Critical, Motivated, Hopeful: Empowering Students Through Sociotechnical Data Science Ethics Education

Article *in* Teaching Ethics · July 2024

DOI: 10.5840/tej202478152

CITATIONS
0

READS
126

2 authors, including:

Desen Ozkan
University of Connecticut
33 PUBLICATIONS **171** CITATIONS

SEE PROFILE

Critical, Motivated, Hopeful: Empowering Students Through Sociotechnical Data Science Ethics Education

Desen S. Özkan
University of Connecticut
Nicholas Rabb
Tufts University

ABSTRACT: Ethics education and societal understandings are critical to an education in engineering. However, researchers have found that students do not always see ethics as a part of engineering. In this paper, we present a sociotechnical approach to teaching ethics around the topic of surveillance technology in an interdisciplinary, co-designed and co-taught course. We describe and reflect on our curricular and pedagogical approach that uplifts cross-disciplinary dialogue, social theoretical frameworks to guide ethical thinking, and highlighting collective action and resistance in our course content and praxis to inspire students. Through a reflexive thematic analysis of student reflection writing, we examine the ways students relate society and technology, generate ethical skills and questions, and are motivated to act. We find that, in fact, this approach resonates with student experience and desire for discipline-specific ethical analysis, and is highly motivating.

Introduction

"Of all the previous classes I've taken that have even touched on ethics, the treatment was never great. For example, I took a class entirely focused on the ethics of computers. The class promised a deep dive into real ethical problems that computer scientists need to think about. . . . However, I found it focused far too much on buzzwords: self-driving cars, AI sentience, and post-humanism. These topics, and their corresponding in-class discussions, I found far too abstract to take anything meaningful back into the workplace. [. . .] I believe this class, however, does strike a great balance between ethics discussions and transferrable skills. I strongly believe I am leaving this class with a better understanding of

> privacy, how it's been violated in the past, and how it's being violated in the present. I know how to identify and research privacy scandals for tech companies, which will help guide me to a better fitting career for myself. The social considerations in this class have given me skills to design an equitable platform, taking into account surveillance in the past and present." [Final reflection of a computer science graduate student]

WE BEGIN THIS SCHOLARSHIP with a computer science graduate student reflecting on past experiences learning about ethics in STEM. For this student, the course that will be described in this paper was not his first experience with ethics but did offer elements of authentic ethical learning that this student sees himself taking into his career. Ethics education, specifically in engineering and computer science, is not a new endeavor, as practitioners in these fields have called for better ethics and sociotechnical education since the Cold War era (Wisnioski, 2012).

Engineering ethics can be conceptualized as the points in which engineering and society touch. However, engineering and society are so intricately intertwined that there is no engineering without society. Thus, as we think through engineering education, ethics education and societal understandings are critical to an education in engineering. Ethics in engineering has a place throughout the entire engineering process: from who are the engineers and who is funding the project, to the context in which the project is designed and implemented. However, in engineering ethics education scholarship, researchers have found that students do not always see ethics as a part of engineering (Hess and Fore, 2018; Niles, Roudbari, Contreras, 2020; Tormey et al., 2015). Not unrelated, engineering ethics education has also struggled at the curricular level to be integrated into the discipline; often relegated to short modules in the cornerstone and capstone design courses (Barry and Ohland, 2012; Colby and Sullivan, 2008).

In this paper, we present a novel approach to teaching ethics around the topic of surveillance technology in an interdisciplinary, co-designed and co-taught course. We describe and reflect on our curricular and pedagogical approach that uplifts cross-disciplinary dialogue, social theoretical frameworks to guide ethical thinking, and collective action and resistance in our course content and praxis. We position this scholarship as a way to engage students in the ethical and interdisciplinary problem of surveillance. In the course, we draw from past and present examinations of surveillance to connect and motivate students to problems and practices they already are a part of to help them apply and imagine different futures. Through a reflexive thematic analysis, we examine the ways students relate society and technology, generate ethical skills and questions, and are motivated to act and hope. We find that, in fact, this single problem-based approach resonates with student experience and desire for ethical analysis, and is motivating because itt invites students to engage deeply with a complex sociotechnical system.

Background

The method of teaching engineering ethics is varied: content varies from micro-ethics in which the individual choices are emphasized to macro-ethics in which the engineering profession is becomes the center of ethical analysis. In this section, we provide a brief overview of micro and macro ethics education and then discuss the role of case studies in this education. We end by connecting these various types of ethics education to notions of sociotechnical engineering education, which is the orientation we take in this study.

Herkert (2005) argues that there is a need for both of these ways to teach ethical problem solving. In micro-ethics, engineers are discussed as individual agents to prepare students to engage in ethical dilemmas. Students are often equipped with professional codes of ethics and/or ethical frameworks like deontology, virtue ethics, consequentialism. The engineering profession's codes of ethics can be seen to exemplify the overarching values and norms for the engineering profession (Smith, 2021), but do not necessarily emphasize contextual understandings or historical inequities. Engineering education scholars have written more on the limitations of these codes as they operate in the abstract (Riley and Lambrinidou, 2015). While these can help students justify their engineering decisions, they are limited in how they are taken up by students, and not always relevant to their engineering learning (Hess and Fore, 2018). To date, micro-ethics education in engineering is perhaps the most prevalent mode of teaching engineering ethics (Bielefeldt et al., 2016; Colby and Sullivan, 2008; Herkert, 2000; Hess and Fore, 2018), yet macro-ethics education has become more common in the engineering curriculum.

Macro-ethics brings an understanding beyond individual actions and responsibilities to thinking about the broader engineering profession's responsibility while developing technology (Vanderburg, 1989; Herkert, 2005, Polmear Bielefeldt, Knight, Canney, and Swan, 2018). Through macro-ethics, Polmear et al. note that students can engage with the "ethical considerations of the profession and the societal impacts of engineering, including sustainability and social justice" (2018, p. 867). Proponents of a macroethics approach discuss its emphasis on contextualization of engineering that draws from the field of Science, Technology, and Society (STS) (Chance, Lawlor, Direito, and Mitchell, 2021; Conlon and Zandvoort, 2010; Kleine, Zacharias, and Ozkan, 2023).

Case studies are perhaps the most popular mode of teaching engineering ethics (Martin, Conlon, and Bowe, 2021), and can be used at different scales to engage students in micro-ethics and macro-ethics education. They can be short in duration, taking the form of briefs that span just one class unit, or they can be long, taking up several weeks as students engage in the different ideas over time (Davis and Yadav, 2014). Educators have adapted cases from factual scenarios based on historical or current events in engineering. Through factual cases, students can use publicly available data and documents that have to do with the case (Newberry, 2010; Byrne and Svanström 2012; Doorn and Kroesen, 2013;

Shallcross, 2013). There are also hypothetical cases that educators have used to engage students in fictional accounts that are particular to specific learning goals (Watkins, 2017). However, as in many educational adaptations, cases can oversimplify the complex ethical contexts they are being adapted from.

While ethics in the engineering curriculum has often been taught in a standalone course or module that does tie into other facets of the curriculum, ethics are always present in real engineering contexts (Martin, 2020; Leydens and Lucena, 2017). Historically, the culture of engineering has posited that engineering and science are neutral and objective, which has led to the devaluation of social, political, and even economic aspects of engineering in favor of more technical processes (Cech, 2013; Godfrey, 2014; Mitcham, 2009; Roeser, 2012; Riley, 2008). This socio/technical dualism is what Erin Cech describes as a culture of disengagement in engineering in which anything outside of the technical is deemed to "be of lesser value or outside the scope of engineering" (Cech, 2013; Niles et al., 2020, p. 498).

