

WIP: Intersections Between Diversity, Equity, and Inclusion (DEI) and Ethics in Engineering

Justin L Hess
School of Engineering Education
Purdue University
West Lafayette, IN
jhess@purdue.edu

Andrew Whitehead
School of Engineering Education
Purdue University
West Lafayette, IN
white15@purdue.edu

Brent K. Jesiek
School of Engineering Education
Purdue University
West Lafayette, IN
bjesiek@purdue.edu

Andrew Katz
Department of Engineering
Education
Virginia Tech
Blacksburg, VA
akatz4@vt.edu

Donna Riley
School of Engineering Education
Purdue University
West Lafayette, IN
riley@purdue.edu

Abstract— In this work-in-progress (WIP) study, we begin to identify explicit links between ethics and diversity, equity, and inclusion (DEI) in engineering education and closely related fields. We use systematic literature review procedures coupled with a qualitative content analytic approach to identify these explicit links within engineering education journals and conference papers. Through this WIP, we identify preliminary themes that represent explicit discourses connecting ethics and DEI and we cite associated literature. We unpack four themes that have a prominent presence in the abstracts that we have reviewed: cultural, global, social, and sustainable. These explicit connections will support future systematic review procedures wherein we will aim to identify implicit DEI and ethics connections via an analysis of whole manuscripts. While preliminary, we hope that these four themes can prompt strategies to connect ethics and DEI more purposefully when teaching towards these and related topics.

Keywords—ethics; diversity; equity; inclusion; systematic review

I. INTRODUCTION

What does ethics have to do with diversity, equity, and inclusion (DEI) in engineering? Are diversity, equity, and inclusion ethical considerations of import for engineers? These questions can evoke dissonance among individuals, particularly if one has never previously thought about the relationship between ethics and DEI. Moreover, research foci in these domains often exist in separate camps, which can potentially exacerbate disconnections between these domains within an individual's mental model. For example, the American Society for Engineering Education (ASEE) has divisions devoted to "Equity, Cultural, & Social Justice in Education" and "Engineering Ethics." This is not to say that members of these divisions do not collaborate or that members feel that ethics and equity, culture, and social justice are separate entities, but rather to indicate how the *divisional* structure of an organization, such as ASEE, can potentially impact one's views of the boundaries and interrelationships between topical or conceptual domains.

This material is based upon work supported by the National Science Foundation (NSF) under Grant No. EEC-2027519. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF.

There are numerous models, initiatives, and pockets of innovation by scholars and programs that have explicitly coupled DEI and ethics considerations. For example, the National Academies [1] recently commended the efforts of the American Geophysical Union for their development of "program metrics and plans for a longer-term Ethics and Equity Resource Center." Likewise, Canon 8 in the ASCE's [2] former code of ethics included a concerted focus on equity, stating:

Engineers shall, in all matters related to their profession, treat all persons fairly and encourage equitable participation without regard to gender or gender identity, race, national origin, ethnicity, religion, age, sexual orientation, disability, political affiliation, or family, marital, or economic status.

ASCE's current code no longer encompasses this explicit canon, but sentiments of respect, dignity, fairness, and rejection of discrimination are still emphasized in a "Society" category and considerations associated with inclusion and equity are nested in a "Peers" category [3]. These references provide some evidence of concerted efforts at explicitly connecting ethics and DEI in engineering, but these explicit pairings are uncommon.

We theorize that one barrier to change in realizing the integration of diverse ethical values within engineering cultures results from the disjuncture or separation between communities and lines of scholarship from engineering education researchers in intersecting (but often disjointed) scholarly spaces of ethics and DEI. In this WIP, we begin connecting strands of scholarship across these domains by addressing the research question: "How are ethics and DEI **explicitly** related in peer-reviewed literature in engineering education and closely related fields?" We posit that addressing this question will enable us to identify synergies and intersections between ethics and DEI in engineering literature in the future, even when scholars do not explicitly use ethics or DEI terms.

II. THEORETICAL FRAMEWORK

We hypothesize that ethics and DEI are related, but that their connections are often "hidden" in engineering discourses.

Moreover, research communities often *explicitly* pursue these topics separately. We believe the separation of ethics and DEI research communities is one key barrier to more purposefully connecting these phenomena. We hope that this study can begin to support more purposeful modalities of connecting ethics/DEI.

