

Enhancing Diversity, Equity, and Inclusion in Construction Engineering and Management Education

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INTRODUCTION

In recent years, the principles of Diversity, Equity, and Inclusion (DEI) have gained widespread attention across multiple sectors in the United States. These principles play a pivotal role in addressing systemic issues such as racism, bias, and inequality, which affect numerous aspects of daily life, including workplace dynamics. The pervasive impact of these issues has been particularly felt by female and minority groups, influencing their safety, security, and equitable opportunities across many communities.

Recognizing the pressing need for change, organizations, nonprofits, and industry groups have launched initiatives to build trust, combat unethical practices, and mitigate tensions stemming from societal inequities. Despite these widespread efforts, the construction industry remains notably behind other sectors in embracing and implementing meaningful DEI practices, leaving significant gaps in representation and inclusivity.

The construction industry's entrenched male-dominated culture poses significant challenges for female professionals and graduates, who often face unequal opportunities for career advancement [1]. Similarly, minority groups frequently encounter systemic barriers that hinder their access to career pathways equivalent to those available to their peers. This disparity highlights the critical need for robust, targeted DEI strategies within the construction sector.

Higher education institutions offering Construction Engineering and Management (CEM) programs have begun addressing these challenges by working to close enrollment gaps and offering equitable, accessible learning opportunities for underrepresented students. Despite these advancements, only a limited number of programs have expanded their DEI focus to fully encompass the experiences of faculty, staff, and students while fostering collaboration with industry partners.

This paper seeks to examine and evaluate the pedagogical approaches and strategies employed by university programs to advance DEI initiatives in partnership with the construction industry. By analyzing DEI initiatives at a New England area state university and a Southcentral Minnesota area state university, this paper investigates the strategies used to increase the participation of female and minority students in classroom and extracurricular settings. Additionally, it will illustrate the importance of collaboration between academic institutions and industry stakeholders in fostering diversity and inclusivity. The findings aim to provide actionable insights for educators and administrators at higher education institutes designing DEI-focused activities and curricula, ultimately contributing to a more inclusive and equitable future for the construction industry.

LITERATURE REVIEW

The construction industry has long faced criticism for its lack of diversity, with women and minority groups significantly underrepresented [2]. This disparity stems from factors such as implicit biases, discriminatory hiring practices, and limited access to supportive networks and mentorship opportunities [3]. This lack of diversity negatively impacts innovation, team performance, and overall industry growth [4]. Consequently, the industry continues to grapple with persistent challenges in advancing DEI. Women and minorities face significant hurdles in career progression, often due to implicit biases, limited access to leadership roles, and systemic barriers ingrained in educational and professional pathways [5]. Therefore, addressing these challenges is critical to fostering a more inclusive and equitable construction industry.

Specifically, women in construction frequently encounter a “glass ceiling,” facing barriers to advancement despite their qualifications and performance [6]. Studies have highlighted issues such as workplace harassment, unequal pay, and limited access to leadership roles [7]. Similarly, minority groups face systemic obstacles, including cultural biases and a lack of role models, which hinder career progression [8]. As a result, as the construction sector becomes increasingly globalized and complex, the need for DEI has grown, not only for ethical reasons but also to drive innovation and problem-solving [9].

To address these systemic issues, higher education institutions play a crucial role in shaping the future workforce of the construction industry. Many universities have implemented initiatives to address enrollment gaps and foster inclusive learning environments. For example, programs aimed at increasing minority student participation in STEM fields have improved retention and graduation rates [10]. Integrating DEI principles into curricula has also enhanced student engagement and learning outcomes [11]. Strategies such as collaborative learning, culturally responsive teaching, and incorporating DEI topics into course content have proven effective [5]. Furthermore, partnerships between academia and industry provide valuable real-world experiences and support networks for underrepresented students [12].

