Cultivating Inclusive Excellence: Peer Mentoring Programs for Minoritized Students in Engineering(Research)

Dr. DeAnna Katey, Virginia Polytechnic Institute and State University

Dr. DeAnna Katey current serves as the Director of Undergraduate Student Programs for the Center for the Enhancement of Engineering Diversity (CEED) within the College of Engineering at Virginia Tech. In her role, she is charged with increasing the diversity of the undergraduate student population and creating spaces for student's academic, professional, and personal development. This includes a wide range of programs including Galileo and Hypatia Living-Learning Communities and the CEED Peer Mentoring program. Previously, Dr. Katey served as the Assistant Director of Student Success and First-year Experience at Siena Heights University located in Adrian, Michigan, where she played a pivotal role in creating an environment of success for first-year students. Her professional interests and research focus on the retention of underrepresented and underserved students. Dr. Katey graduated from Clarion University of Pennsylvania (Clarion, PA) where she earned a Bachelor of Science in Education (2007) and a Master of Education in Curriculum and Instruction (2010). In 2019, she graduated from Morgan State University's Higher Education Administration doctoral program (Baltimore, MD).

Terrance I Harris, Drexel University

Terrance Harris serves as the inaugural Director of Diversity, Equity, & Inclusion for the College of Engineering at Drexel University. Terrance received his bachelor's degree in business from Western Kentucky University and his master's degree in Higher Education from the University of North Texas. As director, Harris is responsible for the college's DEI initiatives supporting and promoting programs, policies, events, and other activities to foster conversations and create a sustainable framework to advance DEI across Drexel Engineering. His role includes chairing the college's committee on DEI, working collaboratively with Drexel's Office of Equality and Diversity to ensure the planning and implementation of relevant DEI training and educational opportunities for college faculty and staff, as well as with HR and the college leadership on initiatives to improve the recruitment and retention of diverse faculty and staff. Harris also coordinates with affinity student organizations and programs across the college including, NSBE, SHPE, and SWE to name a few, acting as secondary advisor as well as primary college contact for external affinity-based organizations.

Prior to joining Drexel Engineering, Harris served six years as the Director of the Lonnie B. Harris Black Cultural Center at Oregon State University. As Director of the BCC, Harris worked collectively with campus partners, alumni, and various corporate entities to provide support and opportunities for students (specifically Black identified students), faculty, staff, and alumni. Harris advised multiple organizations such as the Black Student Union (BSU), Black Graduate Student Association (BGSA), African Student Association (ASA), National Society of Black Engineers (NSBE), and the National Panhellenic Council (NPHC) while also building bridges between alumni and community outreach. He served as Co-Chair for the President's Commission on the Status of Black Faculty & Staff Affairs actively advocated for Black faculty and staff support at Oregon State University.

As director, Harris vision is to be an advocate, innovator and equitable leader of inclusive excellence who is committed to supporting the consistent development of our diverse student, faculty and staff populations in engineering.

Terrance is actively involved with the National Conference on Race & Ethnicity (NCORE), a member of the National Association of Student Personnel Administrators (NASPA), and a proud member of Kappa Alpha Psi Fraternity, Inc. Harris is a true southerner originally from Louisville, KY Terrance has lived all over the south in cities such as Dallas, Atlanta, and Orlando. Terrance believes that his everyday mission is to be the vessel to foster student development while always being your authentic self.

Full Paper: Cultivating Inclusive Excellence in Engineering Education

Black students remain significantly underrepresented in engineering, comprising only 5.4% of full-time undergraduate engineering enrollment in 2023 [1]. Despite a 9.2% increase in enrollment since 2019 [2], retention remains a critical challenge due to systemic barriers, including institutional racism and lack of support structures [3]. While many institutions focus on increasing access, fewer address the retention and success of Black students once enrolled.

Peer mentoring has emerged as a promising strategy to support underrepresented students, offering academic, social, and emotional guidance. This study explores the lived experiences of Black first-year engineering students who participated in peer mentoring programs at two institutions. Using Astin's Input-Environment-Output (IEO) [4] model, the research investigates how mentoring influences students' development and persistence. The goal is to inform institutional practices that foster inclusive excellence and improve retention among Black engineering students.

