2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023

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Paper ID #36778

Conceptualizing Social Justice in Civil Engineering and Professors' Perspective: A Systematic Literature Review

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Introduction

The term social justice has become increasingly popular in recent years as the nation's collective consciousness has shifted to consider structural inequalities. Social Justice, as a term, varies in description depending on the group, race, gender, and religion in relation to a circumstance that results in unfair treatment. Dr. Donna Riley[5] describes social justice in her book Engineering and Social Justice as *"...openness to change. It recognizes that people in every time and place continue the struggle for justice in new contexts."* Ultimately, social justice is the idea that all members of society deserve equitable treatment from all conceivable social institutions.

Equal treatment within social institutions is directly relevant to civil engineers because they utilize their knowledge to create the world we see, experience and imagine. Their decisions have an impact beyond the end users of their creations, which gives their work broader social implications. The breath of one's knowledge, stemming from individual or group experiences, encompass a multitude of factors such as ability, socioeconomic status, gender and race – is often overlooked in the decision-making process. If there is failure to consider the experiences of all stakeholders when considering the design, implementation, and execution of projects, there are lasting negative effects. A good example of this phenomenon was the construction of the Cross Bronx Expressway [6] which was built between 1948 and 1972. When Robert Moses envisioned it, he had no regard for the fact that the proposed location of the expressway was where thousands of people lived. So, while the expressway achieved its goal of creating an efficient means to travel through the Bronx via automobile, it destroyed a community in the process. As a result, 5,000 residents were displaced from 1,500+ apartments, 113 streets reworked, housing prices plummeted, and unemployment skyrocketed, to name a few of the negative consequences. The alternative route suggested by engineers and community members would have displaced only a total of nineteen families—with the demolition of the Third Avenue transport depot and six dilapidated tenement brownstones according to Journalist, Robert Caro. This goes beyond the efficiency of the design of the expressway and centers on ethical concerns.

Civil Engineering curricula have traditionally neglected social justice concerns or topics around public welfare in partnership with diversity, equity and inclusion which can be encompassed under justice. However, recent years have witnessed these topics enter the public discourse of engineering education [7]. Engineering courses are often viewed as technical versus non-technical or hard or soft engineering [8]. Topics outside of the scope of traditional engineering, particularly as it pertains to ethics or social science are seen as an elective, and not a requirement. These courses in particular provide opportunities for discussion around societal and public considerations. Although having a positive impact on society is cited [9] as a draw to the engineering major, engineering students tend to leave engineering programs due to the lack of focus on social impact and not centering change necessary for more inclusivity [10]. For this

reason, it is important diversity, equity, inclusion and justice work in conjunction with ethical tenants within civil engineering curricula. Definitions are important to understanding the scope of this work. The American Society of Civil Engineers pulls from two sources for the definition of diversity, equity, inclusion and justice. We will use the definition of diversity, equity and inclusion as defined by the Accreditation Board for Engineering and Technology [11]. Diversity is a "range of human differences, encompassing the characteristics that make one individual or group different from another". These experiences can expand the breadth of identities including race, gender, culture, cognitive differences and physical ability. Equity is defined as "fair treatment, access, opportunity and advancement for all people, achieved by intentional focus on their disparate needs, conditions and abilities." ABET goes on to mention the importance of understanding historical and systemic patterns to eradicate impediments to equality. Inclusion is defined as an "environment [which] provides equitable access to opportunities and resources, empowers everyone to participate equally, and offers respect in words and actions for all" [11]. Inclusion creates space for diverse people and groups to thrive. The definition of justice is taken from J.E.D.I. Collaborative which states it is "dismantling barriers to resources and opportunities in society so that all individuals and communities can live a full and dignified life" [12]. To create a more inclusive society, we must maintain the capacity to constantly challenge our presumptions of why we engineer and for whom [13].

Given that engineers are key stakeholders in society, instructors in engineering courses play a pivotal role in shaping their perspectives. Therefore, civil engineering education must teach engineering students to consider those broader social implications to fully appreciate and understand the broader impact of their engineering decisions. While the idea is popular in an abstract sense, historically, social justice has not been incorporated into the civil engineering curriculum, and thus does not often find its way into the training of civil engineers. Nonetheless, a growing number of researchers have signaled the importance of considering the need for examining social justice implications in proposed engineering outcomes [14], [15]. Depending on the area, authors suggest varying methods of course direction such as diversity in scholarship and case studies to name a few as well as supplemental extracurricular options. There have been several pilot programs introduced in universities that will be discussed in the results.

