Acta Pedagogia Asiana

*Review*
**Volume 4(2), 2025, 115–123**
https://doi.org/10.53623/apga.v4i2.680

# Addressing Diversity, Equity, and Inclusion in Environmental Engineering Education: A Review of Strategies

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**SUBMITTED: 5 May 2025; REVISED: 28 May 2025; ACCEPTED: 30 May 2025**

**ABSTRACT:** While environmental engineering helps to solve major world challenges, it still struggles with diversity, equity and inclusion (DEI). This study seeks to understand the current progress of DEI in environmental engineering education at the university level and for professionals. It analyzes studies related to DEI to discover difficulties that hinder its integration and considers proposed solutions for promoting an inclusive environment. Some main obstacles are the low number of minorities, insufficient DEI information in courses and opposition to reform within institutions. Various promising ways such as making changes to the curriculum, inclusive teaching, student mentorship schemes, instructor development and community involvement are covered. Even so, these different approaches often miss proper support and coordination which reduces their usefulness over time. The review points out flaws in how assessment is done and suggests incorporating DEI concepts throughout education policies, teaching activities and professional life. In the end, it recommends ways that teachers, schools and policy groups can promote DEI by staying committed and joining forces.

**KEYWORDS:** Environmental education; diversity; equity; inclusion; STEM; teaching strategies.

## 1. Introduction

The Science, Technology, Engineering, and Mathematics (STEM) fields have historically faced multiple barriers regarding DEI [1]. Environmental engineering, which integrates engineering design with environmental science and public health, has served as a crucial social force in addressing global challenges such as climate change, resource depletion, and environmental equity problems [2]. Since environmental challenges disproportionately affect

vulnerable segments of the global population, expanding diversity within this discipline has been essential.

Environmental engineering education has faced persistent challenges in implementing and meaningfully adopting DEI principles, despite widespread recognition of their importance [3]. Diversity encompassed the inclusion of various identities and perspectives, such as race, ethnicity, gender, socioeconomic status, nationality, ability, religion, and other dimensions [4]. Equity was achieved through fair treatment, ensuring access and opportunities for all, while actively identifying and dismantling systemic barriers that hindered full participation by marginalized groups [5, 6]. Organizations were expected to commit to intentional, ongoing efforts to foster environments where every individual was valued, supported, and actively engaged [7]. These principles of diversity, equity, and inclusion (DEI) were fundamental to environmental engineering education, as they shaped learning environments that prepared students to address complex global challenges through socially just, scientifically rigorous, and culturally responsive methods [8, 9].

Professional organizations such as the American Society for Engineering Education [10] and the National Academy of Engineering [11] emphasized that enhancing DEI in engineering extended beyond social responsibility—it directly fueled innovation and creative problem-solving. Research confirmed that diverse teams consistently outperformed homogeneous groups when tackling complex, open-ended challenges, particularly in environmental engineering contexts [12]. Engineering graduates trained in multicultural environments developed critical competencies for collaborating with diverse communities and global partners, enabling them to devise more equitable and effective solutions [13, 14].

Numerous obstacles continued to restrict participation and achievement success for minority groups within environmental engineering programs. Underrepresented populations faced challenges due to a lack of role models, biased admission processes, exclusionary hiring practices, and an overreliance on dominant content and teaching methods that failed to adapt to diverse learning styles [8, 15]. Most academic departments lacked established DEI support systems, relying instead on sporadic, isolated efforts rather than structured, systemic approaches to lasting change [3, 16]. As a result, environmental engineering remained underrepresented in terms of diversity, with both educational programs and professional practices falling short of their full potential [13].

In recent years, the number of initiatives aimed at addressing these issues increased, driven by the influence of social movements and heightened institutional accountability in higher education. Universities revised curricula to incorporate environmental justice and global sustainability, adopting teaching methodologies that respected diverse needs, supported underrepresented students, and trained faculty to meet DEI goals. Programs also took steps to embed DEI objectives into their strategic frameworks, establishing measurable goals for student and faculty diversity and collaborating with community organizations to discuss relevant DEI topics [17, 18].

