

Disrupting Homeostasis in the Classroom: How Faculty Can Dismantle Gender Bias in the Biology Classroom

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ABSTRACT

Despite women achieving gender parity in undergraduate biological sciences programs, systemic sexism persists, eroding their confidence, sense of belonging, and career aspirations. This phenomenon can be likened to “cultural apoptosis,” where the exclusionary dynamics within academic environments function like a biological process, eliminating diversity and stifling innovation. Dismissive behaviors, microaggressions, and inequitable access to mentorship and resources contribute to this cultural apoptosis, reinforcing systemic barriers that hinder women’s academic engagement and professional development. This article highlights the need to move beyond numerical representation and address the cultural and institutional factors that perpetuate these inequities. Drawing on research findings, it provides actionable recommendations for postsecondary biology faculty to create inclusive classrooms that empower all students. These strategies include, but are not limited to, fostering inclusive mentorship programs, implementing collaborative learning approaches, addressing implicit biases through faculty training, and establishing transparent resource allocation policies. By challenging cultural apoptosis and promoting equity-focused practices, faculty can play a transformative role in supporting women in biology and cultivating a more diverse and innovative STEM workforce.

Key Words: sexism, higher education, biological sciences, gender inequity, inclusivity

Sexism in higher education endures as a deeply rooted barrier to academic success for women in the sciences (Llorens et al., 2021). Dismissive behaviors, gender bias, and microaggressions—including microassaults (e.g., sexist jokes), microinsults (e.g., backhanded praise questioning competence), and microinvalidations (e.g., minimizing or ignoring women’s expertise)—shape women’s educational experiences even in environments where women are the numerical majority (Nadal, 2010; Prieto-Rodriguez et al., 2022). Undergraduate biological science programs, while often celebrated for achieving numerically based gender equality, remain plagued by practices and structures

of institutionalized sexism that continue to marginalize women (Brown, 2008; Llorens et al., 2021). These barriers not only erode women’s confidence and sense of belonging but also hinder their academic engagement and professional development (Llorens et al., 2021; Rosa & Clavero, 2021). This phenomenon can be equated to “cultural apoptosis.” Just as apoptosis in tissues leads to the elimination of cells to maintain homeostasis, these interpersonal dynamics function to create a culture that excludes women, thereby stifling diversity and innovation.

The importance of addressing these issues cannot be overstated. Gender equity is not merely a matter of representation, it is a cornerstone of fostering diverse perspectives, driving scientific innovation, and cultivating inclusive educational environments (Casad et al., 2021; Shannon et al., 2019). Understanding how sexism manifests and operates within these programs, where women are well represented, is essential to dismantling the structural and cultural barriers that hinder women’s success in STEM careers (Peter et al., 2020; Rosa & Clavero, 2021). Key contextual factors shaping these inequities include sociocultural norms, institutional practices, and cultures that fail to support or actively marginalize women (Charlesworth & Banaji, 2019; Prieto-Rodriguez et al., 2022). For example, women in STEM receive fewer opportunities for career counseling, leadership development, and research grant roles compared with their male peers, which can constrain

their long-term career trajectories (Gallen & Wasserman, 2021; Rottinghaus et al., 2018; Van der Linden et al., 2024).

While equitable instruction is a shared endeavor, faculty hold disproportionate influence over the structural and cultural conditions of biology courses, making their role central to efforts aimed at disrupting inequitable participation and recognition (Llorens et al., 2021). As gatekeepers of academic and professional opportunities, professors have the power to shape the experiences of their students through mentorship, classroom dynamics, and equitable resource

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distribution (Ceglie, 2021). When faculty actively foster inclusive learning environments, they counteract the effects of dismissive behaviors and microaggressions, empowering women to persist in STEM (Casad et al., 2021; Ceglie, 2021). Conversely, when faculty fail to address implicit biases or neglect to create equitable opportunities, they inadvertently reinforce the cultural and structural inequities that hinder women's successes (Ceglie, 2021). Examining how faculty actions influence women's confidence, self-efficacy, and career aspirations provides valuable insights into how these dynamics can be reshaped. This article draws on findings from a recent study we conducted to highlight these influences, contributing to the growing body of research on gender equity in STEM and offering actionable strategies for creating more inclusive biology classrooms.

○ Methodology

This study used a transformative mixed methods design to examine women's experiences of sexism in undergraduate biology, a field where women have gender parity yet report exclusionary classroom climates (Brown, 2008; Llorens et al., 2021). Quantitative survey data documented the prevalence and forms of sexist experiences across instructional contexts, while qualitative data captured how classroom practices, interactions, and norms shaped students' engagement, confidence, and persistence (Lent et al., 1994). Sexism was analyzed as an instructional and institutional phenomenon, enabling findings to be translated into actionable guidance for STEM faculty to foster psychological safety, belonging, and equitable participation.