Diversity, Equity and inclusion can be encompassed under the umbrella of social justice. Understanding how each part of DEIJ plays a role in creating a more welcoming environment, going forward we will use DEIJ with social justice at the helm. Prioritizing engineering curricula can potentially address engineering students' diminished concern for public welfare and social impact. When the importance of diverse perspectives is not cultivated, it can perpetuate scenarios in which only specific voices are heard and prioritized. However, those efforts are thwarted when the impacts of engineering projects on human wellbeing and community conditions are considered. Professors are an important part of the overall process of what is being taught while ensuring students are well-rounded engineers. In this paper we seek to better understand the

perspectives of the professors regarding the implementation of DEIJ and potential barriers faced when teaching within civil engineering curricula.

Methods

An extensive literature review was conducted to determine what work has already been done in the space of diversity, equity, inclusion and justice in civil engineering. However, in searching this specific key term, not many results were obtained, so the search was expanded to include all engineering. The review consisted of systematically searching multiple databases for key terms and coding themes. The following search engines were used: Google Scholar, Web of Science, and EBSCO. This literature review focuses on journals associated with social justice, ethics and civil engineering and engineering education with search terms including: *civil engineering, social justice, ethics, engineering education, and professors (see Table 1).* Table 1 shows the results of the searches for these key terms. Also note, (not included in the table), the following search term combinations returned no results: 1) engineering education (EE) + ethics (ET) + social justice (SJ) + professor (PR), and 2) civil engineering (CE) + social justice (SJ) + professors, and (EE) + ethics (ET)+ professors (PR).

Table 1: Key term variations used and number of articles found and excluded of Google Scholar, Web of Science, and EBSCO search engines.
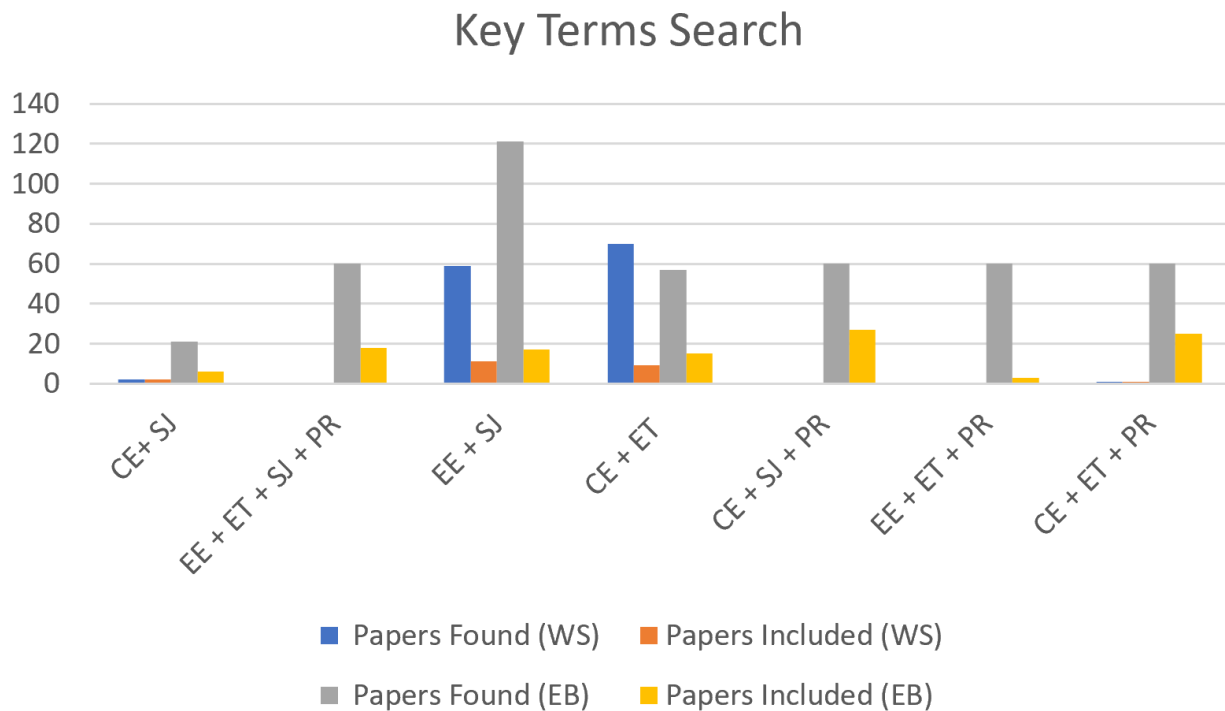

Table 1. Shows the number of papers found and included in both Web of Science (WS), EBSCO (EB) using the following key terms: Civil Engineering (CE) , Social Justice (SJ), Ethics (ET), Engineering Education (EE), Professor (PR),

The search term ethics was also included because it is worth noting that some researchers may consider social justice to be an extension of ethics. Therefore, we used ethics as a broader term in which social justice can be referenced to engineering education. It was also important to understand how scholars connected and made sense of the key terms while centering the voices of professors in the university setting. Only published peer-reviewed papers in academic journals written in English dated between 2010 - 2022 were considered.