In bridging fields of engineering ethics and sociotechnical orientations, Martin, Conlon, and Bowe (2021) call for eight action items to bring about this reorientation. To list a few items relevant to this study, Martin et al., call for educators to reimagine what it means to be an engineer, uplift the humanities in engineering education, prepare students to engage in engineering and social justice, reflect on our socio-environmental contexts, and address political and socio-economic factors as they inform and influence engineering practice (Martin et al., 2021). In our curricular approach and study, we draw from sociotechnical engineering education research to help students wrestle with the power relations within engineering and surveillance and examine these power relations over time. Through this course, we emphasized the value of questioning the present by examining the past 'problem' the present solution (now problem) was poised to fill. In the next section, we describe our curricular approach in more detail.

Curricular Approach

We describe the course structure and our pedagogical approach to give insight into how we embodied a humanistic, sociotechnical treatment of ethics—in the material we chose for class, and the method by which we engaged with it. To create a course that encouraged students to develop critical thinking around surveillance technology, we put careful intention into the design of both the structure of the class, and our pedagogical practice. Encouraging students to adopt a practice of critical inquiry, in our view, was something that required special attention to the presentation of ideas in the classroom, how students interacted with material and each other, and the way students interacted with us as instructors.

Course Structure

This course was designed with three major sections: (1) Problem, (2) Practice, and (3) Application. Briefly, the *Problem* section ideally outlined the contours

of surveillance technologies while introducing students to key critical theory concepts, building a vocabulary of critique; the *Practice* portion emphasized the work of practitioners who are combatting surveillance and oppressive technology, ideally inspiring hope and a desire and blueprint for action in students; and the *Application* section allowed them to take these concepts and practices and put them into action by deconstructing a surveillance technology of their own choosing. Each section was designed with the others in mind, culminating in a progression that introduced students to problems with surveillance, revealed the tools that we used to identify those problems, and then encouraged students to use those same tools to critically examine and reimagine a real-world surveillance measure. At the conclusion of the course, it was our hope that students would have gained some facility with analysis and critique, crucial skills for navigating the world beyond the classroom with a mindset towards ethical behavior. We include a condensed syllabus in Appendix A.

Problem

To engage students in a critical inquiry of surveillance technology, we took inspiration from influential thinkers contributing to current trends in critical data science. Many notable works—including but not limited to Benjamin's (2019) *Race After Technology*, Zuboff's (2019) *The Age of Surveillance Capitalism*, or Noble's (2018) *Algorithms of Oppression*—take the tact of viewing data-driven technologies through social theoretic lenses, whether race and ethnic studies, gender studies, critical historical analysis, or otherwise.

By surveying a handful of these influential works, we identified at least five important dimensions of critical social thought that are frequently brought to analysis of technology: oppression, social logics, power, historical analysis, and theories of change. Oppression is frequently used as a lens to show how technologies reinforce logics like racism, sexism, class hierarchy, and others. Social logics like capitalism, neoliberalism, or democracy were often brought into discussion by these works to contextualize large-scale social forces that shaped how certain technologies came to be, and how they subsequently pursued goals aligned with these logics (e.g., for capitalism, technologies that seek to make a profit for a company). Power is widely considered in terms of who controls technologies, and how technologies give certain people or groups power while withholding it from others. Many notable works examine the historical roots of contemporary technologies—including analogues from the past and what forces shaped a technology's creation—to provide perspective on the continuity of social forces through technologies of past and present. And finally, theories of change are offered as paths leading toward visions for a more ethical technological future.

To foster ethical skills in students, we engaged with works that analyze technology along these dimensions, and further interrogated how they are intertwined with surveillance technology through class discussion and reflection. We believed that by deconstructing surveillance technologies with these social

dimensions in mind, students would develop an ethical vocabulary, being able to describe *why* surveillance technologies may feel wrong and for whom.

With each work that we assigned students in class, multiple of these dimensions of critical thought would be present in the material, and subsequently highlighted in the classroom. For example, when reading Browne's (2015) *Dark Matters,* students were introduced to the concept of racializing surveillance and to historical surveillance of enslaved people in the United States. Racializing surveillance, as defined by Browne, describes how surveillance technologies reify racial categories when they are used by the "white gaze," which classifies nonwhite behavior outside the bounds of normal. This concept introduces students to how surveillance technologies can further racial oppression. It also describes how surveillance technologies are used to secure the power of one group to the detriment of another. And Browne motivates her concept of racializing surveillance by describing examples of historical surveillance. One such example is surveillance of enslaved people in the U.S. through "lantern laws," which required enslaved people to illuminate themselves at night or face disciplinary punishment. This example and others brought historical context to students to enrich their skills of critique.

We also exposed students to surveillance technologies as they appear in several "sites" of surveillance, as Marx calls them (Browne, 2015): political economy of surveillance through Zuboff's (2019) *The Age of Surveillance Capitalism,* racial dimensions and history of surveillance through Browne's (2015) *Dark Matters,* contemporary forms of workplace surveillance (Guendelsberger, 2019), and state surveillance (e.g., by U.S. Immigration and Customs Enforcement (ICE) (Mijente, 2018) and by the Israeli government in the Occupied Territories in Palestine (Goodman, 2022), with help from Google). This array of texts was chosen so that students could get a sense of the breadth that exists when technology interacts with social forces. We hoped that students would see how technologies serve different social actors' needs (e.g., profit incentives for corporations under capitalism, territorial and geopolitical incentives for states) and how those same needs in turn drive technological development. We worked to counter students' notions of technological determinism in which many view the increase of digital technology as the reason for increased surveillance. Rather, surveillance has a long history that can be exacerbated or made visible by the increase of digital technology but is not caused by it. Specifically identifying examples of social structures driving surveillance technologies would ideally complement and solidify the dimensions of critical thought for students.

As we detailed unethical technology, we took pains to highlight explicit ethical action through resistance and change-making practices. These same works also uplifted historical acts of resistance to surveillance by enslaved people (Browne, 2015), resistance by blue-collar workers against their bosses' surveilling them (Guendelsberger, 2019), organizing by students to stop recruitment on campuses by tech companies who profit off of border surveillance (Mijente,

2018), and labor organizing by white-collar tech workers against unethical projects (Goodman, 2022). Traditional engineering education, for example through the examination of ethical case studies, does not take this extra step of detailing social resistance to unethical technologies. More frequently, traditional solutions are presented in technical terms, which in the context of data science, is often the improvement of algorithms (Costanza-Chock, 2020). Detailing specific resistance acts that go beyond technological changes was intended to further expose students to the sociotechnical nature of these problems and their ethics. Studies on critical thinking have suggested that deep engagement with real sociotechnical systems is necessary to facilitate "critical thinking in and about engineering" that includes "student questioning of course content, learning processes, and engineering in society" (Claris and Riley, 2013, p. 35).

In this way, our treatment of ethical thinking for data scientists differed from the typical approach, which often broadly surveys several ethically charged technologies through case studies. We saw value in diving deeply into surveillance technology, showing its complexity in and of itself. We had students research the stated problem each new surveillance measure was working to address—many of these problems were common reasons like public safety and ease of access. Students became used to asking *for whom*—who is considered the public when designing for public safety, and for whom is there ease of access? We hoped that this would demonstrate to students the value of deeply analyzing from multiple perspectives, something that may be lost in hypothetical or shorter treatments of ethical data inquiry.

Practice

After presenting students with the contours of surveillance technology—examined through critical theoretical lenses of oppression, social logic, power, history, and theory of change—we pulled the lens back and exposed students to frameworks to think about how to engage in critical practice: analysis, resistance, change, reimagination.

We worked to bring these ideas to students through readings, video, and classroom discussions. By reading chapters from D'Ignazio and Klein's (2020) *Data Feminism* and Costanza-Chock's (2020) *Design Justice*, students were exposed to data science projects that have aspects of justice in mind. Students also watched a talk from the International Conference on Learning Representations by Dr. Ruha Benjamin, an influential critical scholar of data science and technology, where she discussed a reimagining of the typical imagined trajectory of technology (Benjamin, 2020). This was all complemented by a special class session where we organized a panel discussion among several local change-makers: a local city councilor-at-large, a Harvard graduate student union organizer, and an employee of the American Civil Liberties Union (ACLU) of [State] who testified against surveillance technologies in our local cities. We believed that by having students engage with surveillance issues local to their everyday lived

experience, including meeting those who are actively resisting them, they would be able to connect more deeply to resistance, change, and reimagination.