Many frameworks connect DEI and ethics, but these connections often manifest *implicitly*. As one example, Hoffman [4] offered a developmental theory of prosocial and moral behavior. Herein, Hoffman unpacks two “universal moral principles” of justice and care (p. 222). First, *justice* is “concerned with society’s criteria for allocating resources” (p. 226); it may be defined in terms of impartiality and reciprocity, but as Hoffman shows, it may also be defined in terms of equity (e.g., “equity in voting situations, equality combined with need in charity situations,” p. 17). Second, *care* serves as a “moral imperative” hearkening an individual to “**always** consider others” (p. 225, emphasis original). Thus, care involves including external voices in one’s decision-making acts. Thus, explicit DEI sentiments (i.e., equity, inclusion) are essential aspects of the ethical principles Hoffman puts forth. We use these examples, as scholars have considered care and justice in the context of engineering extensively. We posit that by identifying and unpacking already common aspects of engineering education discourses, including care/justice, can help explicate extant connections between ethics and DEI.

Yet, we hypothesize that discrete mental models of ethics and DEI exist, with some mental models explicitly connecting these phenomena and others disconnecting or separating these phenomena. Our theory is that DEI and ethics interconnect in most existing ethics and DEI frameworks in some manner, although the nature of that interconnection may vary.

III. METHODS

We use systematic literature review procedures to identify intersections between ethics and DEI. Guided by Borrego et al. [5], we employ six steps in our systematic review procedures: (1) “Deciding to do a systematic review”; (2) “Identifying scope and research questions”; (3) “Defining inclusion criteria”; (4) “Finding and cataloging sources”; (5) “Critique and appraisal”; and (6) “Synthesis”. We expand upon each of these steps here.

A. Deciding to do a systematic review

We aim to utilize systematic literature review procedures to develop a comprehensive understanding of interconnections between ethics and DEI in engineering education literature. We anticipate synthesizing both theoretical and empirical studies. We will develop an inductive set of codes whilst analyzing the literature that explicitly connects these phenomena. With this inductive set of codes we aspire to extract a broadened set of literature to find evidence of where mutual goals and approaches to ethics and DEI exist in engineering, even when these terms are not explicitly used.

B. Identifying scope and research questions

We address the research question: “How are ethics and DEI **explicitly** related in peer-reviewed literature in engineering education and closely related fields?” We aim to address multiple sub-research questions in the future, such as, “How are ethics and DEI **implicitly** related in the engineering education

literature?” We propose bringing a discourse analysis lens to further examine the extracted literature, including to address the question: “How are DEI and engineering ethics related based on theoretical and empirical understandings of affective and cognitive development across DEI and ethics communities?” In this WIP, we focus only on the first research question on **explicit** connections. We scoped our search parameters as follows:

- Databases and search strings to narrow to engineering ed.
 - Education databases (ERIC or EBSCOhost) paired with “Engineer*” string in the Title
 - Engineering database (Compendex, INSPEC) paired with “Educat* OR Teach* OR Training” search string in the Title
 - Computing database (ACM Digital) paired with “Education* OR Teach* OR Training” AND “Engineer*” string in the Abstract
- Explicit DEI Term - one of the following in the abstract
 - Diverse OR Diversity
 - Equit* (Equity, Equitable)
 - Inclus* (Inclusion, Inclusive)
- Explicit Ethics Term - one of the following in the abstract
 - Ethic* (Ethics, Ethical, Ethicality)
 - Moral* (Morals, Morality)

We recognize that the terms we use in our study are not the same. For example, moral and ethical are distinct (but related) phenomena [6]. Moreover, our search terms do not encompass all potential considerations associated with these phenomena. We use these terms as a starting point of analysis. We expect our findings will highlight how these terms are operationalized when used in tandem, as well as variations therein.