PRISMA

Direct searches within each of the databases resulted in thousands of articles. To narrow down the field, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Fig 1) framework was used to analyze the data of this literature review. PRISMA analysis includes a process of four phases: Identification, Screening, Eligibility, and Included to help refine the data collected. In the Identification phase, articles were found using the key terms. Due to a large number of articles, we chose to observe the first 6 pages of Google Scholar and EBSCO to reduce the number of articles to 60 in Google Scholar, 360 in EBSCO (including the first 6 pages of each key term combination) and 167 in Web of Science totaling 587 articles. In the Screening phase, the titles of the remaining articles were reduced to 164 by judging that title's ability to answer one of the following research questions: 1) Do professors value DEIJ in engineering education? 2) How do professors perceive the role of DEIJ considerations in the civil engineering curriculum?, and 3) Do professors include DEIJ in their civil engineering curriculum/courses and are there concrete steps to include these principles? In the Eligibility phase, the abstracts of the remaining articles were reviewed against the same 4 research questions from the Screening phase, which produced 48 articles. Finally, in the Included phase, the full article was read to determine if it answered one of the research questions. This narrowed the final number of articles considered in this review to 11.
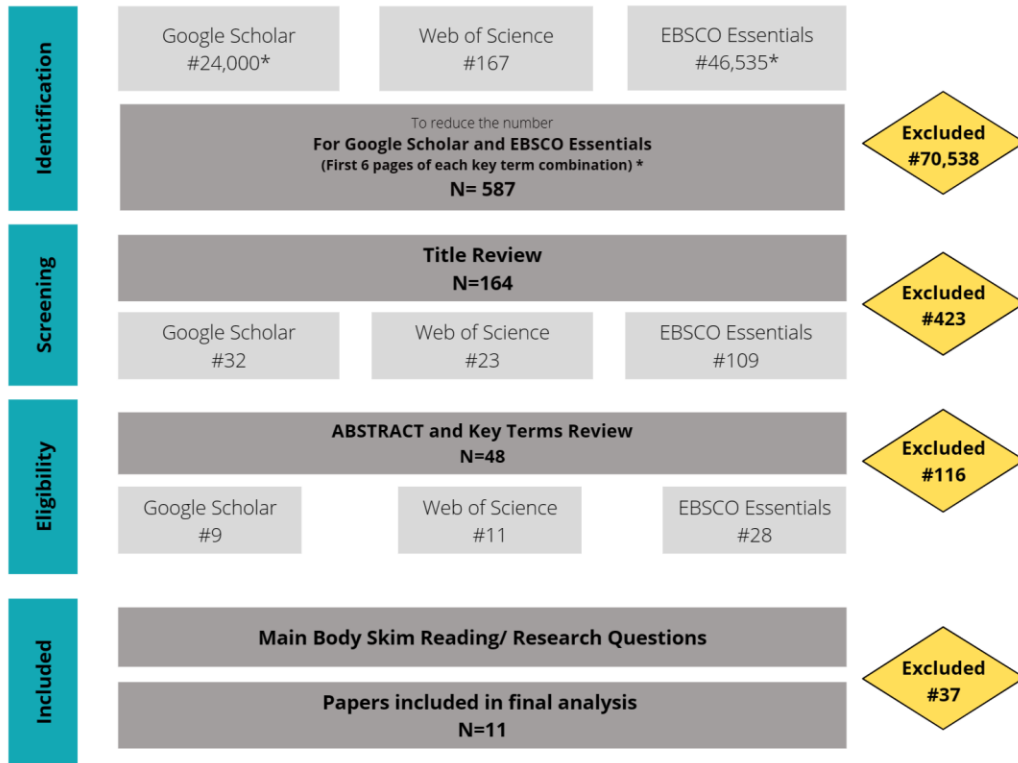
Figure 1. From top, left to right. Inclusion and Exclusion analysis process with PRISMA.*First 6 pages of search reviewed for Google Scholar and EBSCO Essentials (60 articles each). (updated fig see link below- was unable to download)

Inclusion and Exclusion Process for each Database

A total of 48 articles from Google Scholar, Web of Science, and EBSCO were identified in the Eligibility Phase. These articles were reviewed in their entirety to check for relevance to answer the research questions. Since the process used to acquire these 48 articles was different depending on the database used, the procedure for each is described below.

Google Scholar

Google Scholar's advanced search engine was the most restrictive for these categories, and search settings included: "*all of the words*", "*where words may occur - in the title of the article*" and the date range of 2010 - 2022. However, with these settings, no results were returned. With this, the search setting was changed from *"in the title of the article"* selection to "*anywhere in the article,*" which resulted in 24,800 articles. Unfortunately, Google Scholar does not have an option to choose peer reviewed articles. We then reviewed the first 6 pages (60

articles) with the same criteria with the title and abstract focused on secondary education and our key terms, which resulted in 9 articles total.