We hoped that this type of content would inspire students to imagine that there are multiple ways to address the harms identified from outlining surveillance technology; whether through justice-oriented design, reimagination of technological purpose, or community-based politics. In a landscape where the "norm" in computer science and engineering is to decenter the human, social, and political dimensions (Cech, 2013; Malazita and Resetar, 2019), this intentional uplifting of practice was an attempt to ground students in a pro-social view of data science and technology. Moreover, allowing students to interface with those who have taken up the call to address problems in their community would ideally inspire hope in their minds, rebuking what can often amount to a nihilistic technological determinism, by showing the possibility and reality of shaping the direction of social technologies.

Application

Finally, the last section of the course saw students form groups, choose a surveillance technology to study, and conduct an analysis of the technology with the ultimate goal of presenting findings to the broader [University] community. This project encouraged students to analyze these chosen technologies along several lines of questioning. What is the "problem" the surveillance measure was purported to solve? What are the historical and present contexts in which the measure was developed? How has resistance manifested? What may a reimagined intervention or context look like?

Ideally, these questions would encourage students to use the skills built during the Problem and Practice sections of the class to arrive at a multi-faceted analysis with both depth and breadth. By choosing problems that students themselves thought were important, we anticipated that students would form deeper connections with the course material. In line with our pedagogical approach described below, we believe that learning is greatly facilitated when critical skills are applied to problems that students are intrinsically motivated to solve. Moreover, by presenting their critique and reimagination to the broader community, we anticipated that students would work to articulate their ideas in an accessible way for a varied audience, further deepening their learning by putting them in a teaching role.

The surveillance measures that students chose were highly varied, including projects investigating methods of surveillance by corporations, government agencies, and police forces. Out of 13 final projects produced by students, some examined Amazon Alexa, the Ring doorbell, New York City police surveillance of Muslims and Arabs, a gunshot monitoring tool called ShotSpotter, and U.S. government surveillance through COINTELPRO. We describe two of the projects in further detail to showcase how different student teams took up the open-ended project.

One student group focused on the Amazon Ring doorbell, which features a camera which records those who approach the door, and can potentially catch those who may, for example, steal packages. The group was formed by one computer science, one environmental engineering, and one women's gender and sexuality studies student. The interdisciplinary group incorporated surveillance theories from Foucault's writing on Bentham's panopticon (Foucault, 1977) to argue that Ring oversteps its stated goal of safety and rather embodied an all-seeing system that is too powerful. They critiqued that power by reporting Amazon's widespread partnerships with police, who obtain user data from Amazon through warrants, and wield what they see as "government-like power" in an unaccountable, undemocratic way. The group went further to critique the differential impacts of facial recognition technology that could be used in conjunction with the Ring's video feeds, which have been shown to misidentify people of color, especially Black people, and has led to false accusations of crime by police. From this research, the group generated several vignettes to be used as ethical case studies, evidence that learning the abstract theories affecting technological systems allowed them to identify specific potential harms in a more flexible manner than starting with case studies alone. They demonstrated a strong understanding of the social logics driving this technology, its interconnection with oppressive systems along racial lines, and provided a reimagination of the technology so it could serve its stated goal of home safety without overstepping. Moreover, they exemplified the positive learning that can occur when diverse students from interdisciplinary backgrounds collaborate and learn how to leverage each other's strengths.

Another group of three computer science students examined the technology ShotSpotter, which claims to listen for gunshots around cities and quickly alert police to potential crimes. The group pointed out issues with the technology stemming from the racist culture it is deployed in, reporting that ShotSpotter is mostly used in minority communities, and leads to over-policing of non-white neighborhoods. They referenced its over 70% false positive rate to argue that it does not reduce crime. Their project included an interactive simulation where attendees of the student project showcase could apportion a municipal budget to attempt to reduce crime in a digital city. They could choose several programs to purchase, including a youth jobs program, emergency aid, cleaning up vacant lots, or licensing ShotSpotter. The group also uplifted a grassroots campaign in the local area trying to remove ShotSpotter from their community. This project demonstrated the group's understanding that the benefits technologies purport to bring to the social world can also be brought about by social programs—ones which may have far fewer unintended side-effects, are more accountable, and are more effective. This project stood as a strong example of very technical students, all computer science majors, thinking outside of the typical paradigm of technological solutions to technological problems. Their engagement with different

theories of change demonstrated the efficacy of the course content sparking imagination in students.

These projects stood as impressive artifacts—products of students' desire to use what they learned in class to make sense of the world around them and move to change it. Student projects were demonstrated and exhibited by the students themselves during a final project "gala," open to the [University] community and beyond. The community gala is described further in Appendix B.

Pedagogical Approach

In addition to the intention put into the flow and design of course material, we took special care to infuse the course with pedagogy designed to critically engage students, paying particular attention to experiential learning, building a community inside and outside of the classroom, disrupting typical power dynamics and notions of expertise, and embracing the emotional realities of learning through empathetic discussion. For considerations of space, we include a more detailed discussion of our approach in Appendix B.

Briefly, we based our pedagogy on influential educators of critical and progressive pedagogy like Friere (1970), Dewey (1916), hooks (1994), and García Peña (2020). Ethical education depends on students' ability to learn to see themselves as ethical actors in an unethical world, requiring a pedagogy that acknowledges their world, and allows course material to interact within students' individual contexts. We heavily utilized group discussion and individual reflection to encourage students to process content in community, to verbalize their context, and to relate lessons to their real lives. In this way, students were active, experiential learners; perhaps best exemplified in their mid-semester and final projects, where they chose a surveillance method to deconstruct and reimagine, practicing ethical skills in situations that matter to them.

Research Methods

In this study, we examined the reflections of engineering, computer science, and liberal arts students enrolled in a novel special topics computer science course on data, power, and surveillance. We employed a reflexive thematic analysis (Braun and Clark, 2006) to investigate students' critical engagement with societal values in technology and their ability to generate ethical skills and questions. Braun and Clark describe thematic analysis as "a method for identifying, analyzing and reporting patterns (themes) within data" (2006, p. 79).

We are guided by a constructivist philosophy to make meaning from student perspectives and reflections that we then connect to broader scholarship on societal values in technology and ethical skills (Patton, 2002). As students come from cross-disciplinary backgrounds, we found it important to carry out the analysis using an iterative inductive approach to allow for the themes to emerge from the data rather than applying a pre-existing framework developed for specific contexts of students and people (Patton, 1990).

This work is guided by three research questions:

1. How do students see society and technology in relation to each other?
2. How do students critically engage with societal values of technology?
3. How did students develop in their ability to generate ethical questions and behavior?

Our first research question captures broad and less developed student reflections on the ways society and technology are intertwined and interact. The second question is to examine specific values or logics that students name in discussing the interrelations of technology and society. The third research question is to examine the skills and actions that students point to having learned and carry into the future.

Research Setting and Participants

The study is situated in a computer science special topics course at a medium-sized private university in New England. The course was designed for students from all backgrounds and had no prerequisites. The course was co-designed and co-taught by the two authors who have degrees in engineering and computer science. The course was taught for the first time in the Fall of 2022, in which 38 students enrolled. In Table 1, we share participant information with respect to their majors, class years, and gender.

We had 21 students consent to participate in the research study. The consent process was carried out by an outside researcher who introduced students to the study during a class period and collected consent. Consent documents were not given to the co-teachers and researchers until the semester was complete and grades were submitted. Approval from the university's institutional review board was obtained to conduct this study.

Table 1. Participants information.

