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Article 1

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Science, technology, engineering, and mathematics (STEM) education aims to cultivate the capacity for innovation and real-world problem-solving (Marrero et al., 2014). However, STEM pedagogy has not historically aligned with this goal, often failing to teach students the necessary skills and mindset for creative problem-solving (Stehle & Peters-Burton, 2019). Traditional STEM pedagogical methods, such as rote and lecture-based learning, are based on the teacher being the dominant source of knowledge and students being the passive receivers (Achuonye, 2015; Khalaf & Mohammed Zin, 2018). These methods lack student support, collaboration, active learning, and real-world contexts (Gasiewski et al., 2012). Furthermore, the exclusion of cultures, identities, and historical connections about how we come to know scientific facts breed inequities often at the expense of innovation (Graves Jr et al., 2022).

Traditional STEM pedagogy has failed to provide opportunities for *all* students to see themselves as successful (Collins et al., 2020), as it is built on a foundation of White male supremacy culture (Hatfield et al., 2022). This pedagogy was engineered to reinforce racial and gender subordination (Hatfield et al., 2022), discouraging many from persisting in STEM, especially those from historically excluded backgrounds (McGee, 2021). Notably, traditional STEM pedagogy has not yielded a diverse workforce, limiting the potential for creativity and innovation (McGee, 2021). Over the last 20–30 years, the National Science Foundation (NSF, 2021a, 2021b) and National Institutes of Health (Taffe & Gilpin, 2021) have continuously shown that STEM fields are plagued with inequities and that the leaky pipeline for marginalized students starts as soon as the beginning of their undergraduate careers (Hatfield et al., 2022) if not before (Xavier Hall et al., 2022). Yet it was the racial reckoning in the United States in the midst of the COVID-19 pandemic that forced academia and industries to take a public stance for racial justice, assess their inequities, and develop strategies for improvement (Einstein, 2023; Norman & McFarlane-Alvarez, 2023). Since then, more science faculty are entering the conversation to address equity (Graves Jr et al., 2022; Isaacs, 2023), using the intersection of STEM pedagogy and feminist theory, to work towards creating inclusive classrooms where we are all equal contributors —we are all scientists. And given the latest Supreme Court decision banning affirmative action (Mystal, 2023), college educators will have to work harder at recruiting and retaining underrepresented students to STEM fields, as the number of these students entering college is likely to change (Bleemer, 2023).

Feminist pedagogy involves inclusive teaching practices that empower students, including decentralizing classroom power dynamics and recognizing student positionality to achieve social justice in oppressive systems (Webb et al., 2002). Key principles of this pedagogy include representation, recognition, discussions of bias, and science educator activism (Miner & Robinson-Hill, 2021). Feminist pedagogy also encourages the understanding of multiple aspects of identity, connects with other disciplines by utilizing collaborative and interdisciplinary methodologies, and teaches students how to identify power dynamics around how knowledge is produced (Mayberry & Rees, 1997). Giving students more autonomy in the classroom and helping them develop their identities have increased creativity and learning outcomes. Research overwhelmingly shows that improving pedagogy for historically marginalized students improves educational outcomes for all students (Alexiades et al., 2021; Morales-Doyle, 2017). Thus, feminist pedagogy can be transformative in STEM education by increasing learning and persistence in science.

This special issue emerged from a desire to showcase examples of how feminist pedagogy can transform STEM education into an inclusive and equitable enterprise. Here, we share effective teaching activities and commentaries at the intersection of feminist and STEM pedagogies. Themes around community, intersectionality, engagement and representation, and equitable teaching in the COVID-19 pandemic are discussed. Throughout this issue, authors share and reflect on activities that build community, utilize intersectionality to address equity, as well as increase engagement through representation. Given the recent COVID-19 pandemic, which presented an educational equity crisis (Ezra et al., 2021), several articles also discuss using feminist pedagogy to create inclusive online STEM courses.

Community, intersectionality, and representation are important as the classroom is not a race or gender-neutral space but rather a space through which societal inequities persist and must be acknowledged for change. For decades, scientists have used the notion that these fields are “colorblind” or not a space to discuss humanity, as these are considered to be subjective topics. However, science is neither neutral nor apolitical but created and supported by people and communities, usually supporting the dominating population (Ball, 2021; Dilworth, 2004). Thus, the basis of scientific claims and the idea of exactness defined by Western standards (Okere, 2005) are often fertilized by White supremacy culture (Nobles et al., 2022) and can be exclusionary and fraught with bias (Hetherington, 1983). To dismantle White supremacy culture in the classroom, we have to reimagine our courses and teach through a lens of equity.

Thus, this special issue provides concrete examples and creative ideas of how to include and retain more diverse voices in the STEM classroom.