Web of Science

      With Web of Science, the search setting provides an option to choose "*Topic*" where our key terms were entered, the peer review journal box was chosen along with the date range, which returned 167 articles. Due to the refined search options, the articles were organized based on their categorical descriptions. Out of the 23 Web of Science categories, 11 categories were kept (Fig. 1.2) in order to reduce the number of articles that relate to the research questions. The titles and abstracts were reviewed specifically for higher education (i.e., undergraduate and graduate levels), and also professional education for the key terms. Articles were excluded that focused on K-12 education, as well as those about engineering professions without the incorporation of secondary education, which resulted in 11 articles.

Orignial Categories (23)	Final Categories (11)
• Education Educational Research • Education Scientific Disciplines • Engineering Multidisciplinary • Environmental Sciences • History Philosophy Of Science • Engineering Environmental • Green Sustainable Science Technology • Ethics • Multidisciplinary Sciences • Philosophy • Environmental Studies • Management • Chemistry Multidisciplinary • Cultural Studies • Geosciences Multidisciplinary • Meteorology Atmospheric Sciences • Physiology • Psychology Educational • Soil Science • Urban Studies • Water Resources	• Education Educational Research • Education Scientific Disciplines • Engineering Multidisciplinary • Environmental Sciences • History Philosophy Of Science • Engineering Environmental • Green Sustainable Science Technology • Ethics • Multidisciplinary Sciences • Philosophy • Environmental Studies

Figure 2. Description of categories under Web of Science results.

EBSCO Essentials

With EBSCO Essentials, it allowed for peer reviewed articles during the same date range. The *"Subject"* option was used, along with the key terms and "*Abstract*", which found no results. We changed "*Abstract"* to "*Title"*, and no articles were also returned. The option of *All Fields* was chosen from a combination of key terms that resulted in 46,535 articles. To reduce the number of articles, we only reviewed the first 6 pages of each search word combination (36 pages/ 360 articles). After utilizing the exclusion criteria, we were able to reduce the number of articles to 109. Following this, the entire article was reviewed for inclusion of social justice, equity, and diversity within the classroom or curricula and with the professors' and students' perspectives, which resulted in 28 articles.

Results

For the 11 articles that remained after the Included phase, we coded the articles according to the following research questions 1) Do professors value DEIJ in engineering education?, 2) How do professors perceive the role of DEIJ considerations in the civil engineering curriculum?, and 3) Do professors include DEIJ in their civil engineering curriculum/courses and are there concrete steps to include these principles? We looked for relationships between faculty perspectives, courses and curricula, student insights, university participation, and the engineer's responsibility. It was important to understand how scholars connected and made sense of the key terms and centered the voices of professors in the university setting. These results for our included articles can be seen in Figure 3. It was important to understand how scholars centered the voices of professors in the university setting. These results for our included articles can be seen in Figure 3. After reviewing only 4 articles focused specifically on civil engineering and some form of DEIJ, we included the remaining 7 articles which referenced civil engineering education and DEIJ due to the low number. The following results incorporate responses from both civil engineering and engineering education to give a better understanding of the current state of the value and process of integrating DEIJ in order to better understand the perspectives of the professors regarding the implementation of DEIJ and potential barriers faced when teaching within civil engineering curricula.
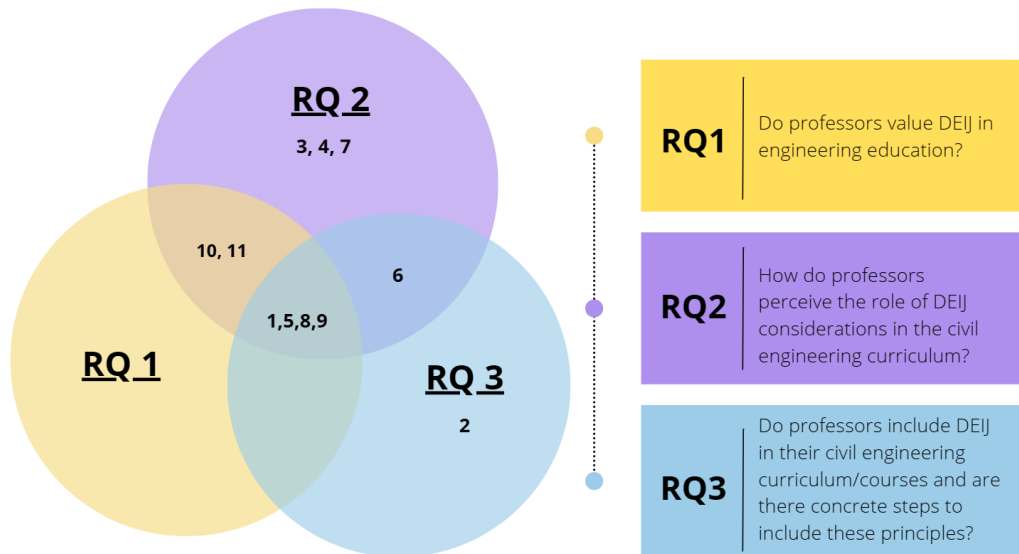
Research Question (RQ) Venn Diagram