	Total Students	Women	Nonbinary	Men	Students of Color	White Students
Science, Math, Computer Science, Engineering Majors	14	7	1	6	11	3
Liberal Arts Majors	7	6	0	1	2	5

Data Sources and Analysis

The course assignments were the main source of data in this study. These consisted of weekly journal assignments where students reflected on a prompt, discussion posts where students posed one to two questions on a reading, mid-semester and

final project reports, and a final semester individual reflection. In our findings, we focus largely on the individual final reflections to answer the research questions, which is listed in Appendix C. The weekly journals and discussion posts served as a method of triangulation to understand how students developed their ideas over the course of the semester. Additionally, the mid-semester and final project documents were helpful to examine, as many students referred to what they learned from these processes in their final reflections. While the weekly assignments and project documents do not appear in the findings of this paper, they were necessary to the process of analysis to ensure that the individual final reflections were taken in context and understood as the students intended.

The first and second authors reviewed all of the data and engaged in the iterative inductive coding process (O'Reilly, 2005). Specifically, we conducted a line-by-line open coding of student final reflections. From themes that emerged, we were able to track down other discussions of them in the recurring reflective assignments leading up to the end of the semester. For trustworthiness, we engaged in reflexive debriefs on our interpretations of student thinking throughout the coding process. This form of dialogic engagement is critical to ensure that we are interrogating our interpretations with each other, as we each have different disciplinary backgrounds and lived experiences informing our interactions with the ideas shared by students (Creswell and Miller, 2000).

Limitations

While our results are noteworthy, they are a first step, with further investigation necessary. Our small sample size of consenting students (21) lends us only so much inferential power. More studies and larger samples are necessary to ameliorate this shortcoming. Moreover, the institutional context of the private, New England university brings us a certain type of student in that, on the whole, they have had more opportunities to excel than the average student. Lastly, the course was offered as a special topics class, self-selecting for motivated students already interested in the topic. Future research should expand the scope of this type of study to include more representative students.

Findings

We now present our major findings from thematically analyzing student reflection response assignments. Throughout our analysis, we identified several prominent themes that we share below. Within a discussion of each theme, student quotes are shared, noting each student's discipline and some demographics at the end of the quote. In Table 2, we display a breakdown of themes discussed by student major, showing in each cell both the total number of students who echoed a theme and a percentage proportional to the total number of students of that discipline.

Table 2. Number and proportion of surveyed students who discussed major themes

	Relation of Technology and Society	Social Values and Logics	Ethical Skills	Student Motivation to Act Ethically	Interdisciplinary or "Different" Class Environment
Computer Science/ Engineering Students (14)	12 (85%)	9 (63%)	10 (71%)	9 (63%)	7 (50%)
Liberal Arts Students (7)	2 (29%)	4 (57%)	3 (43%)	7 (100%)	4 (57%)

Relation of Technology and Society

Students in the course have varied disciplinary backgrounds and came to relate technology and society in different ways. In this theme, we detail the different ways students are beginning to relate a social or political dynamic to technology without naming a specifical social logic. These initial ways of relating technology and society ranged from thinking about technology companies as social actors, wrestling with public and private entanglement, reflecting that people create and maintain surveillance technologies, noticing that intent of technologies can be hidden, and overall costs of technologies.

In a final reflection, one computer science junior described how her "conception of technology and computer science has changed." She states:

> "I never realized big tech companies were such a pressing issue in terms of surveillance. I learned that ethics is a huge part of technology and computer science and that a lot of well known companies are creating dangerous technologies without the knowledge of consumers and even their own employees. We had many discussions in class about a lot of the big tech companies and how some of them sell dangerous technologies to the military and/or government or how companies use technology to surveil employees and how types of surveillance like this can be harmful to workers." [Computer science, third year, she/her]

This student, new to relating technology and society, shows that she is beginning to form concepts around technology and society as public and private entanglement. She points to the transactional relationship between companies and government entities as well as citing the lack of knowledge workers can have when creating dangerous technologies. While these are general descriptions, this student is demonstrating her conceptualization of technological development and profit.

While the computer science student is newer to wrestling with the societal interrelations of technology, we share reflections from a humanities student who

similarly was newer to the technological interrelations of society. This student reflected that:

> "Taking this class opened my eyes to the many ways my majors [political science and women and gender studies] apply to the STEM world."

She goes on to state how "This class showed [her] how to apply theories of politics to the rising field of surveillance technology and understand the dangers of technology without government oversight as well as the dangers of government oversight itself." This student describes different issues in surveillance technology to now connect to her major: linking to "Gender Studies," in which, she states "this class revealed the ways in which societal norms are inscribed in technology and the ways in which technology perpetuates racial, ethnic, and gender stereotypes." Ultimately, this humanities student is able to bridge her disciplinary background to her newly developing understanding of technical dimensions. She concludes:

> "Technology and data has far more to do with my fields of study than I ever thought it would, and this class really opened my eyes to the ways theories I have learned can be applied as a lens through which I can observe the real world." [Political science and Women and gender studies, third year, she/her]

Social Values and Logics

Similarly, but distinct from generally relating technology and society, we also observed a theme of students uplifting specific social values and logics in their reflections. By social values and logics, we are referring to more specific, organized social theoretical schema that could be used to comment on surveillance. For example, referencing concerns of power dynamics, class dynamics, racializing technology, surveillance capitalism, genealogy, or disciplinary power, indicate to us an understanding of specific logics and frameworks being used to describe the world.

A few students noted the interaction of surveillance technology with racial oppression—particularly students of color. One human factors engineering student noted:

> "Particularly, Browne's readings helped me think more about the intersections of race and technology, and how they personally affect me and my communities as a Latinx woman. Reading about the ways early technologies were used to surveil enslaved Black people, with items as simple as lamplights, to the ways they are used in modern day Palestine, was enlightening." [Human factors engineering, fourth year, woman]

What is notable to us is this student's resonance with the material as a Latinx woman, and her tying historical racialized surveillance to modern issues. There are notes of genealogy here, reflecting on the idea that racialized communities who are surveilled today are subject to similar oppression to predecessors. This type of resonance with lived experience, having students use theoretical tools to make sense of their own lives, was echoed by other students:

> "I came into this course with anecdotal and qualitative knowledge of surveillance capitalism and racialized monitoring through my lived experiences as an Arab American in post-9/11 New York. . . . I came into this course with a very clear understanding of the real-world implications that racialized surveillance can have on the health and livelihoods of communities of color. What I didn't have, however, was the vocabulary, background readings, and technical ability to call out this surveillance, label and define it, and pose ways to evade and resist it." [Community health and Arabic student, fourth year, she/her]

Again, a young woman of color, in this case an Arab American woman, understood the tactics and effects of surveillance, but found the course content helpful in giving language and vocabulary to her experience. She specially references surveillance capitalism and racialized surveillance, evidently having linked these concepts to her world model.

Other students uplifted different theoretical concepts when reflecting on their learning from the class. Two international graduate students, both data science majors, shared their resonance with concepts of power, control, and discipline. One student mentioned that he was, "inspired by Foucault's theory of the [Panopticon] and his consideration of surveillance and disciplinary systems in contemporary society." Another expanded on this idea of power and discipline, remarking:

> "Powerful organizations may use technology to maintain control and suppress dissent. In some cases, this can lead to abuses of power and the erosion of civil liberties. We can find numerous cases of big companies like google using their technology and information disparity to monitor users' behaviors." [Data science graduate student, second year, he/him]

These students latched onto the idea of organized power, and institutional use of surveillance as a means of control. Specifically referring to the Panopticon, disciplinary power, and suppression of dissent, these two students related the material to their lives and personal investigations into state surveillance by the Chinese government. But they noted, especially the second student, that corporate power can also erode civil liberties or lead to abuse. Counter to what may be a stereotypical assumption of STEM students, these two internalized and eloquently utilized social theoretical concepts to discuss their learning about surveillance in a style that may be typically considered a "humanities" analysis.

Ethical Skills

Beyond simply naming and detailing the problem with surveillance technology, students' learning extended beyond discussion of what is wrong—many explicitly bridging into what to do about it. We organize student reflections around a third theme of ethical skills. These were broad in scope with commonalities in how students described their insights from the curriculum. The different types of ethical skills that came up in our analysis were critically questioning systems, pointing to theories of change, critiquing different technologies' impacts, and citing a responsibility to be ethical. Notably, we examined students' usage of these skills to *generate* ethical case studies in their projects—a demonstration of skill beyond simply analyzing case studies already given in class.