Environmental engineering practitioners developed new programs that combined technical knowledge with social responsibility and ethical considerations. Educational institutions began integrating environmental justice content into their curricula, providing students with analytical tools to evaluate engineering decisions based on their social consequences across different populations. Design projects increasingly required students to engage stakeholders, particularly marginalized communities traditionally excluded from

environmental policy-making processes. These modifications to educational programs improved DEI representation within academic environments and better prepared students for professional work in diverse global contexts [18, 15].

Despite these efforts, DEI promotion in environmental engineering education remained uneven, as the literature highlighted both promising strategies and areas needing further development. Most current initiatives originated from a limited number of institutions or dedicated individuals, rather than being fully integrated into programs or institutional structures. While many programs focused on increasing diversity through representation, fewer offered comprehensive equity and inclusion efforts that guaranteed support and fostered thriving student environments [19].

This mini-review explored strategies for promoting DEI in environmental engineering education while drawing insights from broader engineering education approaches. It aimed to highlight successful practices, identify recurring challenges, and recommend new areas for research. Through this review, it supported current initiatives seeking to establish diverse learning environments that reflected the communities and global contexts served by environmental engineers.

## 2. Methodology

This study used a methodical approach to identify and analyze literature focused on DEI in environmental engineering education [31]. The following steps were taken:

- Articles and reports were retrieved using Web of Science, Scopus, Google Scholar, and publications from professional societies.
- The following search terms were used: diversity, equity, inclusion, environmental engineering education, STEM diversity, inclusive pedagogy, and engineering DEI.
- Only studies and reports published between 2010 and 2024, related to DEI strategies in engineering education or environmental engineering, were included. Literature on both educational and workplace developments was considered.
- Excluded were articles not in English, not focused on education, or lacking significant detail about DEI strategies.
- Titles and abstracts of approximately 150 documents were screened, reducing the set to 32 for full review.
- Information was gathered on DEI challenges, strategies implemented, results achieved, and remaining issues. The analysis involved grouping similar strategies and evaluating their performance and the challenges of integrating them.

## 3. Understanding DEI in the Context of Environmental Engineering Education

### *3.1. Defining diversity, equity, and inclusion (DEI).*

Diversity covers all kinds of human differences, like race, ethnicity, gender, age, socioeconomic status, ability and beliefs. Equity guarantees equal chance and gets rid of things that stop some people from joining in. Encouraging diversity in education means involving a variety of people in all areas of school life. As a result, these principles help all students flourish and master the skills to deal with today's environmental problems [20, 21].

### *3.2. The imperative for DEI in environmental engineering.*

Environmental engineering management as a discipline faces its core challenges among marginalized populations through problems like pollution of air and water and waste management failure and climate change effects on communities. Making DEI part of environmental engineering stands essential because of the following important factors [22]:

- Historically different communities situated in specific locations experienced the most severe environmental damage. The DEI-focused engineering education helps future professionals detect and rectify such inequalities throughout their professional work activities.
- The combination of various team members brings unique viewpoints which results in better environmental problem solutions that are both creative and thorough.
- Engineering solutions need to adapt to growing population diversity since our societies are becoming more culturally diverse.
- Multiple professional accreditation bodies such as Board of Engineer Malaysia (BEM) state that professionals must comprehend societal outcomes of engineering work with particular focus on behind diversity and inclusivity.

Environmental engineering should help correct existing injustices affecting areas where marginalized communities live. Varying opinions on a team offer opportunities for creating fresher and more useful strategies. Because societies are becoming more diverse, engineering education should become even more inclusive [22]. Accrediting authorities like the Board of Engineers Malaysia put importance on understanding how engineering influences a variety of social groups.

### *3.3. Challenges in implementing DEI in environmental engineering education.*

Several obstacles prevent DEI from fully integrating within environmental engineering educational programs even though its essential nature is widely accepted [23].

