalism, and an individualized society when discussing the causes for homelessness. One student said,

I think the major reasons people become homeless are either being born into the lower class and getting trapped in the often inescapable cycle of poverty or falling into unfortunate circumstances (not necessarily the person's fault) that cause someone to lose their resources and revert to soup kitchens and shelters for care.

Students' responses questioned issues of poverty and the systems that punish individuals for lacking privilege. Some students also suggested examining the problem through a different lens - on that involves more asset-based approaches and values the knowledge that people who experience homelessness bring with them. One student drew from their experience in Brazil to offer a different perspective, "...in places like Brazil people of low income and poverty live in places called favelas. In an area where infrastructure wasn't being built people build their own home using their own skills and unused resources."

Finally, some students reflected on the ways in which engineers may exacerbate problems encountered by people who experience homelessness by identifying how their designs impact marginalized communities. Some of the problematic designs described by the students included some examples of hostile architecture such as spikes on sidewalks, park bench dividers, and working on projects that promote gentrification. One student explained as follows,

The work of engineers may sometimes exacerbate homelessness if their work may solve problems that eliminate the need for employees or they may not practice intersectionality and think about a certain technology or process will affect all different groups of people.

Students began to think more broadly about the role of engineers in decision-making processes. Moreover, students also reflected on their role as citizens and tried to recognize that engineering is only one facet of their lives. One student mentioned that engineers can help address issues of homelessness by "doing the best we can to help them, whether it be in our professional lives or personal time. We can help with technical solutions but also with non-technical solutions."

Discussion

Overall, the student responses to this homelessness project for both semesters were remarkably similar. Although students in each cohort had different design projects, both projects immersed students in issues of homelessness. In Fall 2019, the project was semi-structured around a given design goal to prototype a solar water heater that would be compatible with a non-profit organization's mobile showers for individuals experiencing homelessness [2]. In Spring 2020, the project prompt was more unstructured and provided students a voice and choice in how they used their time and which products they wanted to create [20] regarding COVID public health responses. The COVID project was more open-ended and allowed students to explore their specific topic within homelessness in more depth. The similarities in responses between the two groups of students suggests that the project topic itself plays a minor role in student engagement with issues regarding homelessness.

It was observed that the number of instances when students mentioned inherent deficits and meritocracy as the causes for homelessness decreased after the students worked on their project (i.e., the intervention). We also observed an increase in the number of instances where students' approaches to solving problems from a technical-only standpoint to a more holistic, sociotechnical perspective. This indicates that students started to see the complexities of solving social problems, and that sometimes a technical solution needs to be implemented along with a social approach. We also observed an increase in the instances where students took a counternarrative stance against negative views of individuals who experience homelessness. Although some of these perspectives changed, there were students who held strong deficit-oriented attitudes toward homelessness.

Due to the increased authenticity of a real-world context and increased student choice and voice [2, 20], we expected students from the spring semester to be more attuned to issues regarding homelessness due to their own sustained inquiry within their topic of interest – however, this was not the case. This lack of change may be due to two confounding factors. First, recall that Spring 2020 was the semester in which many institutions of higher education moved to Emergency Remote Teaching mid-way through the semester due to the global pandemic [21], our university included. Completing the second half of the semester online during the pandemic, which included the entirety of the final project, may have contributed to decreased absorption and achievement of course objectives, particularly when these course objectives depend on students embracing vulnerability and humility when engaging with and valuing social issues as important in engineering contexts. Second, students in the spring did not have the same on-campus exposure to homelessness exhibits as students in the fall did. This includes not only the campus-wide presence of Homelessness and Food Insecurity Awareness Week, but also the related class assignments and engagement activities assigned to the Fall students. Yet, though one may fully expect the level and type of engagement that students have with homelessness issues to play a role in changing their perceptions, we did not see more critical responses from students in the Fall semester.

However, we still observed that the intervention appeared to work in both semesters. For example, in Question 7 regarding the major reasons why people are or become homeless, we observed in both semesters that the top 3 categories for student responses remained the same, but what students attributed to inherent deficits in the pre-survey had decreased by the post-survey. In both semesters, students' opinions of the role of engineering in addressing homelessness (Q8) indicated a decrease in technical and meritocratic elements, while increasing in sociotechnical and socially responsible elements. Our intervention seems marginally successful in communicating that engineering alone cannot solve homelessness, as shown by Q10 where students indicated that sociotechnical elements (which increased from pre to post) rather than technical elements (which decreased from pre to post) are critical to addressing homelessness. Additionally, students' understanding of counternarrative elements also increased in both semesters, suggesting that we were able to combat some of their preconceptions about homelessness.