○ Bridging Representation & Equity: Insights From Research

While numerical representation in undergraduate biological sciences programs has improved, the cultural and structural dynamics within these programs often fail to equitably support women (Brown, 2008; Llorens et al., 2021). This recent transformative mixed methods study revealed that systemic barriers—such as dismissive behaviors, microaggressions, and unequal access to resources—continue to undermine women's confidence and academic growth, as well as influence their career trajectories (Cobian et al., 2024; Lent et al., 1994). These findings align with broader research in STEM, which emphasizes the persistent gap between representation and true equity (Casad et al., 2021; Llorens et al., 2021).

One critical takeaway from our study was the transformative role faculty play in addressing these inequities. Through intentional teaching practices, equitable resource distribution, and effective mentorship, professors create environments where all students feel valued and supported. For example, integrating collaborative learning strategies and establishing transparent policies for resource allocation ensures that students—particularly women—experience a more inclusive educational journey (Moss-Racusin et al., 2021; Robnett, 2013). Additionally, equipping faculty with the tools to recognize and address implicit biases is essential for dismantling inequitable classroom dynamics (Kotzee, 2017).

Faculty as Allies: Insights From the Study

Professors can have a profound impact on fostering inclusive and supportive learning environments. Participants shared how faculty actions, such as creating peer networks, providing mentorship, and

implementing inclusive teaching practices, positively shaped their academic experiences and personal growth.

Building peer networks

Intentional efforts to create peer networks emerged as one of the most effective strategies. Professors who facilitated collaborative group work, peer-led reviews, and lab sessions enabled students to form supportive connections. These relationships helped counter feelings of isolation and empowered participants to navigate challenges. One participant provided the following reflection:

I think along with all of that was just the realization that it's not just me. You know, there's something to be said about, you know, support groups in general.... [T]here's something to be said about groups coming together to say, like you're not the only one, I'm here too.

These networks provided a sense of belonging and validation, which are critical for retention and persistence in STEM.

Mentorship & representation

Access to mentorship, particularly from women in science, was another key factor in participants' success. Faculty who connected students with mentors or served as mentors themselves helped women navigate academic challenges and envision professional possibilities. Another participant described the impact of mentorship:

I fell into this research scholars program ... and that program allowed me to partner with a scientist who happened to be a PhD and a DVM ... I took the challenge, and I partnered with her, and did a summer program where I worked in her lab. I learned about research with animals, as well as how you can translate that to human medicine, and that's how I started, really. She showed me it was possible to succeed.

These relationships not only provided role models but also helped participants build confidence and attain professional skills.

Inclusive teaching practices

Professors who implemented inclusive teaching practices also made a significant difference. Intentional efforts to address implicit biases and ensure equitable participation helped women feel empowered in the classroom. A participant shared their experience:

When I finally had a lab faculty that would call on everyone equally during discussions and always made sure no one was talked over, it made me feel like my ideas were just as valid as everyone else's.

Such practices reinforced a culture of mutual respect and encouraged women to actively engage in their studies, countering exclusionary dynamics often present in STEM fields.

○ Recommendations for Fostering Inclusive Biology Classrooms

The following recommendations are designed to help biology faculty implement strategies that address these challenges women experience and create more inclusive learning environments. By taking deliberate action, professors support women

in biology and contribute to a broader cultural shift in STEM education. These actionable steps offer a roadmap for fostering equity and preparing students for innovative and diverse careers in biological sciences. To create more inclusive undergraduate biology classrooms, faculty can focus on three interconnected teaching goals: fostering belonging, empowering students, and creating a legacy of change. By implementing targeted strategies aligned with these goals, professors address the systemic barriers that hinder women's success and create an environment where all students thrive.

Fostering Belonging

A sense of belonging is foundational to student success (Rainey et al., 2018). Faculty can take intentional steps to ensure all students feel valued and included in the classroom.

Facilitate peer networks

Group projects and peer-led study sessions are powerful tools for creating supportive relationships among students (Robnett, 2013). Assigning diverse teams and rotating leadership roles ensures all voices are heard and respected. Encourage participation in women-focused STEM organizations to provide additional spaces for connection and empowerment. These activities help students develop critical skills such as teamwork, leadership, communication, and the ability to navigate diverse perspectives.

Promote inclusive interactions

Professors can make classrooms more welcoming by actively moderating discussions to ensure equitable participation and addressing exclusionary behaviors. Simple actions, such as ensuring that no student is interrupted or ignored during discussions, reinforce a culture of respect (Finn & Campisi, 2015). By modeling inclusivity and respect, professors set a standard for classroom interactions, encouraging students to adopt these behaviors in their own peer relationships.