- Engineering continues to lack gender and ethnic diversity since women and minority groups represent a small minority of its practicing professionals.
- Learning deficiencies exist in traditional engineering programs because they fail to teach students about social justice principles together with ethical practices and community participation for these subject areas.
- The implementation of DEI initiatives commonly meets resistance because organizations struggle with cultural habits that have held on for a long time and insufficient resources and poor awareness of the program.
- There exist obstacles in the assessment of DEI initiatives because establishing effective measurement methods becomes difficult hence making it difficult to properly demonstrate success and maintain consistent institutional support.

### *3.4. Strategies for advancing DEI in environmental engineering education.*

Organizations can implement various approaches to handle these barriers (Table 1) [24].

- Engineering instructors should present cases that illustrate how changes in the environment impact the everyday life of communities.

- All kinds of learners and cultures should be provided for by using several inclusive teaching methods. Part of it is to participate in group activities and teach classes that honor various cultures.
- A mentorship program should connect students who are underrepresented with teachers and professionals, who provide tutoring, counseling and support to assist the students.
- On-going training of faculty and staff is necessary, centered on DEI, to boost inclusivity for everyone in the school.
- Schools ought to join forces with local communities to carry out projects that show students how to be more socially responsible and manage diversity.

**Table 1.** Key strategies to enhance DEI in environmental engineering education.

| Strategy | Description | Intended Impact |
|---|---|---|
| Curriculum Development | Integrate topics such as environmental justice, ethics, and real-world case studies into courses. | Raise awareness of social impacts; promote culturally relevant learning. |
| Inclusive Pedagogy | Use diverse teaching methods (active learning, group work, responsive teaching). | Cater to varied learning styles; foster inclusive classroom engagement. |
| Mentorship and Support | Establish mentoring networks, tutoring, and counseling services for underrepresented students. | Improve retention and success rates of diverse student groups. |
| Faculty and Staff Training | Provide DEI workshops and professional development for educators. | Equip staff with inclusive practices; reduce bias in instruction. |
| Community Partnerships | Collaborate with local communities on environmental projects. | Enhance real-world relevance; increase student empathy and engagement. |

### *3.4.1 Critical comparison and effectiveness.*

Reform efforts in environmental engineering education increasingly include DEI principles, yet many programs rely on voluntary participation, limiting the reach of these initiatives. When DEI concepts are offered only through optional courses or extracurricular activities, a significant number of students may miss out on exposure to these critical topics. To ensure broad understanding, DEI must be integrated into core, required courses [8]. However, this integration requires faculty commitment and effort. Faculty engagement is strongly influenced by institutional support, adequate resources, and recognition for their work. Research shows that inclusive pedagogy, a vital tool for fostering student engagement, depends on faculty being properly trained and supported [33]. Mentorship programs are another important mechanism for advancing DEI goals, yet they require institutional backing, dedicated funding, and staffing to function effectively [9]. Even though faculty training initiatives have demonstrated success in reducing bias, they often fail to gain widespread traction when institutions do not provide appropriate incentives, such as formal recognition or promotion pathways [27]. Furthermore, while community-engaged learning projects help students develop cultural competence and empathy, they can be logistically complex to implement at scale, often requiring significant planning, partnerships, and sustained funding.

## 4. Challenges and Gaps

Numerous important hurdles together with enduring deficits persist even though environmental engineering education incorporates diversity and inclusion (DEI) at increasing levels of institutional awareness. The existing problems prevent the establishment of comprehensive

inclusive learning spaces and equal opportunities for students to learn effectively as showed in Table 2 [25].

**Table 2.** Summary of challenges and gaps in promoting DEI in environmental engineering education.

| Challenge Area | Description |
|---|---|
| Underrepresentation | Low participation of minority groups and women among students and faculty. |
| Curriculum Gaps | Limited integration of DEI, ethics, and social justice content in core engineering courses. |
| Resistance to Change | Institutional inertia and skepticism toward DEI efforts; lack of structural reform. |
| Lack of Training | Few educators receive formal DEI or inclusive teaching training. |
| Weak Assessment | Inadequate tools to evaluate and track DEI progress in programs and initiatives. |
| Overemphasis on Representation | Focus on increasing numbers without supporting structural and cultural change. |

### *4.1. Underrepresentation in the student and faculty body.*

Environmental engineering education faces a primary challenge due to persistent low minority student and female enrolment numbers in these programs. The minority percentage in STEM study has demonstrated limited increases but institutional inequalities in STEM educational access still persist. The engineering pathways show high levels of underrepresentation for students who come from Indigenous communities and individuals from lower socioeconomic backgrounds. Academic departments of environmental engineering commonly reveal demographic uniformity among their faculty because they lack sufficient ethnically diverse mentors who can inspire minority students [26].

