Board 277: Exploring the Intersection of Diversity, Equity, Inclusion, and Ethics in Engineering: Project Overview and Preliminary Results

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Abstract

This study was motivated by the numerous empirical investigations documenting the importance of diversity, equity, and inclusion (DEI) and ethics to engineering education and practice. However, the relationship between these phenomena has not been extensively studied, and research focused on ethics and DEI tends to exist within distinct scholarly spaces. Thus, engineering students, educators, and practitioners may fail to consider how ethics and DEI are related, which may limit how they understand and apply these concepts. To better understand ways that ethics and DEI connect in engineering education and practice, our study includes three phases: (1) a systematic review of how ethics and DEI are connected in peer-reviewed literature in engineering education and related fields, (2) semi-structured interviews exploring faculty members' mental models regarding the alignment between ethics and DEI, and (3) semi-structured interviews exploring engineering practitioners' mental models regarding the alignment between ethics and DEI. This ongoing study is in its fourth year and this short paper will provide an overview of project findings and emergent results associated with each phase.

Keywords: Ethics; Engineering Ethics; DEI; Diversity; Equity; Inclusion

Introduction

We began this study with a foundational presumption that diversity, equity, and inclusion (DEI) are intricately linked to ethical engineering. Thus, neglecting DEI while considering engineering ethics (and ethical issues in engineering) compromises engineers' capacity to ensure the public's safety, health, and well-being [1]. Moreover, unethical engineering can occur when engineers disregard diverse stakeholder groups or neglect to pursue equitable design outcomes [2]. Hence, there is an interwoven relationship between ethics and DEI in engineering. The ultimate goal of our research is to foster more inclusive and equitable approaches to engineering education and practice by developing a better understanding of the relationships between ethics and DEI based on academic and practitioner perspectives.

DEI initiatives are now commonplace in higher education, although such initiatives face political opposition in many US states [3]. There are merits for integrating DEI principles into higher education institutions, such as fostering a sense of belonging among faculty members [4], and students [5], promoting non-discrimination in workplaces [6], and generating an engineering body that more closely resembles societal stakeholders [7], [8]. Yet, faculty members from underrepresented groups are more likely to incorporate DEI considerations into their teaching practices [9], thus suggesting that there may be a need to encourage non-underrepresented faculty to design and implement DEI-facing curricula as such efforts have been proven to increase retention and success rates for underrepresented students [10].

While there are many ongoing DEI initiatives, such initiatives may not aspire towards the same ends, as DEI itself brings forth three distinct terms that may be conflated, confused, or contested. For example, diversity can be perceived in ways ranging from foci emphasizing differences in perspectives, demographics, or structural barriers. The concepts of inclusion and equity [11] are likewise subject to various interpretations. Ongoing efforts in engineering education often pursue the combined phrase "DEI" such as in ABET programmatic evaluation efforts [12] and ongoing explorations of how faculty members teach towards ethics and DEI [11]. Thus, to understand how individuals view connections between ethics and DEI (which is the main goal of our project), there is a need for more clarity regarding how scholars and practitioners conceptualize DEI.

Like DEI, what constitutes ethics in engineering is contested. Engineering codes of ethics dates back to the early part of the 20th century [13], and contestations of what should be incorporated within such codes of ethics have existed for even longer [14]. Today, when looking across professional societies, there are noticeable variations in how engineering societies operationalize and conceptualize ethics, including in their respective ethics codes [15]. Thus, like DEI, it is important to understand the variation in understandings regarding what ethics means to engineers and engineering educators.

Examining how stakeholder groups from different backgrounds experience and conceptualize ethics and DEI, including how ethics and DEI manifest in engineering, can inform the development of a shared vocabulary regarding ethics/DEI between academia and industry. Moreover, we posit that a greater understanding of individuals' experiences that inform their conceptions will facilitate the development of more inclusive cultures of engineering and engineering education. To this end, in this NSF project, we are exploring intersections between ethics and DEI in engineering and engineering education. This paper begins with an overview of the project, followed by a summary of findings for each of the three phases of our research study, and then concludes by describing implications and future work.