Immediate and ongoing mentoring during the first semester of the freshmen year can address transitional issues and create a positive experience for first-year engineering students [5]. Numerous studies have investigated peer mentoring for general first-year students [5]-[12] and mentoring for engineering students broadly [5], [13]-[18]. However, research specifically examining mentoring programs for minoritized engineering students remains limited [3], [19], [20]. There is a scarcity of literature addressing the experiences of Black undergraduate engineering students who have participated in peer mentoring programs, despite evidence suggesting that culturally responsive mentoring can significantly improve retention rates among underrepresented groups in STEM fields.

First-year students often face challenges transitioning from high school to college, including adapting to new learning strategies, managing time, and meeting increased academic demands [21]. Mentoring is recognized as a high-impact practice that supports this transition by improving retention and graduation outcomes [10]. This is especially critical for underrepresented minority (URM) students, such as Black engineering students, who encounter additional systemic barriers [22], [23]. Culturally responsive mentoring enhances belonging and academic success, and when implemented systematically, can boost retention rates by up to 15% [3]. Moreover, structured community-building activities create essential counter-spaces that help mitigate isolation and stereotype threat in predominantly white institutions [40].

Peer mentoring programs significantly enhance academic performance and retention among first-year students by helping them adapt to university demands [24], [25]. Mentors provide academic support through tutoring, study groups, and coursework guidance, fostering a collaborative learning environment. Mentees often feel more comfortable seeking help from peers, which encourages engagement and improves outcomes [26]. These programs also promote a sense of belonging, which contributes to persistence and degree completion.

Peer mentoring enhances social integration by fostering reciprocal relationships that build trust and belonging [27]. Mentors help mentees connect with campus communities, engage in extracurricular activities, and develop supportive peer networks. This integration strengthens students' connection to the university and contributes to their overall success.

Peer mentoring supports emotional well-being by providing a safe, inclusive space for students to share challenges and receive guidance [28], [29]. These relationships improve self-confidence, stress management, and interpersonal skills, contributing to the holistic development of students, especially those from diverse backgrounds.

For students from diverse backgrounds, including Black engineering students, cultural adjustment is a significant challenge. The role of peer mentoring provides a sense of belonging and understanding of institutional cultural norms for Black engineering students [29]. Peer mentoring programs help create a sense of belonging among students from diverse backgrounds. Mentors, who often share similar experiences, provide a supportive environment where mentees feel understood and accepted. This sense of belonging is crucial for students who might otherwise feel isolated or marginalized in a predominantly white institution.

Peer mentors play a vital role in helping mentees understand and navigate the cultural norms and expectations of the institution. This includes academic norms, such as classroom behavior and study practices, as well as social norms, such as participation in campus activities and interactions with faculty and peers. By demystifying these norms, mentors help mentees feel more comfortable and confident in their new environment. Furthermore, peer mentoring significantly aids in the cultural adjustment process. Mentors provide guidance on how to balance maintaining one's cultural identity while adapting to the new cultural context of the university. This dual support helps mentees integrate more smoothly into the campus community without feeling pressured to abandon their cultural heritage [29].

Peer mentors offer essential emotional support, especially for students from diverse backgrounds facing cultural adjustment challenges. They create safe spaces for mentees to share concerns and receive reassurance and practical guidance. Research emphasizes the need for mentoring programs to be culturally sensitive [29], recommending diverse mentor recruitment, cultural competency training, inclusive activities, and sustained support. These strategies help students, particularly Black engineering students, navigate predominantly white institutions, enhancing both their academic success and overall well-being.

There are two key areas that significantly improve the experiences of Black engineering students in engineering programs: the importance of having a shared identity with one's peer mentor and the availability of informal community spaces [35].