### *4.2. Limited integration of DEI in the curriculum.*

Another major issue exists because DEI principles are underrepresented in the engineering course material. Educational programs dedicate most attention to technical education while providing scarce instruction on environmental social justice principles and cultural awareness of environmental problems. By concentrating only on technical proficiency educators may create graduates who lack ability to deal with social components of environmental engineering projects. Educational institutions provide electives on environmental justice but these subjects do not appear in a structured format across their complete curriculum [16].

### *4.3. Resistance to change and institutional inertia.*

The critical obstacle preventing progress in DEI comes from institutional resistance. Some faculty along with administrators look at DEI initiatives as unnecessary commitments that seem politically influenced instead of being fundamental to education quality and social importance. Such situations lead educational institutions to adopt diversity language and policies but fail to achieve sustained structural modifications. Weak accountability systems combined with insufficient motivation inhibit faculty members from getting involved in DEI initiatives. Environments controlled by traditional norms typically respond to teaching diversity attempts through uncertainty or resistance [27].

### *4.4. Inadequate DEI training and support for educators.*

Educational institutions need to provide DEI training for faculty members that includes both inclusive education approaches alongside culturally appropriate methods. Few faculty

members have received proper training specific to their responsibilities in both fields. Proficient professional development and supportive training programs are essential because well-intentioned instructors without this training could reinforce forms of exclusion. Feeder institutions face a significant challenge in STEM disciplines due to the promotion and hiring criterion that focuses on research productivity instead of teaching effectiveness and inclusive teaching practices [28].

*4.5. Assessment and measurement limitations.*

The methods to measure how effectively DEI initiatives succeed in environmental engineering education remain insufficient. The absence of standardized assessment tools prevents the identification of genuine improvements made by DEI strategies even though some qualitative changes appear to occur. The lack of assessment prevents the refinement of DEI initiatives and the receipt of ongoing institutional backing [29].

*4.6. Overemphasis on representation without structural change.*

While the fact of greater representation is compulsory objective, there's many a time overemphasis on diversity statistics occurs without weighing deeper equity designed for inclusion issues. Raising the proportion of underrepresented students remains inadequate by itself. Educational experiences will remain negative along with high dropout rates unless the campus environment improves and lesson plans are updated and support services are properly provided. Reform structure – things like fair admissions myth, for inclusion hiring activities, and sustainably culture pedagogies – it is mandatory to go through representation to lasting inclusion [30].

## 5. Conclusion and Recommendations

The review proves that including Diversity, Equity and Inclusion (DEI) in environmental engineering education is necessary since inequality, not enough DEI content and problems from institutions remain common. Teachers and schools ought to add environmental justice and similar DEI issues to their key lessons and management styles, while also taking recurring DEI training. To achieve DEI, institutions should add it to their policies, offer more mentorship and partner with area groups, while reviewing DEI results routinely. It is important that policymakers set aside funds, give awards and involve DEI standards in accreditation. Future research is advised to concentrate on establishing assessment tools for DEI strategies and studying the way different identities affect students simultaneously. For DEI to progress, all parties need to keep trying to make school environments fair and ensure students can address global environmental issues.

## Acknowledgments

The authors thank Curtin University Malaysia for their backing of this study. The authors would like to show appreciation to their colleagues along with students who provided beneficial input while constructing this review. Student and colleague participation greatly improved the discussion about diversity equity and inclusion in environmental engineering education.

## Competing Interest

All authors declared no competing interest.

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