Project Overview

We entered this study with the presupposition that a significant connection exists between ethics and DEI, but this correlation remains largely obscured in current engineering discourses and, as a result, there is much uncertainty about how ethics and DEI co-manifest or relate in engineering research, teaching, and practice. The uncertainty regarding the interplay between ethics and DEI within engineering may stem from disconnections or divisions among communities in the respective ethics and DEI research domains. Our principal aim in this study is to explore the intersections between ethics and DEI in engineering education and the engineering industry. Our objective is to begin revealing discussions and narratives among academics and practitioners, as these narratives themselves may serve to (dis)connect ethics and DEI in engineering.

Our study includes three overarching phases: (1) a systematic review of how engineering educators have connected ethics and DEI within peer-reviewed literature in engineering

education and related fields, (2) semi-structured interviews exploring faculty members' mental models of the alignment between ethics and DEI, and (3) semi-structured interviews exploring engineering practitioners' mental models of the alignment between ethics and DEI. Each phase is guided by a research question (RQ):

- "**RQ1:** How are engineering ethics and DEI related based on theoretical and empirical understandings of affective and cognitive development across these communities?" [16, p. 2]
- "**RQ2:** How are engineering ethics and DEI related based on mental models elicited from academics active in these two areas of research and scholarship?"
- **RQ3:** How are engineering ethics and DEI related based on mental models elicited from a diverse cross-section of industrial practitioners?" [17, p. 3]

Research Methods

To address RQ1, we conducted a systematic literature review of how ethics and DEI connect based on peer-reviewed publications in engineering education and related disciplines. By synthesizing scholarly literature, we aimed to facilitate the convergence of discussions around ethics and DEI in scholarly works, paving the way for the intentional integration of ethics and DEI in both engineering education research and engineering practice. We addressed RQ1, which was itself refined from our original proposal due to the literature we were able to collect. To address RQ1, we adapted systematic review procedures outlined by Borrego et al. [18]. After abstract review (n = 250) and full text review (n = 81), we reduced our sample to 36 papers that met the inclusion criteria we set forth in the study. We then utilized a thematic analysis adapted from Braun and Clarke [19] to inductively generation conceptions of ethics/DEI within the literature and connections between these phenomena therein.

To address RQ2 and RQ3, we conducted 25 interviews with academics and 25 interviews with practitioners who had prior experiences and/or expertise in ethics and/or DEI. Our interview approach was extensively reported in [17]. Unique from most interviews, this protocol asked participants to draw maps or diagrams representing their mental models regarding how ethics and DEI connect in engineering. In a previous conference paper, we unpacked research quality considerations associated with the our design of RQ2 and RQ3 efforts [17], including but not limited to the mental models interview protocol. We briefly describe our interview protocol design in the next paragraph, followed by a paragraph describing our current approaches to analyzing interview data.

We designed a semi-structured mental model interview based on Ford and Sterman's [20] research design. The interview protocol included three parts: (1) positioning, (2) description, and (3) summation [7], [17]. To unpack and extrapolate upon research quality considerations associated with our data collection and analysis approaches, we utilized validation types from Walther and colleagues' (2013) Q3 framework [17], [21]. For example, to promote theoretical validation, or the alignment between "social reality" and the "theory" we aim to develop, we recruited academics and practitioners who have experience in ethics or DEI. By exploring the

perspectives of individuals with variable expertise across ethics or DEI scholarly spaces, we will be positioned to view prominent views from these respective spaces [7].

We began coding towards connections but, like in RQ1, we quickly found that a concerted focus on *conceptions of ethics/DEI* would be invaluable in understanding *connections between ethics/DEI*. We thus shifted our analysis of interviews to conceptions. We assigned leads to three distinct but related coding tasks: (1) coding academicians' *conceptions* of ethics and DEI (led by Author 1), (2) coding practitioners' *conceptions* of ethics and DEI (led by Author 3), and (3) coding mental model maps or diagrams to understand *connections* between ethics and DEI among participants (led by Author 2). To initiate analysis of conceptions, the two leads began with deductive coding based on two sources: (1) Optimal Distinctiveness Theory [22] and (2) DEI-related conceptions we developed during RQ1. Next, coders began independently developing inductive codes to capture individuals' conceptions and experiences regarding DEI as well as themes representing common views among academics and practitioners, respectively. Separately, towards the analysis of *connections*, the lead coder began with a deductive set of hypothetical mental models, as reported in [23, p. 1] coupled with inductive code generation. Preliminary findings from these three lines of analysis are reported below.

