

# Building a Fairer Future: Integrating Social Justice in the Engineering Curriculum

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**Abstract**—Incorporating the social science lens into the engineering curriculum is crucial to creating solutions that are ethically sound, socially responsible, and equally accessible to people of diverse backgrounds. By understanding human behavior, needs, and societal structures, engineers can design technologies and systems that address the complexities of real-world problems. This interdisciplinary approach fosters innovation through diversity of thought and problem-solving strategies, allowing for more creative and effective solutions. It also helps in addressing systemic inequities, ensuring that technologies do not reinforce biases but rather promote inclusivity and fairness. The current study delves into the impact of an online module focused on social justice and hostile design on 22 engineering technology students enrolled in a human factors course. This module was divided into two segments: the first part introduced the concept of social justice, examining systemic racism and environmental injustice within engineering contexts. The second segment delved into the concept and application of hostile design in real-world scenarios. The module was designed to be interactive and engaging and consists of videos, readings, case studies, surveys, and reflection, to deepen students' understanding of these critical issues. The study used a multi-method design to assess the effectiveness of this module on students. The quantitative data was collected in the form of pre- and post-surveys focused on social justice and hostile design. The qualitative data was in the form of final written reflections. The survey data was analyzed using a paired sample t-test. Results indicated that students found the module effective in raising their awareness about social justice and hostile design issues and their application in engineering. Further, thematic analysis of students' final reflections revealed their key takeaways and future intentions. The themes for key takeaways revealed that students emphasized the importance of societal inclusivity and fairness, recognized the impacts of hostile design and systemic racism, and expressed the need for comprehensive solutions to homelessness and public space accessibility. Moreover, the themes that emerged for future intentions were that students felt that as future engineers, they were committed to integrating ethical considerations and inclusivity into their designs, raising awareness of hostile design among their peers, and utilizing their enhanced knowledge for professional and personal growth. In conclusion, the integration of social sciences into engineering education is not just beneficial but essential. The findings from this study emphasize the transformative potential of such interdisciplinary approaches in shaping future engineers who are not only technically skilled but also ethically conscious and socially responsible. By embracing these principles, the next generation of engineers are better equipped to create innovative, equitable, and just solutions.

**Index Terms**—social justice, intercultural competence, engineering technology, undergraduate, human factors

## I. INTRODUCTION

To create a fair society, it is crucial for STEM graduates to understand the societal challenges and develop strategies to combat them. Embedding a social justice lens into the existing curriculum can be one of the ways to help students understand real-world societal problems. Understanding the principles of social justice will enable students to advocate for the equitable distribution of benefits and burdens, safeguard fundamental rights through fair decision-making processes, and ensure the dignified treatment of all individuals, regardless of their status or authority [1]. Social justice in engineering focuses on promoting equity and inclusivity within the field by designing technological products that foster equity, accessibility and sustainability [2]. Prior research has emphasized the importance of integrating social justice concepts across the curriculum and embedding an understanding of social justice within the engineering problem-solving approaches [3] [4]. Studies have also demonstrated that engineers have the potential to make a significant positive impact by aligning their efforts with the needs of marginalized and exploited communities affected by technical endeavors [5]. Despite this potential, it has been noticed that social justice-themed topics are typically absent from the majority of engineering curricula [4].

Casper et al., [6] suggested three strategies to make the engineering curriculum more focused toward social justice: first, openly addressing the culture of disengagement in engineering; second, consistently incorporating social justice topics throughout courses; and third, allocating additional time and support for activities that integrate social context compared to similar activities that do not. Additionally, the study highlighted that students' personal values, ethics, and understanding of engineering ideologies point to the need for integrating social justice concepts across the curriculum and within engineering problem-solving contexts. The approach to engineering social justice focuses on encouraging reflective practice, advancing inclusive collaboration, and recognizing justice as a core element of engineering education. [7].