Despite these efforts, women and minorities remain significantly underrepresented in CEM programs. Research by Dasgupta and Stout [13] emphasizes that women majoring in STEM fields, including CEM, often lack confidence due to these societal and educational barriers. Gender biases and stereotypes further exacerbate the issue. Female students frequently encounter implicit biases that question their abilities and dedication to technical fields [14]. These biases are often perpetuated by peers, faculty, and even family members, creating an unwelcoming environment that discourages women from pursuing or persisting in CEM education. Furthermore, stereotypes about gender roles in technical and physical tasks also pose a significant barrier. Women pursuing careers in CEM are often confronted with the notion that such fields are better suited for men. These pervasive stereotypes can negatively impact women’s self-esteem, academic performance, and long-term career aspirations [15].

Compounding these challenges, mentorship and support networks play a crucial role in the success of students in any academic field. However, in CEM programs, women and minorities often lack access to structured and consistent mentorship. Informal or ad-hoc mentorship programs fail to provide the reliable support that these students need. Without mentors who share similar backgrounds and experiences, women and minority students may feel isolated and

unsupported, leading to higher dropout rates and lower retention [16], [17]. Additionally, access to resources and opportunities, such as internships, research projects, and professional networks, is often limited for underrepresented groups. These opportunities are critical for gaining practical experience, building professional connections, and improving employability after graduation. Systemic inequalities and biases further restrict access, compounding the challenges faced by these students [10].

Moreover, institutional policies and practices often hinder DEI efforts in CEM education. Rigid admission criteria, insufficient financial aid, and inadequate efforts to foster an inclusive campus culture are common barriers. Many institutions lack comprehensive DEI strategies or fail to implement them effectively, resulting in slow progress toward achieving diversity goals [18]. However, practical insight into successful DEI practices can be gleaned from initiatives at various institutions. For example, Purdue University's College of Engineering promotes DEI through mentoring, policy reforms, and professional development [19]. Similarly, the National Action Council for Minorities in Engineering (NACME) has significantly increased minority representation in engineering programs through targeted initiatives [20].

In conclusion, the literature emphasizes the critical role of DEI in the construction industry while highlighting persistent challenges faced by women and minorities. Research indicates that diverse teams improve decision-making, reduce groupthink, and enhance organizational adaptability [21]. This is critical in construction for addressing pressing issues such as supply chain issues, workforce shortages, and safety concerns. Despite these benefits, the industry continues to grapple with barriers to diversity, including a male-dominated culture, systemic biases, and insufficient mentorship opportunities [22]. Higher education can foster diversity in CEM through targeted recruitment, inclusive curricula, and robust support systems [2]. Collaborations between academia and industry are also vital for creating pathways that enable underrepresented groups to thrive in construction careers [12]. Ultimately, to cultivate a diverse and inclusive workforce in the construction sector, educators and industry leaders can implement strategies informed by successful DEI initiatives.

STUDY APPROACH

Analysis of Current DEI Issues in CEM Education

This study investigates current DEI issues within CEM education, specifically examining female student enrollment trends at the New England area state university. Figure 1 reveals a persistent gender gap in enrollment over the past decade, confirming the underrepresentation of women in CEM programs. This underrepresentation is influenced by several factors, including cultural stereotypes, inadequate early exposure to CEM fields, and lack of role models [1].

Addressing DEI issues in CEM education requires coordinated efforts to overcome deeply rooted societal and institutional norms. We believe educational institutions must adopt proactive strategies, including:

- Developing early outreach programs to encourage interest in CEM fields among underrepresented groups.

- Implementing structured mentorship programs that connect students with diverse role models and mentors.
- Addressing implicit biases through faculty and peer training programs to foster a welcoming and inclusive environment.
- Expanding access to internships, professional networks, and resources to ensure equitable opportunities for all students.
- Revising institutional policies to promote diversity, such as adopting holistic admission criteria and increasing financial aid for underrepresented students.

By recognizing and addressing these issues, the CEM field can move toward a more diverse, equitable, and inclusive future. Collaboration among educational institutions, industry stakeholders, and policymakers will be essential to driving meaningful and lasting change.