A computer science student reflected that she would "take away how to dig deeper and question more often" and then gave an example of what this process would look like for her. She shared an insight from digging deeper and questioning a specific surveillance technology with her group members on the mid-semester project:

> "A lot of new technologies are disguised as useful revelations that will have positive impacts on society, when in reality there's a darker motive as to why these technologies are being brought to the public. We did a lot of research on OMNY which is the contactless payment for the New York City public transit system. Although it's disguised as an easy way to pay for transit, OMNY collects data of who enters the subways or bus and gives this data to NYPD and even ICE. This information was actually extremely well disguised because we were only able to find a handful of resources about the harmful collection and distribution of data, and since OMNY is relatively new, their website gave us no information." [Computer science student, second year, she/her]

Interestingly, this research and these insights did not return later in the course, as the group's final project focused on a different topic. However, the process of examining the OMNY surveillance measure seemed useful as a practice of investigation that stayed with this student enough to be a part of her final reflection.

A different student, one double majoring in computer science and social science, connected aspects of the course to her prior research experience in climate change. She states:

> "This class made me think a lot about global issues in a broader context. Most of my prior research experience has focused on climate change. As such, I was initially very set on finding a job or pursuing higher education in the energy sector. However, I started to realize through studying surveillance that many of these seemingly isolated issues are transnational and global in nature. . . . I recently read an article by the New York Times titled 'The Global Carbon Surveillance State Is Coming,' which made me think about the intersection that surveillance and climate change issues

> that could have in the near future. Assessing the real-time state of carbon emissions could drastically change the conventional way we address climate change and the typical obligations that are placed on nations. . . . I am fortunate to have gotten an introductory exposure to the issue, which I think will stay with me in the coming years as I work to tackle different, yet related, global issues. [Computer science and international relations student, fourth year, she/her]

This student, already majoring in cross-disciplinary fields, is drawing connections between her insights from surveillance technologies inspired by the course to her interests in climate change issues. The ability to draw connections between seemingly disparate topics and disciplines is an ethical skill that is not always given space or modeled in single discipline courses.

In her reflection, a different computer science student posted a strong critique of her CS curriculum to date:

> "My curriculum failed to teach me how to think ethically as I had a skewed conception of technology with views that computer science was a theoretical discipline with no significant moral consequences. However, I strongly feel that such flawed conceptions of technology perpetuate systemic injustices and harm vulnerable groups of people, which is the opposite of what I want to do as a programmer. In this regard, I can confidently assert that this course has expanded my understanding of how computer science intersects with the social, economic, and political forces that shape the world. Therefore, I am more cognizant of the ethical sphere of computer science, leading me to confront stigmatized topics and questions there aren't obvious answers to." [Computer science student, second year, she/her]

This student brings a sociopolitical understanding of technological contexts that inform her ability to examine the impacts of technologies in different contexts. She is clear that current methods of neutrality in computer science only serve to perpetuate existing harms, thus noting that she will bring an understanding of the social, economic, and political forces that shape the world into her future work as a programmer.

For the social science and humanities students, there was also an emphasis on ethical skills. A humanities student shared that the focus on resistance to surveillance technologies were critical in changing her conception of technology. She writes:

> "I feel that my understanding of resistance measures grew substantially during this class. Some of the readings challenged my prior assumptions about what resistance might look like. For example, I tend to wholly reject the philosophy of modernity and its implications. I thought Simone Browne's concept of 'sous-veillance' introduced some interesting nuance

> to the question of resistance. During this unit I thought further about the limits and benefits of using technology to resist technology—for example hacking, taking videos, or using social media. Generally I believe that 'the master's tools will never dismantle the master's house,' however, I came to question whether technology is intrinsically a tool of oppression." [International relations and Race, colonialism, and diaspora student, third year, she/her]

This student described how her conception of technology expanded such that specific examples of technology in use challenged her views that it is intrinsically a tool of oppression to bringing more nuance to this view.

A second humanities student reflected on a side project she worked on during the course that was inspired by the topic of surveillance. She shared this example of ethical skills in her reflection:

> "It was also exciting to take a lot of the things I learned in this class and use them to write a [University Magazine] article on Surveillance. I found several examples of surveillance at [University], from the recently expanded parking/surveillance camera system to [University Police Department's] surveillance tactics to educational surveillance. I hope this is an issue that the [University] community continues to engage with, and that the administration takes seriously." [Computer science student, fourth year, she/her]

This student, working as a student journalist, examined her own community's practice of surveillance and through an investigation was able to publish an article documenting surveillance measures in use on campus.

Student Motivation to Act Ethically and Actively Hope

The next theme we drew from student responses was a desire to not just think ethically, but to *act* ethically without giving up, overburdened by despair. In our view, this is a crucial step in the process of developing ethical practice. Action is key, or else what remains is all talk. Moreover, in our view, taking action *requires* hoping that change is possible, so students must adopt a hopeful but realistic attitude in order to act ethically.

This theme was additionally important to us because we observed that students often had a hopeless attitude about changing the state of surveillance, and acting ethically in general. In their reflections, students noted that this topic may be "discouraging," "grim," or "hopeless," with a risk to "leave the class feeling pessimistic," or "[lean] towards nihilism." In light of these risks, we were heartened to see that students actually felt empowered in the aftermath of the course. Notably, two students who were worried about the potential hopelessness of the course content shared that the change-maker panel inspired them to embrace action:

> "Often when courses focus on a topic that might be discouraging to learn more about, like the state of surveillance, students leave the class feeling pessimistic—but with this class, I felt like I understood what I could do to combat surveillance in my life and community, while also acknowledging that there was only so much I could do alone and that real change comes from building collective power in a community." [Computer science student, fourth year, she/her]

> "As someone who leans towards nihilism, I find considering how one can work towards the larger project of abolishing a specific system through smaller mini-abolition projects to be a sign of hope. This allows anyone engaged in the transformation to focus on the root of the problem rather than wasting energy to find a surface-level solution that maintains the status quo." [Race, colonialism and diaspora student, fourth year, she/her]

Seeing others tackling the issues that worry them proved to be a powerful form of inspiration and motivation to act. Not only were students empowered by the panel of local organizers, but they also called out that their worry of the analysis being too depressing was assuaged by finding examples of organizations who were tackling the issue, something that was encouraged as part of the final project:

> "Luckily, however, not all of this research was grim and hopeless. I learned that there are actually many organizations recognizing and combating these issues, and that the burden of decolonizing surveillance and dismantling invasive policing is not the sole responsibility of any one group or entity in particular." [Community health and Arabic student, fourth year, she/her]

Others also found the presentation of their research and findings to a broad community empowering, noting the reactions of those who came to view their exhibition on the U.S. Transportation Security Administration (TSA) surveillance in airports:

> "I truly felt I was able to make an impact when I spoke to people at the fair. I saw the looks of shock in their eyes when they started to realize the significance of taking off their shoes at the airport. That reaction was enough to convince me about the importance of educating the public and spreading awareness about such topics." [Computer science and International relations student, fourth year, she/her]

These are all powerful examples of students learning through experience, example, and their own preliminary ethical actions facilitated by the class. Both computer science and humanities students expressed the same fears and showed the capacity to push past them and learn to fight for justice.

Interdisciplinary or "Different" Class Environment

While we have emphasized that the students enrolled in the course came from different disciplinary backgrounds, this does not always mean that they can engage in interdisciplinary work. In this study, we take interdisciplinarity to mean that people from different disciplines are learning from other disciplinary ways of thinking in ways that help them reflect back on their own disciplinary perspective (Rhoten, Boix Mansilla, Chun, and Klein, 2006). In their final reflections, students pointed to the interdisciplinary aspects of the course. A humanities student stated that "studying alongside students who concentrate in STEM gave perspective on how my peers were approaching questions of surveillance." This student went on to say why these perspectives stood out.

