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Editorial: Exploring STEM environments that broaden participation

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Editorial on the Research Topic

Exploring STEM environments that broaden participation

Introduction

The persistent underrepresentation of marginalized groups in science, technology, engineering, and mathematics (STEM) fields remains a pressing concern, highlighting systemic inequities that impede innovation and the broad cultivation of our human potential and capital. “*Exploring STEM environments that broaden participation*,” in Frontiers in Education, addresses this challenge by examining the barriers at key academic junctures that disproportionately impact historically marginalized groups. This collection features evidence-based practices and innovative approaches. Accordingly, this provides actionable insights for dismantling systemic barriers and cultivating rich learning environments that support the success of all.

The significance of this work cannot be overstated. The issue of broadening participation to make use of the full breadth of the United States citizenry in the STEM workforce is not merely an issue of social justice but also one of innovation and economic vitality. A robust talent pool brings varied perspectives, fostering creativity and driving solutions to complex, global challenges. Consequently, ensuring full participation in STEM education and careers requires strategies that tackle both overt and subtle barriers. The articles featured in this collection provide comprehensive examinations of these strategies. Moreover, they present clear pathways forward for educators, researchers, and institutional leaders.

Mentorship and self-efficacy: cornerstones of STEM persistence

Within the collection, the pivotal role of mentoring in enhancing student self-efficacy is explored in several articles. More specifically, authors investigated the impact of mentoring during critical junctures, such as academic transitions, and in unique contexts. Mentoring

is widely recognized as a powerful intervention that can significantly influence students' academic trajectories and professional aspirations. Davis and Wilson-Kennedy exemplify this in their exploration of holistic mentoring ecosystems, demonstrating how structured, comprehensive mentorship can mitigate adverse external factors such as the COVID-19 pandemic, particularly for low-income STEM students. Their work highlights the vital role that robust support systems can play in fostering resilience and persistence among college students, especially for those navigating complex paradigms.

Similarly, Oyelaran calls attention to the significance of early research experiences and mentoring, especially for improving the persistence of underrepresented racial minority science majors. Peer mentors can provide meaningful interactions that help students build the self-efficacy necessary to persist through challenging coursework and competitive environments. These findings collectively suggest that structured mentoring is instrumental to helping students navigate STEM education and careers. Moreover, these studies reinforce that effective mentoring goes beyond academic advising; it involves psychosocial elements, i.e., nurturing self-belief, providing role modeling, and fostering a sense of belonging within the STEM community.

Redefining STEM learning environments

Beyond mentorship, the collection explores the transformation of STEM learning environments to nurture scientific creativity to stimulate STEM identity and engagement. Pont-Niclòs et al. argue that integrating creativity-focused educational strategies can revitalize students' interest in STEM by connecting conceptual learning to real-world applications, encouraging divergent thinking, and promoting metacognitive skill development. Their findings reveal that cultivating creativity is a vital, yet underutilized, tool for building inclusive and motivating STEM environments that prepare students to meet the challenges of the future.

Mori extends this conversation by examining collaborative educational outreach strategies between high schools and universities in Japan. This work demonstrates how outreach efforts can create pathways that reduce barriers to STEM engagement. Herein, outreach coordinators serve as bridges that connect academic institutions with target communities. This approach expands access to potentially underserved communities and fosters access at critical educational junctures. Additionally, this work positions scientific creativity as a core competency and leverages academic partnerships to build opportunities for expanding this creativity. Consequently, it illustrates how strategically designed STEM learning environments can expand opportunities for all students to be successful.

Innovative approaches to STEM engagement

The collection also presents innovative STEM engagement approaches. Delogu et al. explore the impact of culturally responsive learning experiences on undergraduate students. This

work shows how course-based research experiences can increase engagement and understanding for STEM undergraduates. By embedding research directly into coursework, the study demonstrates an approach to expanding access to research experience. Access to research experiences is a common barrier to participation, especially for students balancing academics with competing responsibilities. This approach highlights a strategy for expanding access to meaningful STEM engagement.

Calkins et al. advocate for centering positive youth development approaches from sports in STEM education, encouraging environments to validate and leverage students' diverse backgrounds, minimize performance anxiety in math through continuous exposure, and skill development to enhance identity. By incorporating environments that engage role models and peers, STEM identity is fostered. Their work argues that in recognizing and respecting these diverse identities, engaging role models and peers, the sport model can profoundly impact women students' academic success and their sustained identity in STEM. Together, these studies explore innovative approaches to STEM engagement through reactive strategies that remodel traditional learning environments and leverage flexible, modern learning environments to broaden access, increase participation, and support sustained interest in STEM.

Addressing intersectionality and identity in STEM

Intersectionality emerges as another area of focus within the collection. Intersectionality examines how overlapping identities, such as race, gender, socioeconomic status, etc., can influence experiences and opportunities within STEM (McCurdy, 2021). Erichsen et al. discuss institutional strategies aimed at "warming the chilly climate" for women in STEM, advocating for macrostructural changes that address systemic biases. Their analysis highlights macrostructural strategies designed to dismantle systemic biases and alter institutional cultures that perpetuate inequities. Such comprehensive changes are critical in reversing historical patterns of exclusion and marginalization, facilitating environments where all students can thrive.

Zucker et al. examine the impact of culturally relevant informal STEM learning experiences on STEM family engagement, demonstrating how virtual and in-person STEM experiences can contribute to family self-efficacy in exploring STEM with children. Their findings emphasize the importance of delivering STEM programming in culturally responsive environments. It also advocates for modes of engagement that support families in developing confidence and capacity to participate in STEM learning together. Understanding intersectionality and identity in STEM is not only about acknowledging differences. It is about transforming systems to ensure engagement for all learners. By focusing on the varied lived experiences of students and their families, the studies in this Research Topic call for intentional efforts that

recognize identity as a critical perspective for developing inclusive STEM environments.

Paving the way for inclusive excellence in STEM

As higher education in the United States, and beyond, continues to evolve, it is imperative that empirical insights inform ongoing efforts to create high-impact learning ecosystems where all students have the opportunity to excel. These contributions, featuring original research, reviews, perspectives, and commentaries, provide evidence for best practice. These works suggest actions for cultivating robust educational ecosystems that empower students from all backgrounds to succeed and contribute to STEM innovation and progress. This Research Topic offers evidence for strategies and practices within STEM education. It is a timely resource actively broadening STEM participation.

Author contributions

TW: Conceptualization, Writing – review & editing, Writing – original draft. ZW-K: Writing – review & editing, Writing – original draft. RR: Writing – original draft, Writing – review & editing.

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Conflict of interest

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