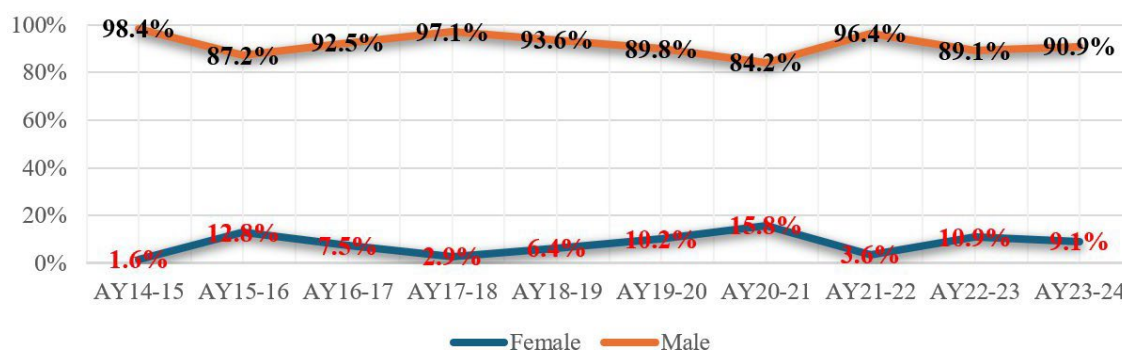


Figure 1. Female vs. Male Enrollment Over Time

Review of Recent DEI Initiatives at the Southcentral Minnesota Area State University

The tragic George Floyd incident in Minnesota catalyzed a renewed focus on DEI efforts across multiple sectors, including higher education [23]. At the Southcentral Minnesota area state university, this event spurred a comprehensive evaluation of DEI practices within the institution's operations and daily activities. These efforts aimed to address and mitigate systemic issues such as bias, discrimination, and unproductive behaviors that negatively impact individuals' ability to thrive both professionally and personally. At the university level, these initiatives aligned closely with state-recommended goals, including the elimination of educational equity gaps across all state colleges and universities as part of a broader equity initiative.

The university has undertaken significant steps to advance DEI through strategic diversity and inclusion plans informed by contributions from university community groups. Following guidance from state equity initiatives, the university reviewed its system-wide vision and incorporated DEI principles into its institutional framework. Key actions included the formation of task forces and committees focused on diversity and inclusion at various levels of governance. These groups assessed current policies and practices, identifying barriers to equity and opportunities for growth. A new DEI-focused vision and mission were crafted to reflect these priorities, accompanied by regular faculty and staff training programs. These training sessions

highlighted best practices for fostering a healthy, inclusive work environment. Efforts to close equity gaps among student groups were reinforced through targeted initiatives, such as hosting two events per semester featuring guest speakers who shared success stories and best practices in advancing DEI. These events emphasized the practical benefits of DEI for both the university community and society at large.

Since 2021, the university's colleges have made substantial progress in advancing DEI initiatives. Under university leadership, college deans initiated reviews of DEI-related policies and statutes, forming dedicated task forces comprised of faculty and staff. During the first year, these task forces conducted comprehensive assessments of existing systems and resources to identify challenges and opportunities. Based on these findings, new DEI-aligned visions and missions were established. Colleges also implemented regular training sessions designed to equip faculty and staff with the tools to foster inclusivity and equitable practices. These sessions aimed to create a more welcoming and supportive environment for all members of the college community.