> "Generally, my classes are full of students whose academic interests are parallel to mine, which hinders our ability to engage in discourse on a topic. While I also learn a lot from these classes, it was helpful for me to hear other voices. For this reason, our class discussions were my favorite part of the class. I really liked when my classmates brought in their experiences and knowledge from other courses. It made me think more deeply about how pedagogical methods differ in the hard sciences and the humanities." [International relations and Race, colonialism, and diaspora student, third year, she/her]

Specifically, this humanities students pointed out that her "classmates in Computer Science approached certain topics with a much more grounded lens." A different humanities student discussed appreciating her position "as a non-STEM major." She specifically stated that "[she] loved feeling like [her] perspective had a soldi place in [the] class discussions." The in-class discussions were important learning spaces for students to engage with their cross-disciplinary peers' ideas and build community.

Computer science students had similarly appreciative reflections in discussing their liberal arts peers. One CS student remarked on past ethics of computer science experiences in relation to being able to learn from her humanities classmates. She states:

> "I have sat through so many 'ethics of computer science' discussions that are typically on the last day of the course and do not even scratch the surface of the work that needs to be done to educate computer science majors on the nature of their field. I feel I learned just as much from the other people in our class as I did from the content itself. Specifically, the people majoring in political science and other humanities disciplines were incredibly helpful giving historical context I am not well-versed in. I loved the format of the small presentations mid-semester and all of the final projects because it allowed me to learn from other groups' work and not just my own project." [Computer science and liberal arts co-major, second year, she/her]

Importantly, students reflected that their existing perspectives and ideas were welcome in the class. One student commented on this by stating that "[the class] started from the point that students walked into the course with their interests rather than being empty vessels to fill with information." Both this student and a student above reflected on the pedagogical methods in this course—an aspect of teaching that can be rendered invisible. As we discuss in our pedagogical approach, teaching is a series of choices before, during, and after each class thus being transparent and reflexive of this process is important to model for students as they develop their own ethical practices in their contexts.

Discussion and Conclusions

By designing and teaching a sociotechnical course examining surveillance technology through social theory, contemporary examples, and student experience, we strove to impart in students a type of ethical skill that would help them navigate an inherently political, technological world. Through intentional curriculum and pedagogical design, we integrated critical theoretical concepts with the human dynamics present in our classroom to create a learning experience where students could meaningfully integrate ethical considerations and a desire to act ethically into their own lives and worldviews. By analyzing student reflections on the class, we found prevalent themes in their writing indicating that students did, indeed, come away with nuanced understandings of a sociotechnical world, a shared vocabulary to define and discuss that world, a cooperative and interdisciplinary spirit, motivations to act ethically to mitigate technological harm, and a sense of hope and possibility for change.

This method of "teaching" ethics (truly, inviting structured exploration by lending tools and support to help students make sense of their world and what they already care about) seems to succeed where typical engineering ethics education falls short. The typical approach, centering "objective" philosophies of consequentialism, deontology, or virtue, remains too abstract and irrelevant to students (Riley and Lambrinidou, 2015). By ignoring their subjectivities, life experiences, and the social and political dimensions of real problems concerning students, typical instruction can fail to resonate and even disempower budding practitioners (Malazita and Resetar, 2019; Benjamin, 2020). In contrast, an explicit analysis via social and political frameworks, discussion of theories of change, and demonstration of change-makers in the community, seems to have inspired students to see the world, see themselves in it, and act to address technologically-driven harms. In our view, there must be a reckoning in engineering ethics education: the abstract and ungrounded is failing to meet the desires of students to learn how to act for the benefit of society in a technological world that they know is social, political, and causing harm. A new approach is needed.

We are living through a critical juncture in the continuum of social and technological development, rife with visible, large-scale issues that demand redress. In the face of this, students can often feel existentially burdened, hopeless,

stressed, and not seen in their concern about a struggling society (Danowitz and Beddoes, 2018). We feel strongly that frank discussion and collaboration with students, attempting to arrive at realistic interventions they can make in their lives, is urgently needed. Especially as educational institutions move to diversify their pool of STEM students, curricula can not ignore the real problems students see in the world (increasingly problems of gender inequity, racial oppression, state violence, class exploitation, and more) by clinging to apolitical views of technical education (Slaton, 2015). Doing so will result in more student alienation (Malazita and Resetar, 2019; Ozkan and Andrews, 2022), disengagement (Cech, 2013), and likely perpetuate the very social harms they are concerned with.

These findings show that students are craving realism, hope, and the chance to explore what concerns them with guidance from peers and instructors. Our analysis showed that minoritized students, particularly the women of color, resonated with examples of racializing surveillance and felt empowered by having vocabulary to describe their lived experience. It revealed that students whose government used surveillance as a means of state control were grateful to be given a chance to resist through their class projects. It made clear the inspiration several students felt from meeting local change-makers, moving from hopelessness to hope and a desire to act. These types of experiences in the classroom can be replicated, and would likely continue to move away from student disempowerment, and towards giving students a sense that their problems are real, they have agency, and they can make meaningful change. Further research is needed to attend to how different students take up these different experiences of connection between sociotechnical engineering education and lived experience.

Our hope is that our course can serve as a preliminary blueprint for a more holistic, sociopolitical, relevant, and unabashedly human discussion of engineering ethics in university education. But perhaps paradoxically, the course's imperfection, and our acknowledgement to students as instructors that it stands as an imperfect course, is its greatest strength. The best outcome of a course like this would not be perfect, objectively ethical students, but students who have a drive to continue to figure out how to act ethically, moving through the world with hope and motivation to keep trying. We echo this call to students to the broader teaching community: we hope that other instructors take seriously the opportunity to discuss ethics in the classroom with realism, vulnerability, and grounded hopefulness. The classroom is a site where imagination, courage, and empathy can weave their way into honest discourse with an eager community. It can be a site of radical change, if only the choice is continually made to try to make it so.

References

Alpay, E. "Student-Inspired Activities for the Teaching and Learning of Engineering Ethics." *Science and Engineering Ethics* 19, no. 4 (2013): 1455–1468.

Barry, Bruce E., and Matthew W. Ohland. "ABET Criterion 3.f: How Much Curriculum Content Is Enough?" *Science and Engineering Ethics* 18, no. 2 (2012): 369–392.

Benjamin, Ruha. "2020 Vision: Reimagining the Default Settings of Technology & Society." *International Conference on Learning Representation,* 2020.

Benjamin, Ruha. *Race After Technology: Abolitionist Tools for the New Jim Code.* Boston: Polity, 2019.

Bielefeldt, Angela R., Nathan E. Canney, Crystal Swan, and Daniel Knight. "Efficacy of Macroethics Education in Engineering." In *2016 ASEE Annual Conference and Exposition Proceedings*, 2016.

Braun, V., and V. Clarke. "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology* 3, no. 2 (2006): 77–101.

http://dx.doi.org/10.1191/1478088706qp063oa

Browne, Simone. *Dark Matters: On the Surveillance of Blackness*. Durham: Duke University Press, 2015.

Byrne, E. P., and M. Svanström. "Teaching Engineering Ethics with Sustainability as Context." *International Journal of Sustainability in Higher Education* 13, no. 3 (2012): 232–248. doi:10.1108/14676371211242553

Cech, E. A. "Culture of disengagement in engineering education?" *Science, Technology, & Human Values* 39, no. 1 (2013): 42–72.

Chance, S., R. Lawlor, I. Direito, and J. Mitchell. "Above and beyond: Ethics and responsibility in civil engineering." *Australasian Journal of Engineering Education* 26, no. 1 (2021): 93–116.