C. Defining inclusion (and exclusion) criteria

Given the objective of finding *explicit* connections between ethics and DEI, our inclusion criteria to retain articles were: (1) a concerted focus on *engineering education* (note: we retained articles focused on engineering technology education, computer science education, and computing education); (2) a concerted focus on *DEI*; (3) a concerted focus on *ethics* or *morality*; and (4) explicit discourse describing interconnections between ethics and DEI. Also, we used several *exclusion criteria* (EC):

- **EC1**: Duplicate reference across databases;
- **EC2**: Authored by one of the authors of this paper;
- **EC3**: Focus is peripheral but not directly related to engineering education (e.g., engineering technology development, bioethics, other STEM fields)
- **EC4**: Does not include a concerted focus on DEI. For example, A DEI term is used but not in relation to human-oriented education considerations (e.g., diverse technologies, “include” is used in a non-DEI sense).
- **EC5**: Does not include a concerted focus on ethics. For example, an ethics term is expressed once in the abstract but it is apparent that an emphasis on ethics is peripheral or limited to the main objectives of the work.
- **EC6**: Does not explicitly connect ethics and DEI. For example, ethics and DEI may be separate program

outcomes and results of these outcomes may be presented alongside one another but without any description of the interplay between outcomes.

D. Finding and cataloging sources

Figure 2 provides a visual representation of the search process that we employed (adapted from Jesiek et al. [7]). First, we **identified** potential data through the procedures listed above. Second, we **screened** articles by reviewing their abstracts. Third, we are currently **appraising** articles by reviewing the full text and using the same set of inclusion/exclusion criteria. Fourth, via **critique and appraisal**, we will assess the quality of articles. As we appraise and critique articles, we will consider adding referenced articles, specifically in instances where authors suggest an explicit DEI/ethics pairing exists therein.

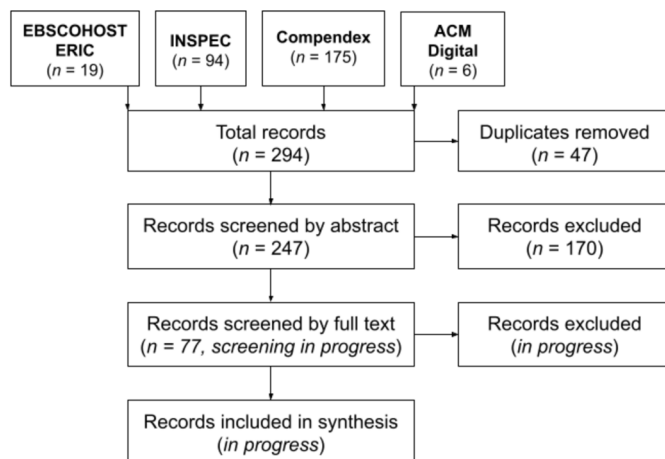


Fig. 1. Search process on explicit ethics/DEI connections (adapted from [7])

E. Critique and appraisal

As Borrego et al. [5] describes, the purpose of this step is to “systematically assess the quality of each primary study” (p. 57). This quality check aims to characterize literature in terms of types of papers and several quality considerations [8]. We intend to use the quality criteria applied by Jesiek et al. [7] which were adapted from multiple authors [9, 10]. These criteria include:

- **Statement of Purpose:** Clearly defined aims, objectives, research questions, and/or hypotheses.
- **Study Design Description:** Clearly defined research procedures that are explicit enough to replicate.
- **Participant Description:** Adequate description of the subject or sample (e.g., number, demographics)
- **Research Quality Procedures:** Use of best practices to achieve research quality (e.g., for qualitative papers – “audit trails, member checking, triangulation, multiple coders, peer review, and iterative data collection and analysis; and for quantitative papers – “advanced statistical methods, variance estimates, standard errors, effect sizes, evidence of scale quality, discussions of comparable populations, and explicit discussions of bias.” (quotes from Jesiek et al, [7], p. 388)

F. Synthesis or Qualitative Analysis

Finally, Borrego et al. [5] offered “synthesis” as the data analysis step, which includes three sub-steps: (1) mapping, or “organizing the studies and reporting certain characteristics”; (2) “critique within studies,” or “presenting the assessment of quality for each study in turn”; and (3) “critique across studies,” or exploring differences in theories/results across studies (p. 60).

As Borrego describes, researchers can employ other qualitative analytic techniques to facilitate synthesis. In the future, we will use Gee’s [11] discourse analysis framework to bring a critical perspective to our synthesis of the extracted literature. Gee defined seven building tasks that describe how individuals construct the world through discourse. In Table 1, we list Gee’s building tasks, provide a brief description of each, and identify associated questions we will address in the future.