At the departmental level, meaningful discussions were initiated among faculty members to explore how DEI principles could be applied to benefit faculty, staff, and students alike. These discussions were complemented by input from industry professionals, who were invited to share insights on DEI strategies within the construction industry. These conversations helped uncover critical gaps in terminology, professional relationships, and workplace practices, which were subsequently addressed through immediate and long-term actions. The department collaborated to update its mission and vision statements to reflect its commitment to inclusivity and equitable goals. Additionally, the industry advisory board formed a DEI-focused task force that partnered with faculty to develop a formal DEI statement. This statement emphasized core values such as celebrating diverse life experiences, fostering inclusivity, preparing equitable industry leaders, and building a strong foundation of belonging within the program. To further integrate DEI into the curriculum, the program incorporated DEI-focused activities and guest speakers into various courses. These efforts highlighted the broader societal benefits of diversity and demonstrated how inclusivity contributes to career success and professional growth. Students were encouraged to engage in meaningful discussions about the importance of DEI in both their personal and professional lives.

The DEI advancements at this university illustrate the importance of a multi-level approach to fostering inclusivity and equity. From university-wide initiatives to department-specific strategies, the collaborative efforts of faculty, staff, students, and industry stakeholders have created a more inclusive and supportive environment. These initiatives not only contribute to the university's mission of eliminating equity gaps but also prepare students to become leaders who champion DEI principles in their professional careers.

Review of Recent DEI Initiatives at the New England Area State University

Addressing the persistent challenges in promoting DEI within the CEM fields requires a multifaceted approach. Higher education institutions play a critical role in bridging representation gaps, providing equitable opportunities, and fostering inclusive learning

environments. This section highlights key DEI initiatives undertaken by the New England area state university to support underrepresented groups at the university.

One of the primary goals of the university's DEI initiatives is to increase enrollment and retention among underrepresented groups. Recognizing the importance of early engagement, the university has developed outreach programs aimed at high school students from diverse backgrounds. Pre-college summer programs and STEM camps offer hands-on experiences and introduce students to CEM concepts, helping to cultivate interest and build a pipeline of diverse talent entering these fields. Additionally, the university has established partnerships with local high schools, community colleges, and regional businesses to create seamless pathways for minority students to transition into higher education. For instance, the university's construction management program provides a seamless transfer process for community college students, accompanied by tailored support and resources to ensure their academic success.

Financial constraints remain one of the most significant barriers for underrepresented students pursuing higher education. To combat this, the university has implemented scholarship programs, grants, and financial aid packages for underrepresented students. By reducing financial hurdles, these initiatives aim to provide equitable access to quality education and increase retention rates. Partnerships with organizations like the National Action Council for Minorities in Engineering (NACME) further bolster these efforts, offering scholarships and academic support specifically for underrepresented populations [20].

To broaden access for students from diverse backgrounds, the university has adopted holistic admission policies. These practices evaluate a wider range of student experiences, skills, and potential, going beyond traditional academic metrics. By identifying candidates who demonstrate resilience and promise, these inclusive admission strategies help diversify the student body and ensure equitable opportunities for underrepresented groups [24].

Embedding DEI principles into the curriculum is essential for cultivating an inclusive educational environment. The university has integrated Equity, Justice, and Inclusion (EJI) topics into its degree requirements to ensure students understand the importance of diversity within their fields. Courses on ethics, social responsibility, and global perspectives are designed to enhance students' appreciation for diverse perspectives and prepare them to work effectively in multicultural teams [25]. Active learning techniques, such as collaborative projects and problem-based learning, have also been implemented to improve engagement and foster inclusivity in the classroom [26]. For example, the construction management program recently introduced a senior capstone course aimed at creating a more inclusive and team-oriented learning experience. These pedagogical strategies not only enhance learning outcomes but also promote teamwork and communication skills essential for professional success [27].

Equipping faculty and staff to support DEI initiatives is a critical component of the university's strategy. Professional development workshops focusing on implicit bias, cultural competency, and inclusive teaching practices help faculty create supportive and welcoming environments for all students [28]. By state law, all university employees are required to complete diversity training, reinforcing a campus-wide commitment to DEI principles. In addition, mentorship programs for junior faculty, particularly those from underrepresented backgrounds, provide vital

support in navigating academic challenges and advancing their careers. These programs foster a culture of inclusion while enabling faculty to contribute meaningfully to DEI efforts across the institution.