| RQ1 | Do professors value DEIJ in engineering education? |

| RQ2 | How do professors perceive the role of DEIJ considerations in the civil engineering curriculum? |

| RQ3 | Do professors include DEIJ in their civil engineering curriculum/courses and are there concrete steps to include these principles? |

Figure 3. Final 11 articles categorized by research questions (RQ).

#	Authors	Title	RQ
1	Dr. Daniel Erian Armanios, Ms. Andrea Francioni Rooney , Dr. Millard L. McElwee, Joe Dallas Moore, Dr. Destenie Nock, Prof. Constantine Samaras, Prof. Gerald J. Wang	Diversity, Equity, and Inclusion in Civil and Environmental Engineering Education: Social Justice in a Changing Climate	1,2,3
2	Chioma Ohajunwa, Judith McKenzie, Anneli Hardy &Theresa Lorenzo	Inclusion of disability in teaching and research in higher education	3*
3	Brittany A. White, Joseph R. Miles, & Keri A. Frantell	Intergroup dialogue: A justice-centered pedagogy to address gender inequity in STEM	2
4	Denise R. Simmons and Susan M. Lord	Removing Invisible Barriers and changing mindsets to improve and diversify pathways in Engineering	2

5	Mr. Cristian Eduardo Vargas-Ordo´nez and Dr. Morgan M Hynes	Engineering design and social justice: A systematized literature review	1,2,3
6	Diana A. Chen, Joel Alejandro Mejia and Samantha Breslin	Navigating equity work in engineering: Contradicting messages encountered by minority faculty	1,3*
7	Ebony McGee and Lydia Bentley	The Equity Ethic: Black and Latinx College Students reengineering their STEM careers toward Justice	2
8	Donna Riley	Hidden in Plain View: Feminists Doing Engineering Ethics, Engineering Doing Feminist Ethics	1,2,3*
9	Cindy Rottman and Douglas Reeve	Equity as Rebar: Bridging the Micro/Macro divide in Engineering Education	1,2,3
10	Ramzi N. Nasser and Michael H. Romanowski	Social Justice and the Engineering Profession: Challenging Engineering Education to move beyond the technical	1,2
11	Jon A. Leydens, Kathryn E. Johnson, Barbara M. Moskal	Engineering student perceptions of social justice in a feedback control system course	1,2

Table 2. RQ (research question), (*) indicates discussion of incorporating DEIJ in some form, however it lacks step-by-step classroom implementation process.

1) Do professors value DEIJ in engineering education?

Professors are the gatekeepers to the information disseminated in a university. Historically, STEM education was created for white males. Their understanding of the foundations of education for whom it was created and for whom it was not created, stands out most in the literature. Not many articles explicitly identify the "historically privileged" perspective like [8]. However, it does give the foundational understanding of the approach that leaves out the perspectives and lived experiences of those who are not white and male. Often the authors who address the value of DEIJ in the curriculum are those who have directly dealt with bias due to their race and/or gender, as well as those who understand systemic bias in the educational framework [8], [16], [17].

When answering the question do professors value DEIJ much of what is found speaks to using ethics as a frame in which to situate social justice. For some professors, ethics is seen as a by-product of social justice, to which one professor responded *"if social justice is not applied then there is something wrong with ethics"*([18] pg 419). What is found in the literature is that professors "deliberately confront issues of DEI" and that civil engineering is connected to inequitable societal outcomes [19]. For this reason, incorporating social justice within the classroom is of great importance. What is rather unique, is the acknowledgement that neither the educational system nor science are neutral [18]. The myth of 'ethical neutrality' in science can be seen as a barrier to validating the importance of diversity, equity, inclusion and justice in

engineering. For those leading the way, incorporating social justice in the curriculum is intentional.

2) How do professors perceive the role of DEIJ considerations in the civil engineering curriculum?