TABLE I. DISCOURSE ANALYSIS QUESTIONS

Building Task	Description	Discourse Analysis Question
Significance	Markers of what one considers meaningful to a context	What ethical and diversity, equity, & inclusion (DEI) frameworks does this article indicate are most relevant to engineering? In what ways are these relevant?
Practices (Activities)	Socially recognized and supported endeavors	What practices pertaining to both ethics and DEI does this article highlight, if any?
Identities	Roles or ontologies attributed to self or others	According to this article, where and how (if at all) do ethics and DEI co-manifest in engineering practice?
Relationships	People and things with whom one interacts and how	What relationships does this article suggest engineers should have with others for making ethical decisions? Where and how do DEI concerns factor in?
Politics	Considerations of proper distribution of social goods	How does this article indicate ethics manifests in DEI concerns, and vice versa (if at all)?
Connections	Markers of what one deems relevant considerations	How does this article connect issues of ethics and DEI? Does this speak to systemic considerations that promote or block such connectivity?
Sign Systems and Knowledge	Claims about what sign systems and knowledge are worthwhile	How does this study privilege (and de-privilege) certain ethical and DEI frameworks?

IV. PRELIMINARY RESULTS

At this stage of analysis, we have screened abstracts and are transitioning to *critique and appraisal* and *qualitative analysis*. Thus, while we have reviewed portions of articles, we have not thoroughly examined whole manuscripts to identify their alignment with the inclusion/exclusion criteria. Moreover, we have not yet begun engaging in “synthesis” or addressing the discourse questions (Table 1).

By reviewing the 77 abstracts, we identified concepts that commonly manifested alongside explicit ethics and DEI connections therein. Here, we introduce an evolving list of these concepts in the form of themes, each of which had an explicit

presence in at least ten abstracts: *cultural*, *global*, *social*, and *sustainable*. While our focus on these themes is based on their presence in abstracts, we use text beyond abstracts to contextualize how authors have employed these concepts to explicitly connect DEI and ethics.

A. Cultural

Over 20 abstracts explicitly used the term culture, albeit, with a variety of foci (e.g., cross-cultural studies [12], culture of engineering education [13], cultural engagement [14], multicultural [15], cultural values [16]). The prominent explicit use of culture in abstracts draws attention to the influential role of culture in informing ethics/DEI interrelationships. Rottman and Reeve [17], whose work focused on bridging *micro/macro-ethics* considerations via the integration of a critical social justice framework, argued that institutional culture can impede inclusion, such as when “subtle discriminatory practices” manifest over extended periods of time. Similarly, Cicmil and Gaggiotti [18] suggested organizational culture has a large influence on workforce project management activities, writing: “The organisational context of projects is messy, ambiguous, fragmented, culturally diverse and political” (p. 211).

Tooley [19] prompted us to consider what may result from a more purposeful integration of diversity within engineering ethics pedagogy, asking, “Would including **diversity awareness as part of engineering ethics education** result in a more **inclusive culture** in the engineering profession?” Tooley expanded on how educators might prompt considerations of group representation and relative impacts across societal groups:

Unawareness of ethical issues is more likely to take place when considering actions taken against underrepresented group members within a society (i.e., underrepresented minorities in engineering). Individuals in the majority group are less likely to view underrepresented group members as legitimate because of their societal position. Instead of focusing on the ethical implications of their actions, individuals in the majority group may disregard the broader moral implications of their actions and the potential harm created for underrepresented group members. Therefore, one key component of ethics and diversity education would be to enable individuals to recognize the ethical implications of their actions when considering actions impacting underrepresented group members within society [18].

B. Global

Over 15 abstracts explicitly used the term global, sometimes prompting a “global perspective,” [20], evoking considerations of “global issues” [21], or related aspects. Often (but not always) this term appeared alongside *culture*. Thus, many authors called attention to cultural differences across national or like contexts. For example, Wang and Buckeridge [22] stated, “The construction industry, in both developing and developed countries, is vulnerable to unethical behavior or corruption – vulnerability in part because of differences in culture and managerial systems across countries” (p. 6). While these authors emphasize *diversity* here, Wang and Buckeridge also suggest “equitable and just treatment of employees” is one of the most critical “ethical problems for organizations” to address (p. 6).

C. Social

Social appeared in over 25 abstracts and scholars paired the term with a wide variety of specific social considerations (e.g., social issues [23], social perspectives [24], social responsibility [25]). Many authors connected “social” considerations alongside others. For example, Naphan-Kingery et al. [26] discussed the import of *social empathy* for engaging with *social justice* and *social responsibility*. As they write, “Witnessing and empathizing with the social suffering of others due to group-based stigma and discrimination are significant factors in developing an equity ethic” (p. 9). Like these authors, many scholars paired “social” with “justice.” Rottman and Reeve [17] argued that *critical social justice* can motivate institutional cultural changes to realize better integration of ethics and DEI, and they offered four aspects of critical social justice to drive such integration in engineering, including “subjectivity,” “systemic oppression,” “society,” and “equitable outcomes.”