Preliminary Findings

Connections between Ethics and DEI in Engineering Education Literature

The first phase of our study was completed and we published our findings in a conference and then a journal paper [16], [24]. We generated three main themes: (1) lenses scholars use to connect ethics and DEI in engineering education, (2) roots that inform whether and how such lenses manifest, and (3) engagement strategies to promote ethics and DEI connections in engineering. Here, we offer a summary of these key findings.

Theme 1- Lenses: We utilized various lenses to establish connections between ethics and DEI. These lenses may serve as structures, goals, or outcomes for engineering processes, providing a framework for making ethical decisions that consider DEI or facilitating actions that promote inclusivity and equity, ultimately leading to ethical outcomes. Three sub-themes emerged: "(1) social, (2) justice-oriented, and (3) professional" [24, p. 150]. For example, in the sub-theme "social" we observed the connection between ethics and DEI as evident through different social framing devices, such as "social issues," "social responsibility," "social commitment," and "social justice" [24].

Theme 2- Roots: This theme explores "roots" which shape engineers' understanding of and connections between ethics and DEI. Roots underscore the significance of individual experiences or cultural histories, acknowledging that both play a role in shaping perspectives on ethics and DEI connections [24]. We generated three sub-themes here: "(1) individual demographics, (2) engineering cultures, and (3) institutional cultures" [24, p. 152]. Taken together, our analysis of the articles suggested that institutional norms encapsulate and shape disciplinary values,

influencing diverse views on how individuals - whether they be practitioners, students, or educators - establish connections between ethics and DEI in the field of engineering [24].

Theme 3- Engagements: This theme delves into various approaches aimed at increasing awareness of how ethics and DEI are related. We identified three sub-themes: "(1) affinity toward ethics/DEI content, (2) understanding diverse stakeholders, and (3) working in diverse teams" [24, p. 154]. These engagement strategies can function as instructional aids for students to establish connections between ethics and DEI [24]. Simultaneously, they can serve as heuristics for instructors, aiding in the integration of DEI students' and practitioners' ethical engineering practice. Notably, these engagement strategies can play pivotal role in supporting the integration of different lenses (e.g., "social," see Theme 1) for connecting ethics and DEI within engineering education and industry [24].

Conceptions of DEI among Academics and Practitioners

During the data analysis for Phase 2, we began by exploring conceptions or conceptualizations of Diversity, Equity, and Inclusion in engineering education [7]. We began by employing deductive codes informed by the Optimal Distinctiveness Theory (ODT) by Brewer [22] and our conception codes generated during RQ1 [24]. This analysis quickly became challenging as some participants defined DEI as a whole whereas others conceptualized the D-E-I terms separately (i.e., diversity, equity, inclusion). While our findings are preliminary, emergent themes among academics (as represented through a critical mass of associated codes) include foci on privilege, microaggressions, bias, discrimination, and taking actions toward DEI issues. Separately, emergent themes associated with academics include prioritizing diversity and inclusion and leveraging analogies (namely, the "party" analogy) to articulate how DEI manifests in their curriculums, research, or associated experiences. As these themes highlight, we observed interview participants conceptualized DEI in different ways when compared to engineering education literature (i.e., RQ1 findings). We also saw emergent distinctions across participant groups. For example, equity seemed to be a more familiar concept to academics. Taken together, this analysis will support our exploration of how individual participants and participant groups characterize and explain the intersection of ethics and DEI in engineering.