Shared identities between mentors and mentees play a critical role in the success of minoritized students. When mentors share similar backgrounds and experiences with their mentees, it fosters a sense of understanding and relatability. This shared identity helps build trust and rapport, making mentees feel more comfortable and supported. For Black engineering students, having mentors who understand their unique challenges and experiences can be particularly empowering. These mentors can provide not only academic guidance but also emotional support, helping mentees navigate the complexities of their academic and social environments.

Informal community spaces are also significant in the success of minoritized students. These spaces provide a setting where minoritized students can gather, share experiences, and build a sense of community. Informal community spaces allow students to connect with peers and faculty who share similar identities and experiences, fostering a supportive and inclusive environment. The study found that these spaces are crucial for promoting a sense of belonging and reducing feelings of isolation among minoritized students.

This research explores the prominent issue of persistence of Black engineering students by raising the following research question: How does participation in a peer mentoring program influence the retention of Black undergraduate engineering students from their first to second year at a predominately white institution? Previous research has discussed the overall experiences of URM peer mentoring participants. However, there is a dearth of research on the experiences of Black engineering students who participated in a peer mentoring program during their first year. This study attempts to understand the lived experiences of Black engineering students and how participation in a peer mentoring program has shaped their success.

This study employs Astin's Input-Environment-Output (IEO) model to analyze factors influencing the development of first-year Black engineering students. The IEO framework underscores the need to understand student characteristics upon acceptance into an institution (input), student's exposure to institutional programming (environment), and the development of talent after exposure to the environment (outcome) [4]. This theoretical foundation provides a structured approach for examining how peer mentoring affects Black engineering students' experiences and outcomes.

The research illuminates the lived experiences of Black students participating in peer mentoring programs across two engineering institutions, each implementing distinct initiatives designed for minoritized engineering students: DELTA at Drexel University and CEED at Virginia Tech. This comparative approach sought to examine institutional contexts when evaluating support programs for underrepresented students. By applying the IEO model to these specific programs, the study can systematically analyze how pre-college characteristics interact with mentoring interventions to influence retention outcomes.

This study employed a qualitative narrative inquiry approach to explore the lived experiences of Black first-year engineering students who participated in peer mentoring programs. Narrative inquiry was selected for its strength in capturing personal stories and contextualizing complex social experiences, particularly among historically marginalized populations.

A total of 6 participants were involved in the study: 4 from DELTA (beginning as a residential summer bridge program) and 2 from CEED (a year-long non-residential program). The research team consisted of three researchers, including two lead investigators and one graduate research assistant, all of whom were involved in data collection and analysis.

Each participant completed one semi-structured interview. The interviews were designed to elicit detailed narratives about students' academic and social transitions during their first year. Interview questions focused on topics such as initial expectations and motivations for joining the mentoring program, experience with academic support and campus integration, relationships with mentors and peers, challenges encountered and strategies for persistence, reflections on identity, belonging, and future aspirations.

Thematic analysis was conducted using an inductive approach. Interview transcripts were first reviewed independently by each member of the research team to identify initial codes. The team then met regularly to compare interpretations, refine code definitions, and group codes into broader themes. To ensure rigor and trustworthiness, the team engaged in reflexive journaling, peer debriefing, and member checking with a subset of participants. This iterative process ensured that the themes were grounded in participants' voices and accurately reflected their lived experiences.

Analysis of participant interviews revealed seven interrelated themes: (1) motivation and background, (2) value of peer mentoring, (3) community and belonging, (4) academic and professional growth, (5) challenges faced, (6) suggestions for improvement, and (7) advice to future students.

Motivation and Background Students were drawn to engineering through early exposure to STEM, family encouragement, and personal interests. One participant noted, "I always had a knack for STEM… building stuff with Legos." Another cited immigrant parents who fostered curiosity through museum visits and hands-on learning.

Value of Peer Mentoring Mentors provided critical support in navigating college life, offering guidance on course selection, resume building, and professional development. Students emphasized the importance of having mentors who had "been there" and could relate to their experiences.