Highlight representation

Integrate the contributions of women scientists into course content and discussions. These examples provide students with role models and challenge stereotypes about who belongs in STEM, inspiring students to envision themselves as future leaders in biology (McKinnon & O'Connell, 2020). By fostering belonging, faculty create a classroom environment where students can feel connected, supported, and confident in their ability to succeed (Rainey et al., 2018).

Empowering Students

Empowering students means equipping them with the resources, opportunities, and confidence to navigate academic and professional challenges effectively (Falco & Summers, 2019).

Provide equitable access to opportunities

Transparency is key to ensuring fairness in resource distribution (Moss-Racusin et al., 2012). Professors should develop clear criteria for access to research projects, leadership roles, and extra-credit opportunities. They should also periodically evaluate and update these criteria to reflect evolving student needs, promote equity, and address any unintended biases that may arise over time. By consistently applying and communicating these criteria, professors build trust.

Integrate mentorship opportunities

Mentorship is a vital resource for students, especially women navigating challenges in STEM (Beck et al., 2022). Partnering with institutional initiatives or creating class-specific mentorship pairings connects students with mentors who can provide tailored guidance. Highlighting women mentors offers invaluable representation and support. Faculty should prioritize mentorship within their teaching and advising structures, recognizing their role in shaping the next generation of biology teachers, faculty, researchers, and professionals.

Participate in faculty development

Faculty training programs on implicit bias and inclusive pedagogy equip faculty to create equitable learning environments. By using varied assessment methods that recognize multiple ways students can demonstrate learning and by intentionally structuring classroom participation to share authority, slow the pace of interaction, and broaden what counts as contribution, professors create more inclusive learning environments in which students are better supported to participate confidently and engage deeply with course material (Cobian et al., 2024). Empowered and engaged students are better prepared to overcome barriers, develop self-efficacy, and pursue meaningful careers in STEM (Falco & Summers, 2019).

Creating a Legacy of Change

To drive systemic progress, faculty must go beyond their classrooms and contribute to a cultural shift that fosters long-term equity in biology education (Llorens et al., 2021; Moss-Racusin et al., 2012).

Redefine success beyond representation

Representation alone does not ensure equity. In biology classrooms, gender parity can create the appearance of inclusion, while disciplinary norms related to competition, high-stakes assessment, and scientific authority continue to shape whose knowledge is recognized and rewarded. Because faculty play a central role in reinforcing or disrupting these norms, regular reflection on teaching practices is essential to preventing the persistence of sexism beyond numerical representation. Tools such as anonymous student feedback can further support this process by revealing whether students feel supported and included, providing actionable insight for instructional improvement (Llorens et al., 2021).

Advocate for equity assessments

Collaborate with department leaders to conduct periodic reviews of classroom practices and resource allocation. Equity-focused assessments can identify gaps and guide evidence-based reforms that promote inclusivity (Llorens et al., 2021). Such collaborations not only enhance the overall learning environment but also contribute to the professional growth of faculty, fostering a culture of continuous improvement and accountability.

Promote advocacy & representation

Partner with women's advocacy groups or interdisciplinary STEM initiatives to amplify diverse voices (McKinnon & O'Connell, 2020). Highlight efforts to address gender equity in STEM, inspiring students to engage in initiatives that challenge systemic inequities. By prioritizing systemic change, professors leave a lasting impact that extends beyond their classrooms, fostering an academic culture that

Table 1. Recommendations for Creating Inclusive Undergraduate Biology Classrooms

Teaching Goal	Recommendation	Actionable Steps	Expected Outcome
Fostering Belonging	Facilitate Peer Networks	– Use group projects with diverse teams and rotating leadership roles. – Promote peer-led study sessions and encourage participation in women-focused STEM organizations.	Stronger student collaboration and a sense of inclusion and support among peers.
	Promote Inclusive Interactions	– Actively moderate discussions to ensure equitable participation. – Address exclusionary behaviors, such as interruptions or dismissive comments, during class.	A respectful and inclusive classroom environment where all voices are heard and valued.
	Highlight Representation	– Incorporate examples of women scientists' contributions into lectures and discussions. – Invite women speakers or showcase research by women scientists.	Inspires students by providing diverse role models and challenges stereotypes about STEM fields.
Empowering Students	Provide Equitable Access to Opportunities	– Develop and communicate transparent criteria for accessing research projects, leadership roles, and extra-credit opportunities. – Ensure fairness in resource allocation.	Increased student confidence and a sense of fairness in accessing academic opportunities.
	Integrate Mentorship Opportunities	– Partner with institutional mentorship initiatives or create class-specific mentorship pairings. – Encourage mentoring relationships with women scientists.	Students receive tailored guidance, enhancing their self-efficacy and career aspirations.
	Participate in Faculty Development	– Engage in professional development to recognize implicit biases and promote inclusive pedagogy. – Incorporate varied assessment methods and equitable teaching strategies.	Educators are better equipped to create equitable and supportive classroom environments.
Creating a Legacy of Change	Redefine Success Beyond Representation	– Reflect on teaching practices to ensure equity extends beyond numerical representation. – Use anonymous feedback tools to gauge inclusivity and adjust accordingly.	Equity becomes embedded in classroom culture, addressing systemic challenges beyond surface-level metrics.
	Advocate for Equity Assessments	– Collaborate with department leaders to conduct periodic equity audits. – Use findings to implement evidence-based reforms that improve inclusivity.	Sustained progress in creating inclusive and equitable academic environments.
	Promote Advocacy and Representation	– Partner with women's advocacy groups and interdisciplinary initiatives to bring diverse voices into the classroom. – Highlight efforts addressing gender equity in STEM.	Students are inspired to engage in transformative initiatives, fostering a culture of equity in STEM.