Connections between Ethics and DEI in Participant Drawings

During interviews in Phases 2 and 3, participants created drawings representing their mental models of ethics-DEI connections. These visualizations included concept maps or diagrams and illustrated the complex relationships and connections they perceived between ethics and DEI. We brought a deductive codebook which was grounded in the authors' anecdotal experiences and which was comprised of six types of mental models, including: "(1) some overlap, (2) ethics = DEI, (3) DEI is part of ethics, (4) ethics is part of DEI, (5) ethics and DEI are separate, and (6) uncertainty regarding the overlap between ethics and DEI" [23, p. 1]. While we depicted each of these mental models in the form of concentric circles with varying levels of overlap, many participants made process-oriented models that suggested either (7) ethics leads to DEI or (8)

DEI leads to ethics. Moreover, we noted that some participants' mental models rather suggested (9) slight overlap between ethics/DEI versus (10) significant overlap between ethics and DEI. Thus, during coding, we expanded the 6 mental models to 10 which represent many participant discourses and graphical depictions. However, even these 10 groupings miss important facets of participants' mental models. For example, many participants developed drawings that drew attention to common aspects between ethics and DEI, such as safe interpersonal interactions or global implications of ethics/DEI efforts. Another challenge in this coding has been the conceptual starting point. Specifically, participant discourses varied based on (1) ethics versus engineering ethics and (2) DEI as a collective topic versus specific dimensions of DEI. We will continue engaging in this analysis, trying to discern a parsimonious but representative way to capture the wide range of mental models elicited from participants.

Implications & Future Work

Taken together, this project will inform understandings of how ethics and DEI manifest in the engineering workforce and academic contexts. These efforts will help engineering education scholars advance initiatives within and at the intersection of ethics and DEI and will position practitioners to integrate these topics in their daily practice. Ultimately, we hope that by facilitating ethics/DEI integrations, this work can support shifts in engineering culture to become more ethical, inclusive, and equitable, thus improving efforts towards supporting minoritized individuals and groups in universities, workplaces, and other engineering environments.

We started this project with a presumption that engineering education offered one area of research where ethics and DEI co-manifest, but we postulated that different ways of operationalizing justice might yield distinct types of connections. Many scholars in our literature review work [24] indeed utilized justice as an ethics/DEI connector and recognized how distinct ways of framing justice draw forth distinct ethics/DEI connections (e.g., [25]). Following Rottmann & Reeve [11], we offered social justice as a key framework for connecting ethics and DEI. Moreover, like Rottmann & Reeve, we encourage instructors to consider and attend to individual and structural factors when integrating ethics and DEI in their engineering courses and programs.

Our next research steps involve further exploration and analysis of our 50 interviews to address our research questions. Building on the preliminary findings from Phases 2 and 3, we aim to conduct a more nuanced and in-depth analysis of faculty members' conceptions of ethics and DEI. This analysis will involve exploring the connections between these concepts, considering how faculty members and engineering practitioners perceive and navigate the intersection of ethics and DEI in engineering education and practice, and relationships between codes regarding conceptions of ethics/DEI and the categorization of mental models. Following these lines of inquiry, we aim to leverage results to generate meaningful and accessible initiatives for positive change within the engineering community.

We are also curious how findings might change if we were to engage in data collection today rather than in 2021 or 2022 (which was the time of our interview collection). Once we have a near-final version of themes associated with conceptions and connections, we intend to use the results to design a survey. We intend to first send the survey back to our interview participants to discern if the results resonate with them as a form of member checking. In addition, we plan to send the survey to a large sample with a concerted (but not exclusive) recruiting focus on participants who do and do not bring expertise in DEI. Taken together, these efforts will bolster validation of our findings and serve as a check of agreement across participant groups, thus understanding to what extent the views captured in our dataset resonate with engineering academicians and practitioners across the US.

Acknowledgment

This material is based upon work supported by the National Science Foundation (NSF) under Grant No. EEC-2027519 and EEC-2027486. Any opinions, findings, conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the NSF. We would like to acknowledge the big role of research participants who shared their knowledge and experiences with us during data collection- thank you for making this study happen. We also thank our advisory board for their expertise and feedback for each phase of our study. Moreover, we thank Andrew Whitehead for their contributions to the research design and data collection processes reported herein.

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