Social Justice is a lens through which students should view the world. To do so, these courses should not be optional, but required for all engineering students. As noted by Nasser and Romanowski [18], ethics courses offered do not address social justice. The content outlines ethical codes to abide by from a technical standpoint within the scholastic programs and engineering firms. According to students who were asked about social justice in the classroom, ABET standards discussed do not address what happens outside of the classroom setting. Courses about social impact responsibility and social justice will support their desire to make the world better and support change for public good [10]. The few courses offered allow for students to explore their desire to utilize their voices for good. However, the lack of content around real world application and historical context leave students desiring true integration [9]. There have been several instances of integration into engineering education beyond a stand alone ethics class. Professors, particularly those that identify as a minority or woman, find DEIJ to be a critical part of the engineering curriculum. Much of the decisions around infrastructure and design impact neighborhoods of minority and low-income areas disproportionately [19]. The consideration of DEIJ within civil engineering development is seen as imperative.

3) Do professors include DEIJ in their civil engineering curriculum/courses, if so, are there concrete steps to include these principles?

The American Society of Engineering Education (ASEE) provides a platform for engineers to present findings that describe the importance of DEIJ in engineering education. In particular Armanios [19] and his colleagues outline the efforts of the Civil and Environmental Engineering department at Carnegie Mellon to incorporate diversity, equity and inclusion within the engineering curriculum. Carnegie Mellon's work in DEI builds upon Baillie [20] and Riley's work [5] as they present the connection between engineering and social justice in their respective books. Specific examples of how this incorporation was carried out will be presented in a subsequent section. As Bucciarelli [1] mentions, to solve many of the world's problems, there needs to be a more collective response. The best responses are not one size fits all. Therefore the value of diversity of perspectives must be considered to build a more inclusive society.

Placing value on a thing and actually positioning yourself and others to actively prioritize a thing is different. Including DEIJ in the curriculum and/or course work requires intentionality. That intentionality trickles to the student. Through this literature review, we wanted to understand the

effort taken to ensure universities are creating a more inclusive, diverse and equitable environment for students, as well as faculty.

For civil engineering students at universities, what is taught and experienced in the classroom regarding moral agency is presented through the elective course of engineering ethics. Ethics courses provide "understanding of professional and ethical responsibility"[1]. Much of what is discussed focuses on the technical and lacks the social nature of diverse experiences. A renovation is necessary that expands beyond an ethics course [1]. According to Rottman and Reeve [21], "*personal and professional ethics are irrevocably tied to social justice, leaving engineering ethics education incomplete when decoupled from equity.*"

For change to take place, engineering programs must move away from "tacked on" approaches for ethics and social justice courses. Social Justice is a lens through which students should view the world. To do so, these courses should not be optional, but required for all engineering students. However, the lack of content around real world application and historical context leave students desiring true integration. Being as though civil engineering has not offered integration, students expand their options to opportunities to the larger engineering department. There have been several instances of integration into engineering education beyond a stand alone ethics class, within the curriculum itself, through co-curricular activities, and through self-selection.

Curriculum

Universities such as Carnegie Mellon University took more of a direct approach. The Civil and Environmental Engineering (CEE) Department incorporated Diversity, Equity and Inclusion principles in the curricula. The support from the DEI Committee at Carnegie Mellon, helped facilitate the implementation of the social justice courses rather swiftly. These efforts were intentional to span both the pedagogical framework and departmental culture [19]. At the foundation, instructors took a hands-on approach to deliberately challenge the lack of DEI issues addressed in coursework. Professors centered Black, Indigenous, People of Color's (BIPOC) scholarship in the classes. The department redesigned the curriculum both at the undergraduate and graduate levels. Courses are specifically tailored to each level – freshman, sophomore, junior and senior.

Co-curricular

For some student's participation in co-curricular activities helps to bridge the gap between courses and curriculum. The extracurricular activities provide an opportunity to use their knowledge of civil engineering in a real-world setting. Students are able to assess the importance of stakeholder input within each project. Capstone and community projects bring solutions to issues local communities face, while removing the students from the center and putting the focus

on how they can make the lives of others better. The primary skill set is not just technical, but the ability to listen and consider the perspectives of others. Additionally, ethics and social impact co-curricular activities such as NSBE (National Society of Black Engineers), or Society of Women Engineers (SWE) and Engineers Without Borders (EWB) help students view social responsibility in a more impactful way as a young professional [22].

Self-Selection

In some instances, students have the opportunity to choose to participate in non-required courses and co-curricular activities via self-selection. Therefore students that participate are aware of the importance of understanding the role diversity, equity and inclusion play in society. Those students who do not seek other resources or participate in extracurricular activities are not required to learn about the importance of varying perspectives. There is no mandatory policy that ensures all students receive the exposure to social justice in the classroom as well as the benefit of the knowledge to apply to actual real-world scenarios.

Reviewing the literature, we only know when professors incorporate DEIJ in the curriculum. The authors have not described instances when a professor intentionally refrains from incorporating social justice in the curriculum.