The original teaching activities in this issue create community in the classroom through novel teaching activities that allow students to express their understanding of course content. In *Building Community, Competency, and Creativity in Calculus 2: Summary of a Pilot Year of Project Implementation*, Jennifer Beichman and Candice Price discuss how they adjusted the assessments in their coordinated Calculus II course from exams to group projects. This shift, originally thought to be a COVID-19 needed change, empowered students, celebrated different learning styles, and gave students the agency of being creative in a mathematics course. COVID-19 also inspired *Creating Meaningful Connections with the Electron Transport Chain Beyond a Virtual Classroom,* in which Lesley-Ann Giddings presents a creative, scaffolded assignment to support the learning of an important topic in Biochemistry – the Electron Transport Chain. Within this assignment, students engage in scientific literacy and gain a deep understanding of the topic by using artistic expression to teach others. This article shares how lessons can be created to both help students develop their scientific communication skills within their communities and learn science while teaching others in creative ways.

In *Centering Equity in Our STEM Teaching: Connecting Theory with Practice,* author Ileana Vasu provides our readers with resources for STEM instructors who want to center their students' lived experiences using culturally-relevant and feminist pedagogies. The author shares tools for assessments and teaching that further an inclusive feminist perspective in mathematics and other science courses. The specific activity, “STEM Ideas that Change(d) the World,” provides students the opportunity to present to their classmates an article about a STEM idea. The activity gives students the chance to bring their own expertise and interests into the classroom, while also providing support for them to be better science communicators. In our final activity, *Feminist Pedagogy in the Biology Classroom*, Carla Bonilla, Nicole Danos, and Sofia Leung describe a prompt that will challenge students in a general biology class to center “female biology.” This activity encourages students to move away from the male-centered narrative of biological study and view biology concepts from the female perspective. The authors goals are to create a classroom community that acknowledges the female perspective while also providing a sense of belonging to female-identifying students in the biology community at large.

The critical commentaries in this issue explore students’ lived experiences and intersectionality while decentering authority in STEM education. For example,

Eduardo Caro-Diaz and coworkers' critical commentary on *Feminist Pedagogy in the STEM Research Laboratory: An Intersectional Approach* provides a first-hand perspective on how creating a space for diversity, equity, and inclusion and celebrating the 'whole student' in the laboratory provides positive support for trainees, particularly underrepresented women. Caro-Diaz and coworkers describe trainee mentorship in Puerto Rico where students face the challenges of intersectionality along race-gender and socio-political-economic issues while working in a STEM laboratory. However, they show us that listening and participating in deep self-reflection before stepping into the role of a principle investigator or mentor can create brave spaces for more growth, grace, learning, and curiosity among students. Self-reflection is also critical on the part of the student, which is further emphasized in the commentary *Ungrading: Reflections Through a Feminist Pedagogical Lens* by Erin Eggleston and Shelby Kimmel. The authors discuss using an ungrading approach, a student-reflective practice, in two separate upper-division STEM classes. Their semester-long approach focused on feminist pedagogical principles of empowering the students to take agency in their learning and reducing the student-professor power imbalance. Eggleston and Kimmel found that students remained engaged with the classroom material despite the absence of graded assignments and have an increased sense of democratization in the classroom.

Another major theme discussed is centering equity in STEM practices, such as science competitions and courses. For example, in *Robotics and Engineering Competitions Motivate Boys to Engage, but not Girls*, Alysson Light and Sonia Roberts discuss ways in which robotics competitions can be more welcoming to increase the participation of historically excluded groups, including women. The competitive nature of these activities causes women to suffer from stereotype threat and does not align with their learning styles, which favor collaboration and community-oriented experiences versus competition and individual learning. Light and Roberts conclude with the notion that all competition-based programs ultimately fail to engage women in STEM and ask why competitions are even necessary. The inclusion and engagement of all historically underrepresented groups should be considered when designing engaging science activities, which is further emphasized in *Exploring Representation in Microbiology Introductory Courses* by Jill Mikucki and Elizabeth Fozo. This commentary highlights the importance of representation for increased engagement. Mikucki and Fozo discuss classroom activities that make historically excluded scientists and their contribution visible to students has grown awareness around systemic issues that limit diverse representation in microbiology and STEM. These activities demonstrate how discussions around representation can improve student engagement and raise awareness of the need to build a culture of equity.

The issue culminates with a book review written by Michelle Guinn on Nicole Joseph's book *Making Black Girls Count in Math Education: A Black Feminist Vision for Transformative Teaching*. The review highlights the intersectional challenges faced by Black girls in mathematics education and how these perceived obstacles do not have to define student success. Culturally-responsive teaching can empower Black girls to achieve a high-quality mathematics education.

Equity results in excellence (Warnert et al., 2021). In this special issue, we demonstrate that centering community, intersectionality, representation, and inclusion in STEM education create meaningful learning experiences in which everyone is taught through a lens of equity. These teaching activities and ideas are critical to creating STEM courses in which all students feel liberated and emboldened to be the best versions of themselves in our classes. Bringing out the best in students in our courses will increase their engagement and persistence. Finally, as scientists we are innovators, and we are excited to see how STEM educators will continue to develop and integrate feminist pedagogical strategies in their courses to create inclusive student learning experiences. These pedagogies will ultimately shape the future of scientific innovation, especially *who* does the innovating.

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