Claris, L., and D. Riley. "Situation Critical: Critical Theory and Critical Thinking in Engineering Education." *Engineering Studies* 4, no. 2 (2012): 101–120. https://doi.org/10.1080/19378629.2011.649920

Claris, L., and D. Riley. "Situation Critical: Critical Theory and Critical Thinking in Engineering Education." *IEEE Women in Engineering Magazine* 7, no. 1 (2013): 32–36. https://doi.org/10.1109/MWIE.2013.2249993

Colby, Anne, and William Sullivan. "Ethics Teaching in Undergraduate Engineering Education." *Journal of Engineering Education* 97, no. 3 (2008): 327–338.

Conlon, Eddie, and Henk Zandvoort. "Broadening Ethics Teaching in Engineering: Beyond the Individualistic Approach." *Science and Engineering Ethics* 17, no. 2 (2010): 217–232. https://doi.org/10.1007/s11948-010-9205-7

Costanza-Chock, Sasha. *Design Justice: Community-Led Practice toBuild the Worlds We Need*. Cambridge: MIT Press, 2020.

Creswell, J. W., and D. L. Miller. "Determining Validity in Qualitative Inquiry." *Theory into Practice* 39 (2000): 124–134.

Davis, C., and A. Yadav. "Case Studies in Engineering." In *Cambridge Handbook of Engineering Education Research,* edited by A. Johri and B. M. Olds, 161–180. New York, NY: Cambridge University Press, 2014.

Danowitz, Andrew, and Kacey Beddoes. "Characterizing Mental Health and Wellness in Students Across Engineering Disciplines." In *2018 The Collaborative Network for Engineering and Computing Diversity Conference Proceedings*. 2018.

Dewey, John. *Democracy and Education*. New York: Macmillan, 1916.

D'Ignazio, Catherine and Lauren F. Klein. *Data Feminism*. Cambridge: MIT Press, 2020.

Doorn, N., and J. O. Kroesen. "Using and Developing Role Plays in Teaching Aimed at Preparing for Social Responsibility." *Science and Engineering Ethics* 19 (2013): 1513–1527. https://doi.org/10.1007/s11948-011-9335-6

Foucault, Michel. *Discipline and Punish: The Birth of the Prison*. Pantheon Books (English Edition), 1977 (Originally 1975).

Freire, Paulo. *Pedagogy of the Oppressed*. New York: Herder & Herder, 1970 (Originally 1968).

García Peña, Lorgia. *Community as Rebellion: A Syllabus for Surviving Academia as a Woman of Color.* Chicago: Haymarket Books, 2020.

Godfrey, Elizabeth. "Understanding Disciplinary Cultures." In *Cambridge Handbook of Engineering Education Research,* edited by Aditya Johri and Barbara Olds, 437–456. Cambridge: Cambridge University Press, 2014.

Goodman, Amy. "'No Tech for Apartheid': Google Workers Push for Cancellation of Secretive $1.2B Project with Israel" *Democracy Now!*, September 1, 2022. https://www.democracynow.org/2022/9/1/google_project_nimbus_israeli_military_unionizing

Guendelsberger, Emily. *On the Clock: What Low-Wage Work Did to Me and How It Drives America Insane*. Boston: Little, Brown and Company, 2019.

Herkert, Joseph R. "Engineering Ethics Education in the USA: Content, Pedagogy and Curriculum." *European Journal of Engineering Education* 25, no. 4 (2000): 303–313.

Herkert, J. R. "Ways of Thinking About and Teaching Ethical Problem Solving: Microethics and Macroethics in Engineering." *Science and Engineering Ethics* 11 (2005): 373–385. https://doi.org/10.1007/s11948-005-0006-3

hooks, bell. *Teaching to Transgress: Education as the Practice of Freedom*. New York: Routledge, 1994.

Kleine, M. S., K. Zacharias, and D. Ozkan. "Contextualization in Engineering Education: A Scoping Literature Review." *Journal of Engineering Education* (2023): 1–25. https://doi.org/10.1002/jee.20570

Leydens, Jon A., and Juan C. Lucena. *Engineering Justice: Transforming Engineering Education and Practice.* John Wiley & Sons, 2017.

Malazita, John W., and Kelly Resetar. "Infrastructures of Abstraction: How Computer Science Education Produces Anti-Political Subjects." *Digital Creativity* 30, no. 4 (2019): 300–312.

Martin, D. A., E. Conlon, and B. Bowe. "Using Case Studies in Engineering Ethics Education: The Case for Immersive Scenarios Through Stakeholder Engagement and Real Life Data." *Australasian Journal of Engineering Education* 26, no. 1 (2021): 47–63.

Mijente, *Who's Behind ICE? The Tech and Data Companies Fueling Deportations*. Mexico City: Empower, LLC, 2018.

Mitcham, Carl. "A Historico-Ethical Perspective on Engineering Education: From Use and Convenience to Policy Engagement." *Engineering Studies* 1, no. 1 (2009): 35–53.

Newberry, B. "Katrina: Macro-ethical Issues for Engineers." *Science and Engineering Ethics* 16, vol. 3 (2010): 535–571. https://doi.org/10.1007/s11948-009-9167-9

Niles, Susan, Saba Roudbari, and Sergio Contreras. "Integrating Social Justice and Political Engagement into Engineering." *International Journal of Engineering, Social Justice, and Peace* 7, no. 1 (2020): 52–64.

Noble, Safiya Umoja. *Algorithms of Oppression: How Search Engines Reinforce Racism*. New York: NYU Press, 2018.

O'Reilly, K. *Ethnographic Methods.* New York: Routledge, 2005.

Ozkan, Desen, and Chelsea Andrews. "Perspectives of Seven Minoritized Students in a First-Year Course Redesign toward Sociotechnical Engineering Education." In *2022 ASEE Annual Conference & Exposition*. 2022.

Patton, M. Q. *Qualitative Evaluation and Research Methods.* 2nd ed. Newbury Park, CA: Sage, 1990.

Patton, M. Q. "Two Decades of Developments in Qualitative Inquiry: A Personal, Experiential Perspective." *Qualitative Social Work* 1, no. 3 (2002): 261–283.

Polmear, M., A. R. Bielefeldt, D. Knight, N. Canney, and C. Swan. "Analysis of Macroethics Teaching practices and perceptions in engineering: a cultural comparison." *European Journal of Engineering Education* 44, no. 6 (2019): 866–881. https://doi.org/10.1080/03043797.2019.1593323

Rhoten, Diana, Veronica Boix Mansilla, Mei-Chih Chun, and Julie Thompson Klein. "Interdisciplinary Education at Liberal Arts Institutions." *Teagle Foundation White Paper,* no. 13 (2006): 2007.

Riley, D. "Engineering and Social Justice." *Synthesis Lectures on Engineers, Technology, and Society* 3, no. 1 (2008): 1–152.

Riley, D., and Y. Lambrinidou. "Canons Against Cannons? Social Justice and the Engineering Ethics Imaginary." Paper presented at the *American Society for Engineering Education,* Seattle, WA, 2015. https://doi.org/10.18260/p.23661

Roeser, Sabine. "Emotional Engineers: Toward Morally Responsible Design." *Science and Engineering Ethics* 18, no. 1 (2012): 103–115.

Shallcross, D. "Safety Education through Case Study Presentations." *Education for Chemical Engineers* 8, no. 1 (2013): e12–e30. https://doi.org/10.1016/j.ece.2012.10.002

Tormey, Robert, Isabelle LeDuc, Sabine Isaac, Christian Hardebolle, and Ines Valentina Cardia. "The Formal and Hidden Curricula of Ethics in Engineering Education." In 43rd *Annual SEFI Conference Proceedings,* 2015.

Watkins, S. E. "Hypothetical Cases in Engineering Ethics." Proceedings of the 2017 ASEE Gulf-Southwest Section Annual Conference, *American Society for Engineering Education,* Dallas, TX, 2017.

Wisnioski, Matthew, and Matthew H. Wisnioski. *Engineers for Change: Competing Visions of Technology in 1960s America*. Cambridge, MA: MIT Press, 2012.

Zuboff, Shoshana. *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power.* London: Profile Books, 2019.