University	Paper reference	Integration Process
Carnegie Mellon	Armanios implemented DEIJ in classroom, wrote paper	Curriculum and class integration (freshman to senior year)
University of San Diego	Armanios et al., 2021	Two Required Diversity, Inclusion and Social Justice (DISJ) Classes
UC-Berkeley	Armanios et al., 2021	Center for Effective and Global Action
Stanford	Armanios et al., 2021	Specific Courses not found

Table 3. Universities with DEIJ focus

In the literature professors that are incorporating DEIJ in the classroom use similar means in which to introduce the topic to students. Similar to the value professors place on DEIJ, the process of integrating requires a more detailed level of intention. Often professors use projects, new vocabulary and current events to present information in a palpable manner. Above we

discussed more of a systematic way in which to include the topic of DEIJ. The integration extends to how professors ensure understanding. Examples found in the literature include: reorientation, current events, historical content, community based participatory research, scholarship and peer-to-peer participation. Topics such as justice and equity are included in a way in which students are more familiar. However, topics such as gender equality are rarely discussed [17] [23].

Reorientation

As discussed previously, the importance of DEIJ is balanced with the understanding of the foundation of the educational system and discourse on whose perspectives are fundamentally at the forefront [8]. Reorienting students whose views are often dismissed or left out can empower them to speak about their experience while also seeing themselves in the curriculum [9]. Respecting students and caring for their feelings during the process of engaging with materials that may be difficult to discuss in class was paramount, considering the nature of the topic [9]. Researchers discussed the importance of understanding the implications of DEJI not only in history but also how we teach engineering and whose voices are at the forefront.

Armanios et al.,[19], introduced students to social justice through a scaffolding approach. Initially, students were given key terms to learn. They were also asked to describe the type of engineering legacy they would like to leave. Professors reoriented the students by highlighting their agency and aided to increase awareness that as engineers their decisions can affect "social and environmental justice or injustice" ([19] pg. 6).

Historical Content

Much of the educational content presents only historical figures that identify as white-male. Instructors felt it was important to amplify research and engineering voices that were non-white, non-male. To combat the misconception that the only voices whose contributions are worth acknowledging in engineering all look the same, majority of the content used in the course were from scholars who identify as BIPOC and/ or a woman [19]. For the first year course CEE Infrastructure and Environment for a Changing World , students are provided with an article to discuss all stakeholders involved, as well as the current and future implications of the decision engineers have made regarding a project.

Current Events

At Carnegie Mellon, Professors incorporated current events in the junior-level Environmental Engineering course such as the Flint water crisis in order to engage students giving a better perspective and orient social justice in engineering by presenting case studies they are familiar

with. Flint is an example of social justice and environmental injustice where the result has lasting effects on a marginalized community and the environment. Bringing a real world perspective to the classroom helps to center the importance of considering all stakeholders in the decision making process.

Community based participatory research

Whether for a capstone project or in class research, instructors use *Community based participatory research* (CBPR) to engage community members and students equitably to share knowledge in order solve some of the more pressing issues. It is also a way to share power and influence with those whose insights are often disregarded [24]. Problem-based learning allows for students to engage with end-users and community experts to work collaboratively towards a solution [22].
As an example, identifying the heating source for the Navajo Nation, community members and researchers worked together and concluded a wood/ coal burning stove would be best.

Capstone

*Community based participatory research (*CBPR) is often used in Capstone projects to help end-users and for students to utilize their knowledge to not only benefit communities, but also create a final project. (Vargas-Ordonez and Hynes). Interdisciplinary work and team building skills are developed through this project as well. Students have an opportunity to use their project to develop solutions and while working alongside a diverse group of people or take the opportunity to present how DEIJ informs equitable design.

Scholarship

Armanios et al. [19] focuses on incorporating the works of BIPOC scholars in the introductory infrastructure and environment class. Non-white, non-male-identifying engineers' perspectives are centered as a way of encouraging diversity of thought and including voices traditionally marginalized. Discussing the contributions of Dr. Katherine Johnson (during the unit on root finding), and Dr. Phyllis Nicolson (during the unit on ordinary differential equations") helps to center scholarship that is often left out.

Peer-to-Peer

Rottman and Reeve reference the use of curricular integration strategies to introduce ethics and equity to students. Faculty members offer an invitation for instructors to incorporate case studies or co-construct classes that allow for modules to present ways in which these ideas are explored and demonstrated in real world contexts.

Accessibility: Students with disabilities

At Carnegie Mellon, course materials are adjusted for file format and font to make it easier for students with visual disabilities to view. [19].

Only a few articles outlined concrete steps for implementation. A few touch on professors orienting students to understand equity in engineering through the Liberal social justice theory. "*Liberal social justice theory frames citizens as individuals with the right to equal opportunities, while critical social justice theory frames inequitable outcomes at the group level as evidence of widespread discrimination in our education, economic and governance systems*" [21]. Carnegie Mellon University is one of the few universities that integrate DEI practices and tenants into the Civil and Environmental Engineering department and throughout the curriculum. Combating discrimination and inequities around 'race, gender, sexual orientation, disability, and socioeconomic status'. [19]. Class by class objectives were provided to help orientate the reader to better understand the intentionality of the integration of DEI.