Community and Belonging Mentoring programs fostered strong peer networks, especially among students of similar racial and academic backgrounds. These communities helped mitigate isolation and imposter syndrome, particularly for Black women in engineering.

Academic and Professional CEED Mentors helped students prepare for career fairs, join student organizations like NSBE, and develop leadership skills. These experiences boosted confidence and professional readiness.

Challenges Faced Participants reported being the only Black or female student in many classes, leading to discomfort and self-doubt. Mentors encouraged resilience, with one student recalling advice to "get comfortable being uncomfortable."

Suggestions for Improvement Students recommended more structured mentor-mentee interactions, personality-based matching, and increased program visibility to enhance engagement and impact.

Advice to Future Students Participants urged new students to "just do it"—to join mentoring programs early, build networks, and take full advantage of available resources.

This study highlights the multifaceted impact of peer mentoring on Black first-year engineering students, revealing how culturally responsive mentoring fosters academic success, social integration, and personal CEED. Participants' narratives emphasized the importance of shared identity with mentors, which enhanced trust, relatability, and emotional support. These findings align with Seery et al. [32], who describe peer mentors as both informational and emotional anchors.

Mentoring relationships also cultivated a strong sense of community and belonging, particularly among students who were often the only Black or female individuals in their classes. This sense of solidarity helped mitigate imposter syndrome and isolation, consistent with literature on counter-spaces and identity-affirming practices [3], [35]. Participants also described a reciprocal mentoring dynamic, where mentees later became mentors, reinforcing leadership development and community uplift. This supports Hurd and Zimmerman's [34] findings on the cyclical nature of empowerment in mentoring.

A comparative analysis of participant narratives from the DELTA and CEED programs revealed nuanced differences in student experiences. While both programs were positively received, DELTA participants often cited the intensive summer experience as critical for building early confidence and peer networks. In contrast, CEED participants valued the extended duration of support, which allowed for deeper mentor relationships and ongoing academic guidance. These findings suggest that program design—whether front-loaded or longitudinal—can shape the nature of student support and outcomes. DELTA's strength lay in fostering early belonging and cohort identity, while CEED excelled in providing sustained, individualized mentorship. These insights underscore the value of offering diverse mentoring models to meet students' evolving needs.

The study reinforces the need for institutions to implement structured, culturally responsive mentoring programs that address the unique challenges faced by underrepresented students in STEM. These programs should be integrated into broader retention strategies and supported through institutional policy and funding.

This study is limited by its small sample size and focus on two institutions, which may affect the generalizability of findings. Participants were selected based on their continued enrollment and willingness to share their experiences, introducing potential self-selection bias. Additionally, the narrative inquiry approach, while rich in detail, is inherently interpretive and shaped by both participant and

researcher perspectives. The institutional contexts of the DELTA and CEED programs may not reflect the diversity of mentoring models across other universities.

These findings have key implications for practice, policy, and research. Institutions should develop culturally responsive, structured mentoring programs, ideally matching mentors and mentees by shared identity or academic interests. Universities should embed peer mentoring into retention strategies, supported by adequate funding and training. Future research should examine long-term outcomes such as persistence and graduation, compare models across institutions, and explore mentors' experiences to understand reciprocal benefits.

This study's insights are limited by a small, self-selected sample from two institutions, which may affect generalizability. The narrative inquiry approach, while rich, is interpretive and shaped by participant and researcher perspectives. Additionally, the specific contexts of the DELTA and CEED programs may not reflect the diversity of mentoring models elsewhere, limiting broader applicability.

This study explored the experiences of Black first-year engineering students in peer mentoring programs, revealing seven key themes: motivation, mentoring value, community, academic growth, challenges, improvement suggestions, and student advice. Culturally responsive mentoring, especially when mentors share racial or cultural identity—was found to be instrumental in fostering belonging, confidence, and persistence.

The findings underscore the importance of structured, identity-affirming mentoring programs in supporting underrepresented students in STEM. Institutions should prioritize such programs as part of broader equity and retention strategies. Future research should examine long-term outcomes and explore diverse institutional contexts to further validate and expand these insights.

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