Appendix A. Condensed Syllabus

	Week	**Topic**	**Read/Do for the Start of Class**
Week 0	Pre-Class	Introductions on Canvas	
Part 1 - Problem			
Week 1	Wednesday 9/7	What is a problem? Surveillance—Intro	Video: *Shoshana Zuboff on surveillance capitalism | VPRO Documentary*
Week 2	Monday 9/12	Surveillance Capitalism—Past and present surveillance	*Zuboff—Chapter 1—Home or Exile in the Digital Future p. 3–26*
	Wednesday 9/14	Surveillance Capitalism	*Zuboff - Chapter 2 - August 9, 2011: Setting the Stage for Surveillance Capitalism p. 27–62*
Week 3	Monday 9/19	Histories of surveillance	*Browne—p. 12–24 (Intro—Surveillance studies)* *Philosophize This! Podcast—Foucault Part 1 and Part 3*
	Wednesday 9/21	Racialization in Power/Knowledge Introduce Paired Research Project	*Browne—p. 76–83 (Crisis and Lantern Laws)*

Week 4	Monday 9/26	Work day for Paired Research Project	Submit initial drafts to questions for the research project
	Wednesday 9/28	Presentations of Paired Research Projects	3–5 minute presentation on your research project Submit a 1-page memo on the crisis you chose for your project
Week 5	Monday 10/3		
	Wednesday 10/5	Non-Academic ways to make change—*Organizing*	*Guendelsberger chapters on Taylorism* *Revisit—Browne—Resistance Themes from Intro and Ch1 (p. 48, 54, 55, 72)*
Monday 10/10 NO CLASS			
Week 6	Wednesday 10/12	***Panel of Local Organizers and Changemakers:***	*Read about guests and their work* *You can use these to prepare some questions that you can ask to the panel. Think about the arc that we've traveled as we've deconstructed surveillance thus far in class: recognizing the problem, seeing it from many angles, and then asking some questions about "how do we change this?" Our panelists are especially suited to talk about the last aspect—how to change certain systems and policies. Keep all that in mind as you craft your questions!*
Part 2 - Practice			
Week 7	Monday 10/17	Non-Academic ways of making change—Examples from tech organizing	*No tech for apartheid/Union Organizing* *Mijente—'Who's Behind ICE' report (executive summary); #NoTechForICE student toolkit*
	Wednesday 10/19	Building a framework: Defining and understanding problems	*D'Ignazio and Klein:* *Chapter 1—Power* *Chapter 2—Collect, Analyze, Imagine, Tech*

Week 8	Monday 10/24	Stakeholders through a lens of power	*Costanza-Chock—Design Justice—Chapter 3—Who's not at the table*
	Wednesday 10/26	Reimagining the Default Settings of Technology and Society by Dr. Ruha Benjamin	*https://iclr.cc/virtual_2020/speaker_3.html*
Week 9	Monday 10/31	Starting Final Projects	Final Project Planning
	Wednesday 11/2	Forming groups and picking projects	Final Project Planning
Part 3—Application			
Week 10	Monday 11/7	What is YOUR problem? Defining and understanding YOUR problem	Documenting research process Submit on canvas: What are you reading this week for your project?
	Wednesday 11/9	Initial Group Meeting and Brainstorm	Your own project research. Nothing to submit.
Week 11	Monday 11/14	Historicizing your problem	Submit on canvas: >2 article titles and links per group to discuss with another group.
	Wednesday 11/16	Workshop and Feedback for Final Projects	Prepare introduction to your final project with specific aspects you want feedback on.
THANKSGIVING BREAK WEEK OF 11/21			
Week 12	Monday 11/28	Who are the stakeholders of your problem?	Submit on canvas: Discussion posts based on student-driven research
	Wednesday 11/30		Your own project research. Nothing to submit.
Week 13	Monday 12/5	Student Presentations (3–5 minutes) to get ready for Poster Gala	Submit on canvas: Discussion posts based on student-driven research
	Wednesday 12/7	Incorporate feedback from Monday—Final Work Day	Your own project research. Nothing to submit.

Week 14	Monday 12/12	Final—Poster Gala for Tufts Community with food	Submit on canvas: Discussion posts based on student-driven research

Appendix B. Pedagogical Approach

Our pedagogical approach is grounded in critical pedagogy that centers the importance of community to learning. Pulling from educational practitioners and theorists like Friere (1970) and Dewey (1916), we rejected the notion that we were depositing knowledge in the minds of students, and rather strove to facilitate learning through group discussion, reflection, and questioning. As scholars, hooks and García Peña teach us in *Teaching to Transgress* (1994) and *Community as Rebellion* (2020) respectively, the method of teaching is just, as if not more, substantial than the topics chosen for the course. We were well aware that teaching ethics can sometimes be at odds with the institutional contexts in which 'teaching ethics' occurs: the class is its own community and thus must reflect and interrogate on our own power relations within the university.

We attempted to embody these ideas in practice through several methods, the first of which being experiential, constructivist learning techniques. Rather than reading from slides and presenting information as in the 'banking theory' of knowledge (Freire, 1970), we recognized that students are coming in to the classroom with their own context, models of the world, and concepts. To account for this, we introduced readings and theoretical concepts not as the end-all-be-all, but as tools or frameworks useful for making sense of their experience. Then, by engaging in several group discussions to digest new content, students use those tools cooperatively to share what is interesting them, how it related to their lives, and learn from others. We additionally assigned a personal reflection each week, prompting students to reflect on how new material interacts with their lives.

As the course progressed, we also encouraged and centered the formation of community as integral to the learning. "Inside" the classroom, group discussions were frequently used to process new information and make sense of it. We encouraged students to create both mid-semester and final projects in groups, working cooperatively to investigate something that interested them. All the while, we attempted to break down typical power dynamics of teacher and student, clearly communicating that we had much to learn from students, just as they had from us, and that we are not perfect experts, but still in a process of developing our own thought. We shared with students our own reflections about our teaching process, and how it was often difficult for us as co-instructors to arrive at the same conclusions regarding materials (and okay if we did not). Being a duo composed of a computer science PhD candidate with a political organizing background and a postdoctoral engineering education researcher with a focus on sociopolitical engineering education, our interdisciplinary tension was made

explicit to students, modeling the idea that their own interdisciplinary tensions are okay, natural, and that collaboration is still possible and desirable.

Yet we also expanded the notion of community "outside" of the classroom. For our final project "gala," we invited faculty and students from outside of the classroom to come and provide feedback and praise for students' work. While students were working on projects, we invited other colleagues to come to class, hear preliminary thoughts from groups, and assist with any questions students were grappling with. Moreover, hosting a panel of local change-makers during a class brought the students in contact with the greater geographical community. We encouraged students to bring their whole selves with integrity to class, not viewing the classroom as a compartment to fit into, but as a place where they can announce events they were planning, campus organization happenings, and other opportunities to plug into "other parts" of their lives.

Throughout the process, we recognized with students that this type of learning can be very emotionally taxing: the realities of surveillance and technological domination can be scary and the prospects seemingly hopeless. Making this explicit and emphasizing that we, as instructors, are also grappling with these emotions made space for emotion to be part of instruction. We checked in with students periodically to see how they were feeling, and provided small comforts (food, drink, celebration time) during class milestones like the community check-in and final project exhibition. Through this grounded, empathetic pedagogy, we hoped that we could bring new ideas into students' lives, make them meaningful through their own context, and inspire hope and community care amidst heavy content.

Appendix C. Final Reflection Prompt

This reflection is more involved than the typical reflection post, so make sure to give this some time and more words than usual. Instead of the typical 200–300 words, this reflection should be somewhere between 600–800 words.

To help you with your task, we created a scaffold of questions that you can answer to help you think through the assignment.

- How did this class compare to your typical courses thus far at Tufts?
- How did you feel that your conception of technology, computer science or data science was critiqued or challenged (if at all)?
- How did you feel that your conception of surveillance, power, or social systems was critiqued or challenged (if at all)?
- How did you feel that your domain-specific knowledge was utilized or not utilized during the class?
- What might you take away with you from the class?