The curriculum integration to promote social justice shall incorporate methods to teach various aspects of interpersonal and social empathy. The content should emphasize on understanding systemic barriers within different contexts and

adopting broader perspectives to solve them [8]. Designing with empathy ensures that technological systems prioritize human needs and consider both individuals and communities by upholding justice, and maintaining consistent values, which are essential for resilience [9]. Using empathy in design helps engineers understand the end user's needs [10]. Guan et. al, [11] highlighted engineering education should take into account students' perspectives when teaching empathy, emphasizing the cultivation of both micro and macro perspectives as well as epistemological openness. Specifically, a shift from a micro to a macro perspective is crucial in fostering empathy, as it enables students to recognize the diverse array of stakeholders who are impacted, directly or indirectly, by engineering design choices.

Moreover, social justice lens in engineering education can strengthen the connection between innovation, sustainability, and social equity [12]. Therefore, higher education institutions should start taking steps to embed a social justice lens within the engineering curriculum. Through this study, we intend to showcase the impact of embedding an intentionally structured educational module on social justice and hostile design in engineering technology course. The research question that we plan to answer is: **How does incorporating a module on social justice and hostile design in engineering technology curricula influence students' perceptions of urban planning and social equity?**

## II. METHODS

1) *Context and Participants*: This study was conducted in an undergraduate junior 300-level course titled "Human Factors for Technology Systems". Total of 22 students were enrolled in the course. The course aimed to explore the intersection of people, technology, policy, and work within technology systems, with a focus on human factors. Throughout the course, all the students engaged deeply with coursework, analysis, and evaluations of design, and developed strategies to make design recommendations to improve the safety, usability, and efficiency of human-technology interactions across various work environments, tasks, and products. As part of their coursework, students conducted several observational studies of public facilities. These studies were designed to critically analyze usability and design elements, enabling students to appreciate the principle that making systems usable for a broader group not only simplifies tasks and enhances safety but also improves overall health and performance.

The module on social justice and hostile design was implemented in the course, particularly because a central theme of the course is to make technology-based systems accessible and user-friendly for a diverse demographic, including different age groups, genders, nationalities, and cultures. Furthermore, the module enriched the students' learning by providing a solid understanding of how design can either facilitate or hinder social equity. This perspective was especially beneficial for the final group project, where students were tasked with performing ergonomic and usability evaluations and proposing

design improvements for an existing system. The comprehensive information on inclusive design principles provided by the module equipped students with valuable insights and strategies to apply to their projects. Overall, the integration of this module into the course curriculum enhanced the students' technical skills in human factors and usability. It also helped them develop a deeper understanding of the ethical implications of design choices, fostering a greater sense of social responsibility and advocacy for inclusivity in technological developments.

2) *Module on Social Justice and Hostile Design*: This 90-minute online module, was developed by an expert in intercultural development and STEM education. The goal of the module was to familiarize students with social justice concepts and the realities of hostile design in contemporary urban planning. The module was structured into two primary segments. Initially, students were introduced to the principles of social justice through readings and videos showing examples of social injustice. The sub-modules specifically focused on systemic racism and environmental injustice, illustrated with relevant engineering examples. Students were engaged in scenario-based reflections and analyzed a case study, which required them to reflect critically and think of engineering solutions to address the social injustice issues. The latter part of the module focused on the concept of hostile design. Through readings and videos, students learned about the intentional exclusionary practices embedded in everyday designs. Students also completed a case study and scenario based reflection which allowed them to reflect and analyze hostile design elements in public and private spaces. This comprehensive educational module was designed to equip students with the analytical tools and critical thinking skills to recognize the social injustices and propose innovative engineering solutions.

3) *Data Collection* : The data for this study was collected using survey and written reflections. In order to understand the learning gains of the students, all the students were required to complete a pre-post survey and final reflections. This pre-post survey results and reflection responses served as the data for the study. The survey consisted of four questions that aimed to assess the knowledge and understanding of social justice and hostile design concepts. The responses were collected on a 5 point Likert Scale, 1 – being the Strongly Disagree and 5 being the Strongly Agree. Table I shows the survey question that were used for pre and post assessment.

Students were also required to complete a written reflection at the end of the module. The prompts provided were: Upon completion of this module, what are your major takeaways? (Write in 150 words) How do you plan to use the learnings from this module in future profession? (Write in 150 words)

## III. RESULTS

The paragraph below discusses the quantitative and qualitative results.