Cases

In the classroom is where real-world scenarios should be discussed, not only from a technical and ethical perspective, but also from a social perspective. The Montreal Massacre is rarely discussed in the classroom. In 1989, an armed man opened fire in an engineering classroom at Montreal's École Polytechnique School, killing only the women students. In total 14 women were murdered [17]. The lack of discussion around these cases further supports a lack of viewpoints and inclusion. Whitbeck asserts "feminism is a bad word in engineering and engineering ethics" ([17], p197).

Inclusion of scholarship

Including women in scholarship within the Carnegie Mellon CEE curriculum has been successful for Armanios et al., [19]. Contributions by women are integrated within the computational and data science course for civil and environmental engineering, "Get to Know a Computational Scientist of Engineers!". On a bi–weekly basis, lectures introduce engineers who have made indelible impacts in the field. Outcomes to this particular approach were not provided. These insertions fit within a larger scope of the DEIJ focused curriculum.

Discussion

We understand the effects of engineering on society has been a focus of not causing harm to the public. There are some discussions in the classroom about the harmful decisions made and how those decisions impact specific people groups and demographics, however a step-by-step process specifically for the five areas of civil engineering (Geotechnical, Environmental, Transportation, Water Resources, and Construction Engineering and Management) has not yet been explored.

Much of the material explored around ethics references procedures and how to treat those that work within a corporation; however, the majority of the articles when looking for social justice were found within a description of lived experiences of the authors [8], [17]. The articles varied regarding frameworks and pedagogies a professor could use to implement social justice and the benefits, utilizing those frameworks. Additionally, only a few articles talked about thoughts professors had surrounding social justice in civil engineering education. As well as it discussed how students would like to have more of the topic implemented within the curricula. It is encouraging to see the research focus on social justice, however, much of the literature speaks to how to help students to think differently regarding social justice in the classroom. Nonetheless, not much is written giving voice to the perspective of the instructor and their sentiment of social justice in the civil engineering curriculum. Do instructors believe social justice is necessary to learn and understand?

Some Barriers discussed focused on the overarching need for change and overcoming business as usual in order to increase diversity in academia. [18], [21]. In the classroom, Professors brought up a scenario where a lack of women's perspectives in case studies was discussed in a classroom, which led to backlash and a "men's rights discourse" [21]. Another barrier is professors do not have the knowledge and pedagogical skills to incorporate DEIJ in the courses that shines a light on issues without it remaining siloed in the minds of students. Decision makers within the university may only see the importance of having DEI committees with no commitment for change. Therefore, it is important to have the support of departments to ensure the scope of incorporation is not just limited to one or two courses, but help to change the view of students as well as professors towards a more just society. Montoya discusses how much of the community-based work is often 'carried out by underrepresented minority faculty'. This work is often not rewarded and 'invisible'. It is important for tenure committees to recognize this work.

The "tacked on approach" to teaching social justice is not servicing students. In order to change perspectives and for students to develop the skills and competencies through a critical lens, integration to solve this challenge is paramount [18].

Other barriers were more geared to ensure that the students were able to ease into the discussions and topics by first understanding their positions through reflexive conversations and written work. The barriers discussed did not reflect impediments geared towards faculty, but how as a professor Armanios et al. [19] could help mitigate any negative feelings and ensure the classroom was 'safe' and comfortable'.

Moving forward in the exploration of concrete steps, perhaps understanding the ease of getting permission to discuss the subject of DEIJ and the level of support necessary for student and staff engagement can be of importance. The articles we collected did not speak much on barriers of implementation. There seemed to be more of a focus on easing students into the subject matter. The authors did not include the process preceding course approval.

Conclusion

When researching social justice and engineering education it is fair to say the topic is nascent within the confines of professors' perspectives in civil engineering education specifically. While there is some discussion of the importance of incorporating DEIJ in the curriculum, our research notes that there is a lack of professors' processes regarding implementation and their thoughts on DEIJ in civil engineering education. Existing resources emphasize the importance of educating students to be well-rounded and think outside the box when it comes to decision-making tasks that will have an impact on society's most vulnerable populations. However, there tends to focus on the students' experiences in classroom settings and in the local community, leaving an opportunity for future research to explore and gather information on the integration of principles specifically within civil engineering. It's imperative to have a full understanding of what civil engineering professors and instructors have to manage when it comes to incorporating a more human-centered in this field. What do they believe? What principles do they espouse? What is the best manner in which to proceed? Not until the full picture is seen can we identify the scope of barriers and solutions necessary for successful implementation which leads to more inclusive engineering programs and ultimately a more just society.

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