A supportive and inclusive campus environment is key to fostering a sense of belonging among students from diverse backgrounds. The university emphasizes shared governance, ensuring that students have a voice through organizations such as the student government association, affinity groups, and resource centers. These groups provide spaces for students to connect, share experiences, and access critical resources. Furthermore, professional organizations such as the National Association of Women in Construction (NAWIC) and industry-led employee resource groups, including Whiting-Turner's BERG (Black Employee Resource Group), WOW (Women of Whiting-Turner), and HOW (Hispanic Outreach Workgroup), collaborate with the university to offer mentorship, networking opportunities, and career development workshops. These partnerships help bridge the gap between academia and industry while providing students with the tools needed to succeed professionally.

The university's DEI initiatives represent a comprehensive effort to address barriers faced by underrepresented groups in higher education. By focusing on enrollment pathways, financial support, curriculum integration, faculty development, and campus inclusivity, the university is paving the way for a more diverse and equitable industry. These efforts not only benefit the academic community but also contribute to the broader goal of creating an inclusive and diverse workforce, particularly in the construction sector. Continued innovation and collaboration will be essential to sustaining and expanding these successes, ensuring lasting impact in the years to come.

Review of DEI Initiatives at Other Universities

This study also examines the outcomes of other universities' DEI initiatives in engineering and construction education, focusing on student enrollment, retention, engagement, and the broader implications for the construction industry. The findings underscore the transformative potential of these initiatives while also identifying areas for further improvement.

The implementation of targeted outreach and recruitment programs has led to a notable increase in the enrollment of women and minority students in engineering and construction programs. For instance, data from the University of Illinois at Urbana-Champaign (UIUC) over an eleven-year period showed a 60% increase in female enrollment and a 55% increase in enrollment of underrepresented students [29]. Programs such as the Engineering Pathways Program, Women in Engineering Orientation, and pre-college summer camps have played pivotal roles in attracting diverse applicants. At the New England area state university, similar initiatives, including summer STEM camps and partnerships with community colleges, have expanded access to underrepresented populations. These efforts demonstrate that proactive recruitment strategies are instrumental in closing enrollment gaps in CEM education.

Retention rates for underrepresented students have also improved, reflecting the effectiveness of DEI initiatives in creating supportive learning environments. Scholarships, mentorship programs, and resource networks have provided critical support for students navigating academic

challenges. For example, retention rates for underrepresented minorities at UIUC increased by 6% over a seven-year period due to financial aid and mentorship programs [30].³¹ These findings emphasize the value of targeted financial support and structured mentoring in sustaining student success.

Integrating DEI principles into the curriculum and adopting inclusive pedagogical practices have positively impacted student engagement. Active learning techniques such as collaborative projects, problem-based learning, and real-world applications have proven particularly effective. A study by Freeman et al. [26] found that 85% of students felt more engaged and motivated in classes that emphasized DEI topics and active learning. At the New England area state university, courses designed to include DEI-focused content have shown higher participation rates among underrepresented students. These approaches foster a sense of belonging and demonstrate the practical relevance of DEI in professional settings, encouraging students to remain actively engaged in their studies.

Supportive and inclusive educational environments have also led to improved academic performance among underrepresented students. For example, the Pre-Major in Astronomy Program (Pre-MAP) at the University of Washington, which aimed to recruit and retain underrepresented undergraduates in STEM fields, demonstrated that participants achieved higher average GPAs and degree completion rates compared to the general university population [31]. These results suggest that inclusive strategies not only enhance engagement but also lead to measurable improvements in academic outcomes.

The success of these initiatives has broader implications for the construction industry. By increasing the representation of women and minority groups in CEM programs, universities are contributing to the development of a more diverse workforce. Collaborative efforts between universities and industry partners have been particularly impactful. Industry stakeholders have provided internships, mentorship opportunities, and resources that bridge the gap between academic learning and professional practice. Additionally, partnerships have facilitated the exchange of best practices, helping universities design industry-relevant curricula that prepare students for diverse and inclusive workplaces.