### A. Quantitative Analysis

1) *Data Analysis* : The study used a multi-method design [13] to analyze the data. The quantitative data from the survey

TABLE I  
SOCIAL JUSTICE & HOSTILE DESIGN SURVEY QUESTIONS

	Questions
Q1	I understand the principles of social justice as they relate to urban design
Q2	I can identify the features of hostile design in public
Q3	I feel informed about the challenges and opportunity in making urban design more inclusive
Q4	I feel confident in my ability to apply social justice principles to critique and influence design decisions

TABLE II  
DESCRIPTIVE STATISTICS AND T-TEST RESULTS

	Pre-test		Post-test		t	df	p
	Mean	SD	Mean	SD			
Q1	3.65	0.81	4.40	0.50	3.77	19	0.00
Q2	3.80	1.15	4.50	0.51	2.73	19	0.00
Q3	3.95	0.60	4.40	0.50	3.41	19	0.00
Q4	3.70	0.97	4.30	0.65	3.12	19	0.00

was analyzed using descriptive statistics followed by a t-test. The t-test was used to compare the scores for the pre and post-test results. The qualitative student reflections were analyzed using a thematic analysis approach. Thematic analysis is a widely used approach in education research and has been used by multiple studies to analyze qualitative data [14] [15]. For this study we followed the steps delineated by Braun and Clark [16] to conduct the thematic analysis. To ensure the trustworthiness of the data, first, the 20 percent data was independently coded by two researchers; upon completion of the first round of coding, they met and created a code book. Based on the codebook, the 40 percent data was re-coded by the two researchers, and peer debriefing was conducted. This time, there was a good overlap between the coders. The remaining 60 percent of the data was divided among the two researchers and coded independently by two researchers and the inter-rater reliability was calculated which led to 87 percent of overlap.

The data was analyzed using descriptive statistics and a t-test. Table II shows the mean scores for each question and the difference in the pre-test and post-test scores. It also shows the t-test results for the pre- and post-test.

From Fig. 1, we can observe that the module helped the students to develop a better understanding of social justice and hostile design issues, as we can see increase in scores from the pre- to post-test. Further the analysis of the t-test revealed that students showed statistically significant increase in understanding of social justice concepts related to urban design. Students also showed enhanced ability to identify features of hostile design in urban spaces after completing the module. They also felt informed about the challenges and opportunity in making design more inclusive and they felt more confident to apply design principles to make design decisions.

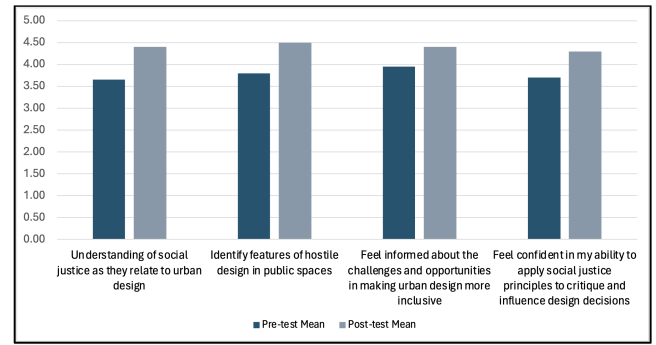


Fig. 1. Pre-post mean for the survey responses

## B. Qualitative Analysis

The reflection questions were qualitatively analyzed using thematic analysis. The themes that we generated from the analysis were divided into two broad categories a) the key take aways and b) future intentions. Under the key take away theme showcases the major take aways of the students upon completion of the module and the future intention themes shows the strategies that students want to use as a future engineering professional to combat such issues in the future

**1) Key Take Away Themes: Theme 1:Need for societal inclusivity and fairness.** Under this theme, students expressed the need to create an inclusive and fair society by understanding the necessity for collective action to build a society that values equal treatment and opportunities for all individuals. For example, a student said, “After completing this module, I’ve come to understand the critical importance of working collectively towards a society that prioritizes inclusivity and fairness. I’ve learned that everyone deserves equal consideration, especially those in low-income communities who are often overlooked. This realization compels me to advocate for policies and practices that ensure equitable opportunities and treatment for all individuals.” This student quote particularly highlights the needs of people in low-income communities and is able to understand the discrimination that happens in the society. It is interesting to note that the student is motivated to advocate for policies and practices that promote equity, ensuring that everyone, regardless of their socio-economic status, receives fair consideration and opportunities. This take-away reflects a significant shift in the mindset of the students and focusing towards a more empathetic and positive attitude towards the social justice issues.