D. Sustainable

Sustainability appeared in 10 abstracts. Authors often drew attention to environmental considerations alongside social and economical considerations. For example, Hasling [25] wrote, “Sustainable development is commonly referring to three aspects: ‘environment’, ‘economy’ and ‘equity/ethics.’” Separately, May [27] suggested that “ethics, diversity, and sustainability” were “social justice” issues, thus offering a similar but distinct mapping between concepts. Among other frameworks, Lantada presented the United Nation’s Sustainable Development Goals (SDGs) [28] as a guiding framework for engineering education. The SDGs often explicitly connect equity concerns throughout this report on the SDGs. While ethics is less explicit in the report, it has a presence through other terms, such as justice. For example, Goal 16 aims to “Promote peaceful and **inclusive** societies for sustainable development, provide access to **justice** for all and build effective, accountable and inclusive institutions at all levels” [28, p. 14].

V. CLOSING DISCUSSION

This WIP study detailed our process and preliminary analysis of a corpus of literature that explicitly connects ethics and DEI. We shared four themes that represent spaces or concepts that scholars oft-deployed alongside explicit pairings of ethics and DEI: *cultural*, *global*, *social*, and *sustainable*. In the future, we will continue synthesizing how authors have operationalized these terms and the role of ethics and DEI therein. At this stage of analysis, we have discussed many other potential themes, such as *civics*, *engagement*, *ethnicity*, *race*, but these concepts were less pervasive in the abstracts than the four themes. Nonetheless, we anticipate that the themes will continue to grow and evolve as we synthesize manuscripts.

While our analysis is ongoing and we do not yet have exhaustive findings, the explicit pairings between DEI and ethics in the form of emergent themes in this study supports our theoretical stance that ethics and DEI connect. Yet, the relatively few articles that we have retained supports our hypothesis that these connections may often be “hidden” in engineering discourses. We hope these findings will help others more explicitly pair ethics and DEI in engineering education research and instruction by extending these early results.