Despite these positive outcomes, challenges remain in fully addressing biases and stereotypes within both academic and industry environments. Implicit biases and discriminatory attitudes continue to hinder progress, requiring sustained efforts to raise awareness, provide training, and implement effective policies. Another significant challenge is the scalability of successful DEI initiatives. While some programs have demonstrated remarkable success, replicating these efforts across diverse institutions and contexts can be challenging. Identifying the key elements that contribute to success and adapting them to suit various educational and organizational settings is essential for broader impact.

The findings of this study highlight the substantial progress made by university DEI initiatives in increasing enrollment, retention, and engagement among underrepresented groups in higher education. These efforts not only prepare a more diverse and innovative workforce but also have broader implications for the growth and success of the construction industry. However, ongoing challenges, including persistent biases and the need for scalable solutions, underscore the

importance of continued investment in DEI efforts. Collaboration between academia, industry, and policymakers will be crucial to overcoming these obstacles and achieving long-term DEI goals, ensuring a more equitable and inclusive future for the construction sector.

STUDY FINDINGS

The implementation of DEI initiatives in CEM education has provided invaluable insights into fostering equity and inclusion in the field. These lessons offer a foundation for improving existing efforts, guiding future initiatives, and ensuring the long-term impact of DEI practices. Figure 2 illustrates a roadmap for enhancing DEI in CEM education, outlining key strategies for creating an inclusive learning environment.

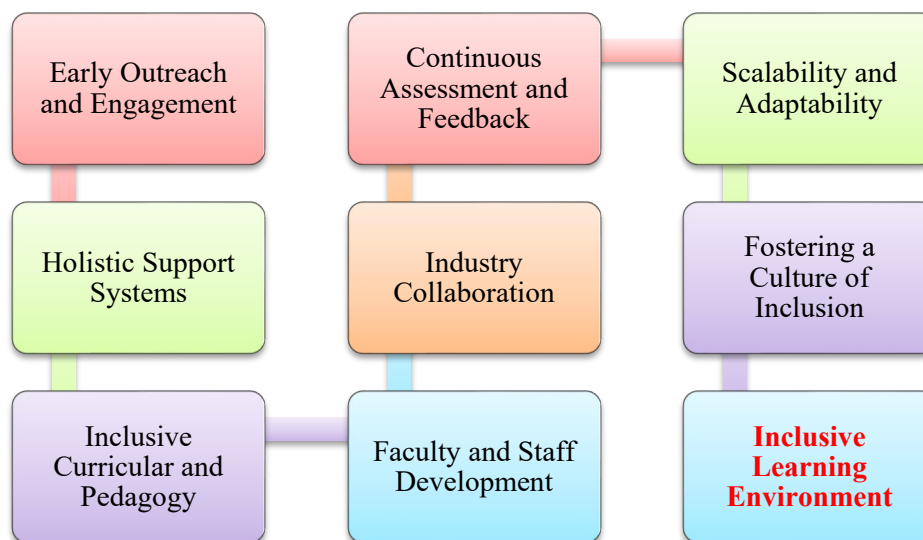


Figure 2. Roadmap to Inclusive Learning Environments

Targeted outreach programs, such as pre-college summer camps, Women in Construction orientations, and high school CEM initiatives, are critical for sparking interest among underrepresented groups. Engaging students early and exposing them to diverse role models can significantly influence their decisions to pursue CEM careers. Expanding such programs to reach younger audiences can build a stronger, more inclusive pipeline into the field.

Providing comprehensive support including scholarships, mentorships, and academic resources is essential for retaining underrepresented students. Financial aid programs alleviate barriers, while structured mentoring and resource networks create a sense of belonging, empowering students to thrive academically and professionally.