**Theme 2: Recognized the effects of hostile design and systemic racism** This theme emphasizes the increased awareness of students about the adverse effects of hostile design and systemic racism, particularly in marginalized communities. Hostile design refers to architectural and urban planning choices that intentionally exclude certain groups of people. Upon completion of the module, students were able to recognize the impact of these practices on broader

societal issues like exclusion and inequality. For instance, one student said, *"This module has opened my eyes to the pervasive impact of hostile design and systemic racism on marginalized communities. Seeing how these practices contribute to exclusion and inequality has made me more aware of the need to challenge and rethink urban planning and architectural decisions. Moving forward, I am committed to supporting design principles that foster social inclusion and equity."* The student quote shows a commitment to the issue and a willingness to reconsider decisions in urban planning and architecture. This reflection shows that the module was able to help students develop a deeper understanding of how physical and systemic barriers operate and helped them to think of ways to design more inclusive and equitable community spaces.

**Theme 3: Need for comprehensive solutions to homelessness and public space accessibility** Under this theme, students emphasized the need to design comprehensive solutions to homelessness and public accessibility issues. For instance, a student said, *"Learning about the intersection of homelessness, public space accessibility, and hostile design has highlighted the urgency of addressing these issues holistically. I now recognize that reducing homelessness and ensuring public spaces are truly public requires a combination of policy intervention, social programs, and inclusive design. This module has motivated me to advocate for changes that make our cities more welcoming and accessible to everyone, regardless of their socio-economic status."* This student reflection illustrates the student's understanding of the issues of homelessness, public space accessibility, and hostile design. Students also showed commitment to promoting inclusivity and accessibility in urban environments by advocating for systemic changes. The module helped the student to recognize that these issues are interconnected and require a comprehensive approach for effective resolution.

2) *Future Intention Themes:* **Theme 1: Incorporate ethical considerations and inclusivity in design.** Under this theme, students perceived them as future engineering and urban planners and they emphasized the importance of integrating ethical considerations and inclusivity into design and engineering projects. The goal was to develop solutions that are beneficial to all community members, especially those who are often marginalized or come from low-income groups. For example, one student mentioned, *"I plan on finding ways to design areas that both improve the environment for a community and benefit the social and economic needs of the community."* From this student quote, it is evident that they are committed to creating designs that not only improve the physical environment but also address the social and economic needs of the community. Similarly, another student said, *"In my future profession, I plan to apply the learnings from this module on hostile design in public spaces by integrating principles of social justice and inclusivity into my work as an urban planner."* This student quote shows a mindful approach to overcoming the negative effects of hostile design in public

spaces and shows their intention to make such areas more welcoming and accessible to all by applying principles of social justice. Together, these student quotes show a shift towards more socially responsible and community-focused design practices by our future engineers.

**Theme 2: Enhancing awareness and understanding of diverse perspectives.** This theme showcases the students' ability to understand the importance of incorporating the varying needs and viewpoints of different community members into urban planning and architecture. Students articulated specifically the role of people from marginalized backgrounds in designing socially just urban community spaces. For example, a student said, *"I just plan to keep in mind the challenges associated with planning and architecture... Planning ahead and thinking about it from many different perspectives can allow one to get a more comprehensive idea for how the design can be improved and optimized."* The student quote reveals an intention to be mindful of the various challenges that can take place within planning and architecture. The student further suggests that a proactive, multi-perspective planning approach is key to improving and optimizing designs. Similarly, another student mentioned, *"I plan to be more aware in the future about how these concepts have disproportionately affected marginalized communities."* The student quote highlights that the module has helped them to become aware of the current discriminatory issues, and they commit to being more conscious in the future while doing urban planning. This awareness among the students can be seen as a first step towards rectifying past oversights and ensuring future projects promote social justice and inclusivity.