REFERENCES

- [1] National Academies of Sciences Engineering and Medicine, S. Olston and K. Jarboe, Eds. *Engineering societies' activities in promoting diversity and inclusion: Proceedings of a workshop in brief*. Washington, DC: The National Academies Press, 2018.
- [2] ASCE. "Board adopts new canon for ASCE code of ethics." <https://source.asce.org/board-adopts-new-canon-for-asce-code-of-ethics/> (accessed July 26, 2021).
- [3] ASCE. "Code of Ethics." <https://www.asce.org/code-of-ethics/> (accessed July 26, 2021).
- [4] M. L. Hoffman, *Empathy and moral development: Implications for caring and justice*. Cambridge, UK: Cambridge University Press, 2000.
- [5] M. Borrego, M. J. Foster, and J. E. Froyd, "Systematic literature reviews in engineering education and other developing interdisciplinary fields," *Journal of Engineering Education*, vol. 103, no. 1, pp. 45-76, 2014, doi: 10.1002/jee.20038.
- [6] M. W. Martin, "Personal meaning and ethics in engineering," *Science and Engineering Ethics*, vol. 8, no. 4, pp. 545-560, 2002.
- [7] B. K. Jesiek, A. Mazzurco, N. T. Buswell, and J. D. Thompson, "Boundary spanning and engineering: A qualitative systematic review," *Journal of Engineering Education*, vol. 107, no. 3, pp. 380-413, 2018.
- [8] M. J. Grant and A. Booth, "A typology of reviews: an analysis of 14 review types and associated methodologies," *Health Information & Libraries Journal*, vol. 26, no. 2, pp. 91-108, 2009.
- [9] L. M. Kmet, L. S. Cook, and R. C. Lee, *Standard quality assessment criteria for evaluating primary research papers from a variety of fields*. Edmonton, Alberta, Canada Alberta Heritage Foundation for Medical Research, 2004.
- [10] J. C. Long, F. C. Cunningham, and J. Braithwaite, "Bridges, brokers and boundary spanners in collaborative networks: a systematic review," *BMC Health Services Research*, vol. 13, no. 1, pp. 1-13, 2013.
- [11] J. P. Gee, *An introduction to critical discourse analysis in education: Theory and method*, 3rd ed. New York, NY: Routledge, 2011.
- [12] P. Baron and C. M. Herr, "Cybernetically informed pedagogy in two tertiary educational contexts: China and South Africa," *Kybernetes*, vol. 48, no. 4, pp. 727-739, 2019, doi: 10.1108/K-12-2017-0479.
- [13] C. Becker and R. Evans, "Changing the Question Changes the Conversation: Qualitative Research Methods, Ethnography, and the Transformation of Engineering Education," presented at the Research in Engineering Education Symposium, Palm Cove, QLD, 2009.
- [14] D. R. Berg and T. Lee, "Incorporation of liberal education into the engineering curriculum at a polytechnic," presented at the ASEE Annual Conference & Exposition, New Orleans, LA, 2016.
- [15] R. I. Murrugarra and W. A. Wallace, "Cross-cultural and cross-national impact of ethics education on engineering students," in *Ethics in Science, Technology and Engineering, 2014 IEEE International Symposium on*, 2014: IEEE, pp. 1-6.
- [16] A. Elmualim, "Moral leadership education in construction," presented at the Annual ARCOM Conference, Cardiff, UK, 2008.
- [17] C. Rottmann and D. Reeve, "Equity as rebar: Bridging the micro/macro divide in engineering ethics education," *Canadian Journal of Science, Mathematicss and Technology Education*, vol. 20, pp. 146-165, 2020.
- [18] S. Cicmil and H. Gaggiotti, "Responsible forms of project management education: Theoretical plurality and reflective pedagogies," *International Journal of Project Management*, vol. 36, no. 1, pp. 208-218, 2018.
- [19] M. S. Tooley and E. E. Umphress, "Work in progress - the ethics of diversity: Addressing diversity issues in undergraduate engineering ethics education," presented at the Frontiers in Education, 2009.
- [20] J. Fu, Q. Lei, D. M. Grzybowski, and D. Cheng, "What should be taught in engineering ethics education under globalization?: Based on the comparative analysis of university textbooks in China and the United States," presented at the ASEE Annual Conference & Exposition, Salt Lake City, UT, 2018.
- [21] M. Castro-Sitiriche, E. O'Neill-Carrillo, C. Papadopoulos, C. Pomales-García, A. Santiago-Román, and J. Seguel, "Work in progress—Leveraging accreditation efforts to foster innovation in engineering education," in *IEEE Frontiers in Education Conference*, 2010: IEEE, pp. T3J-1-T3J-3.
- [22] G. Wang and J. S. Buckeridge, "Teaching Ethics for Construction Management Majored Students: Standalone or Micro-insert?—Globalization and Sustainability Considerations," presented at the ASEE Annual Conference & Exposition, New Orleans, LA, 2016.
- [23] O. Hazzan and T. Lapidot, "Social issues of Computer Science in the" Methods of Teaching Computer Science in the High School" course," *ACM SIGCSE Bulletin*, vol. 38, no. 2, pp. 72-75, 2006.
- [24] D. Braun, E. B. Evans, R. Knight, and T. Ruehr, "Interdisciplinary team teaching: Lessons for engineering instructors from a capstone course in environmental studies," presented at the ASEE Annual Conference & Exposition, Honolulu, Hawaii, 2007.
- [25] K. M. Hasling, "Experiential values as promoters for emerging views on sustainable design education," in *DS 83: Proceedings of the 18th International Conference on Engineering and Product Design Education (E&PDE16), Design Education: Collaboration and Cross-Disciplinarity, Aalborg, Denmark, 8th-9th September 2016*, 2016, pp. 204-209.
- [26] D. E. Naphan-Kingery, M. Miles, A. Brockman, R. McKane, P. Botchway, and E. McGee, "Investigation of an equity ethic in engineering and computing doctoral students," *Journal of Engineering Education*, vol. 108, no. 3, pp. 337-354, 2019.
- [27] J. May, "Science fiction and social justice: Teaching students to consider ethics, sustainability, and diversity issues," presented at the IEEE International Professional Communication Conference, 2020.
- [28] United Nations General Assembly, "Transforming our world: the 2030 Agenda for Sustainable Development," United Nations, 2015.