Incorporating DEI principles into the curriculum and promoting active learning environments are also crucial. Courses that focus on real-world applications, collaborative learning, and DEI topics engage students while emphasizing the importance of diversity in construction. These inclusive approaches benefit all students and effectively address the unique challenges faced by underrepresented groups.

Sustaining inclusivity requires continuous DEI training for faculty and staff. Workshops on implicit bias, cultural competency, and inclusive teaching practices equip educators to foster equitable classrooms and provide tailored support to diverse student populations. Faculty leadership is integral to embedding DEI values across academic programs.

Strong partnerships with industry stakeholders amplify DEI efforts by providing mentorship, internships, and career pathways for students. These collaborations highlight the importance of diversity in professional settings, creating a positive feedback loop between academia and industry. Companies engaged in DEI also model inclusive practices for students, reinforcing cultural shifts in the workforce.

Regular evaluation of DEI initiatives ensures their effectiveness and adaptability. Tracking metrics like enrollment, retention, and student outcomes highlights progress and identifies areas for improvement. This iterative process ensures programs evolve alongside students' needs and industry demands.

Scalability and adaptability are essential for amplifying the impact of DEI efforts. Effective initiatives should be adaptable to diverse institutions and contexts. By identifying core strategies and customizing them to suit various student populations, these efforts can remain relevant and be successfully replicated on a larger scale.

Beyond programs and policies, achieving sustainable DEI progress requires cultivating a deeply embedded culture of inclusion. Institutional leadership must champion DEI as a priority, fostering a shared commitment across faculty, staff, and students. By promoting accountability and shared values, institutions can lay the groundwork for meaningful, enduring change.

The lessons learned from DEI efforts in higher education emphasize the importance of early engagement, comprehensive support systems, inclusive teaching, ongoing faculty training, industry collaboration, regular evaluation, and adaptability. Building a culture of inclusion within academic institutions is critical to sustaining progress and driving meaningful change. By applying these strategies, CEM programs can empower underrepresented students and contribute to a more diverse, equitable, and inclusive construction industry.

DISUCSSION

This paper underscores both the significant progress and persistent challenges in promoting DEI within CEM education. Educational institutions play a critical role in shaping a more diverse and equitable construction workforce by addressing systemic barriers and fostering inclusive cultures. Key strategies, including early outreach, holistic support systems, inclusive curricula, faculty training, and industry partnerships, have proven effective. However, sustained change requires continued innovation, collaboration, and commitment.

A central takeaway is the importance of embedding DEI principles into every facet of educational programs from recruitment and retention to curriculum design, faculty development,

and campus culture. Programs prioritizing these integrated efforts are best positioned to prepare graduates for a diverse workforce and serve as models for academia and industry.

The construction industry stands to gain considerably from these advancements. A more diverse and inclusive workforce fosters innovation, enhances team dynamics, and strengthens problem-solving crucial for industry growth and competitiveness. Evolving university-industry partnerships are essential, providing students with practical experiences and reinforcing the value of diversity in professional settings.

Future efforts should prioritize addressing persistent challenges: implicit biases, limited scalability of successful programs, and the need for sustained institutional commitment. Regular assessment and data-driven approaches are vital for refining DEI initiatives and ensuring long-term success. Expanding program reach, particularly to institutions serving underrepresented communities, will amplify impact and drive systemic change.

Advancing DEI in CEM education demands a multifaceted approach integrating strategic planning, community engagement, and continuous improvement. By building on lessons learned and embracing collaborative opportunities, institutions can make significant strides toward a more equitable future, transforming not only educational environments but also shaping a more inclusive and dynamic construction industry reflective of the diverse society it serves.

Finally, while interest is a key factor in attracting individuals to the construction field, information alone is insufficient to spark engagement, especially among underrepresented groups. Workplace culture, industry perceptions, and the lack of visible role models can significantly influence career choices. Building a more inclusive industry requires not only raising awareness but also fostering belonging and support, while showcasing diverse success stories to inspire the next generation of construction professionals.

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