Whereas we were able to *shift* students' perceptions, there were some misconceptions that we were unable to entirely deconstruct (i.e., they appeared less frequently but did not disappear in the post data). For instance, the concept of meritocracy is very much ingrained in the thinking of our society [8], which can influence how students respond to the world around them, as we observed in their responses. The discourse about meritocracy is so powerful in the United States that short exposures to the myth of meritocracy are insufficient for deconstructing it completely.

This study emphasizes the importance of integration of the liberal arts and social issues throughout the engineering curriculum, not just in stand-alone activities. Empathy and awareness of social impact need to be practiced to be learned, and our teaching must include deep conversations about inequity to help our students through the deconstruction of their misconceptions. If our goal is to help students develop a critical awareness of their impact as engineers [22], these conversations need to be embedded within and throughout the curriculum. We admit that complex topics such as social justice and sociotechnical thinking are challenging for first year students to grasp. However, the reader may be encouraged to know that this class is only the first step in exposing our engineering students to these concepts -- in addition to this lower-division design class, our students also take an upper-division Engineering and Social Justice course [1], alongside multiple courses throughout our curriculum that emphasize engineering as a sociotechnical endeavor [1, 2, 21, 23-25].

Limitations

Some of the limitations of this study are conditioned by the circumstances of the two semesters these projects were assigned. Not only did the two semesters have different projects and access to interactive exhibits (i.e., Homelessness and Food Insecurity Awareness Week), but the second iteration was also impacted by the global pandemic and the sudden shift to emergency remote teaching. These two factors likely impacted how students participated in the class and engaged with the material, which in turn would have affected how they responded to the project, to the questions asked, to the contextualization occurred. Additionally, some student

responses could not be included in the data analysis process due to lack of contextualization in the responses themselves (i.e., incomplete responses). Without additional context in what the student is referring to, we could not code the response appropriately.

In both iterations of the study, the course is only one semester long and early in the engineering curriculum. The study collects pre- and post-survey data at the beginning and end of the semester, which may not be sufficient time for students to absorb lessons regarding the sociotechnical nature of engineering from the course. Anecdotally, we have observed students' appreciation of this course increasing as they approach graduation, more so than when they are in or have just completed the course. Future studies may recollect the post survey data later in students' college career after the lessons learned in this course have had more time to sink in.

Conclusion

The work described in this paper contributes to the growing body of knowledge related to social justice education in engineering. The results show that curriculum materials that seek to challenge deficit perspectives of students can be effective in providing a more sociotechnical approach to engineering. This work also indicates that there is a shift in recognizing the structures of social problems that engineers are often involved in. However, this complexity in problem-solving and decision-making in engineering work will not become tangible for students if the social aspects are never included. It is important to engage students in these activities to counter the depoliticization of engineering narrative and move toward a space where social justice work through engineering is attainable.

Although some of the students attitudes and perceptions may seem to fall in the "naïve" side of things [15, 26], we argue that the first step is exposure to the realities that surround all engineers - whether or not they are directly impacted. It is important for students to learn how to read the word and the world around them [27, 28]. Nonetheless, one must be aware that these types of interventions need to first explore how students interpret social justice issues in the context of engineering. Not all students will agree with what is being said in the classroom, and not all students will concur that engineers bear responsibility for their work. Thus, these interventions require deconstructing strong-held beliefs that are sometimes perpetuated in the classroom itself.

As indicated in this paper, student responses tend to align with the idea that engineering is primarily a technical profession (i.e., providing efficient, cost-effective solutions) and social actors and actions are seen as tangential to or separate from engineering work. Also, we noted that most engineering students do not see themselves as being agentic actors or agents of change – rarely mentioning their role as citizens. Thus, it is important to acknowledge that not all students come to the classroom with the same level of critical perspectives and abilities. Engineering educators must recognize that attitudes and belief systems, such as meritocracy and depoliticization, come from an engineering discourse that is formulated in the classroom and emulated by the students. There is growth that needs to happen, but if students are never exposed to these conversations no development of critical consciousness will ever be achieved.

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