**Theme 3: Applying social justice principles in professional practices.** This theme shows that students felt the need to incorporate a lens of social justice as future engineers. Students discussed ways in which having a social justice lens to such problems can foster equitable and accessible environments. For instance, a student said, *"As an engineer, I will make sure that I provide my services to anyone who needs it not just the higher income places or individuals. In doing that, I hope to help those in need and communities in need so that someday that community won't be mistreated as it once was."* This student quote is a commitment from a future engineer to serve people from diverse communities, including those typically underserved. Similarly, another student emphasized increased sensitivity towards the accessibility of urban structures. For instance, he said, *"In the future, I will be more aware of urban structures that are not accessible to all people. In my future career, I will ensure my designs and products will be available to all people and ensure I am not discriminating against people."* This awareness and commitment to creating universally accessible spaces reflect a proactive approach to designing inclusive environments.

#### IV. DISCUSSION

The study discusses the need to integrate social justice into the engineering curriculum. In this study, we have showcased the impact of an educational module on social justice and hostile design in helping students understand the implication of social justice principles in the context of design and urban planning. The results of the study showcased that the module helped the students to understand the importance of social justice principles in urban designing and fostered skills such as empathy, critical thinking, and social awareness. The students showed a statistically significant gain from pre- to post-tests, highlighting an improved understanding of how urban design can impact social justice issues. Moreover, the analysis of the student reflection showcased that students were able to identify the need for creating a more inclusive society by overcoming systemic racism in urban planning. As future engineers and urban planners they felt the need to incorporate a social justice lens while designing community spaces. Students also emphasized the importance of embedding the voices of marginalized populations into their urban design solutions.

Overall, the results of the study highlight that students reported an increased awareness of the challenges experienced by marginal community members and felt responsive in making the design more inclusive. Moreover, the aspects of hostile design helped the students to think critically about the ethics of design choices. This critical engagement allowed students to question and rethink standard practices, fostering a growth and empathetic mindset that prioritizes ethical considerations alongside technical skills. The results of this study align with the study conducted by Casper et al., [6] and Hendricks and Flores work [17], that upon completion of the module students in this study recognized the need and importance for incorporating social justice principles into the engineering curriculum.

#### V. IMPLICATIONS

Higher educational institutions must continue to integrate curricula that address the social dimensions of engineering problems to produce socially conscious engineers. This involves teaching students to utilize their technical skills to create equitable solutions and encouraging them to consider the long-term impacts of their projects on all community members. Helping engineering students develop empathy and ethical reasoning prepares them to handle complex real-world problems. Therefore, educators need to identify ways to equip future engineers with the ability to design and innovate.

Educators should emphasize multidisciplinary learning experiences that integrate a social science lens to achieve these goals. Having a social science aspect in engineering curriculum will help students to understand the impact of their technological solutions on societal structures and people. Some of the effective ways to integrate the social science lens into engineering is through engaging students in project based learning [18], prior studies have demonstrated that project based learning allows the students to think of practical solutions to solve problems. Moreover, when students

work in project teams it allows them to get various perspectives to solve similar problems. Another effective approach is integrating experiential learning opportunities within the curriculum [19] or through service learning. Integrating the suggested pedagogical approaches will allow the students to deeply reflect on their experiences and develop equitable and sustainable solutions. Studies have demonstrated that engaging students in reflection activities is key as it allows the students to make meaning of their learning experiences and also fosters metacognition [20] [15].

Based on the findings of this study, we can conclude that the study provides evidence that integrating a social justice lens into the engineering technology curriculum was beneficial for students. It also illustrated that engaging in reflective practices allowed students to develop life skills such as empathy, critical thinking, and awareness of complex issues. Therefore, developing such educational interventions can prepare students to meet the technical demands of their professions and also equip them to tackle some of the most pressing challenges of society.

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