Note: This table offers a streamlined, goal-oriented approach for implementing strategies that foster belonging, empower students, and create lasting cultural change in biology classrooms. Professors can use this framework to address specific challenges and contribute to a more inclusive academic environment.

values diversity and inclusion (Llorens et al., 2021; Moss-Racusin et al., 2012).

Bringing It All Together

Each of these strategies, while impactful on their own, becomes even more effective when implemented collectively (Table 1). Together, they create a comprehensive approach to fostering inclusive and equitable biology classrooms. By integrating mentorship, facilitating peer networks, promoting collaboration, and advocating for

systemic change, biology professors address the multifaceted barriers women face in STEM and cultivate environments where all students can thrive (Peter et al., 2020).

○ First Steps & Future Steps

The findings of this study suggest that creating more inclusive biology classrooms begins with intentional, visible instructional choices that signal belonging, respect, and accountability. For

new faculty seeking first steps toward inclusion, establishing clear classroom norms around respectful engagement and equitable participation is critical. This includes explicitly naming expectations for collaboration, addressing biased or dismissive comments when they occur, and designing participation structures that do not privilege the most confident or vocal students. Transparent assessment practices, flexible pathways for demonstrating learning, and regular opportunities for student feedback further support inclusive pedagogy by reducing ambiguity and power imbalances that disproportionately affect women and other marginalized students. Importantly, these practices position inclusion as a core component of effective teaching rather than an add-on or accommodation.

Beyond fostering supportive classroom environments, faculty also play a key role in preparing women for future academic and professional contexts that may be less equitable or affirming (Lent et al., 1994). Our participants' experiences highlight the importance of helping students develop both confidence and critical awareness—skills that allow them to recognize sexism when it occurs, interpret it as a systemic issue rather than a personal failure, and respond strategically. Instructors can support this preparation by openly discussing norms and power dynamics within biology fields, modeling professional responses to bias, and validating students' experiences without minimizing or normalizing harm. Embedding opportunities for mentorship, peer support, and reflection into coursework can further equip women with social and professional tools they may need beyond the classroom.

These findings highlight that inclusive instruction in biology serves a dual function: enhancing students' immediate learning experiences while also operating as a protective and preparatory space (Brown, 2008). By prioritizing belonging, transparency, and equity, faculty can reduce the effects of sexism in the present and support the development of scientific voice, confidence, and critical awareness needed to navigate future academic and professional environments where inclusion cannot be assumed or where sexism is more overt (Lent et al., 1994). For biology faculty, this represents a meaningful opportunity to shape both educational outcomes and women's long-term persistence in science.

○ Conclusion

Cultural apoptosis in undergraduate biology classrooms poses a persistent obstacle to achieving true equity and inclusion. The consequences of gender inequities in biological sciences coursework extend beyond the classroom, leaving lasting impacts on women's confidence and career trajectories (Gartner, 2021; Malespina & Singh, 2023). Repeated exposure to microaggressions, exclusionary practices, and implicit biases erodes women's self-efficacy and discourages their pursuit of leadership roles or advanced studies (Llorens et al., 2021). These experiences reinforce harmful stereotypes and contribute to the underrepresentation of women in STEM leadership (Kim & Meister, 2022; Llorens et al., 2021).

Several strategies can help create more equitable learning spaces. By implementing inclusive mentorship programs, fair resource allocation, and fostering peer networks, faculty create classrooms where all students feel valued and supported (Peter et al., 2020). Moreover, faculty development and collaborative learning approaches are also critical in cultivating an environment that promotes respect and mutual understanding (Cobain

et al., 2024). These efforts go beyond individual classroom practices, driving systemic change within institutions to dismantle the structural and cultural barriers that perpetuate inequities (Llorens et al., 2021).

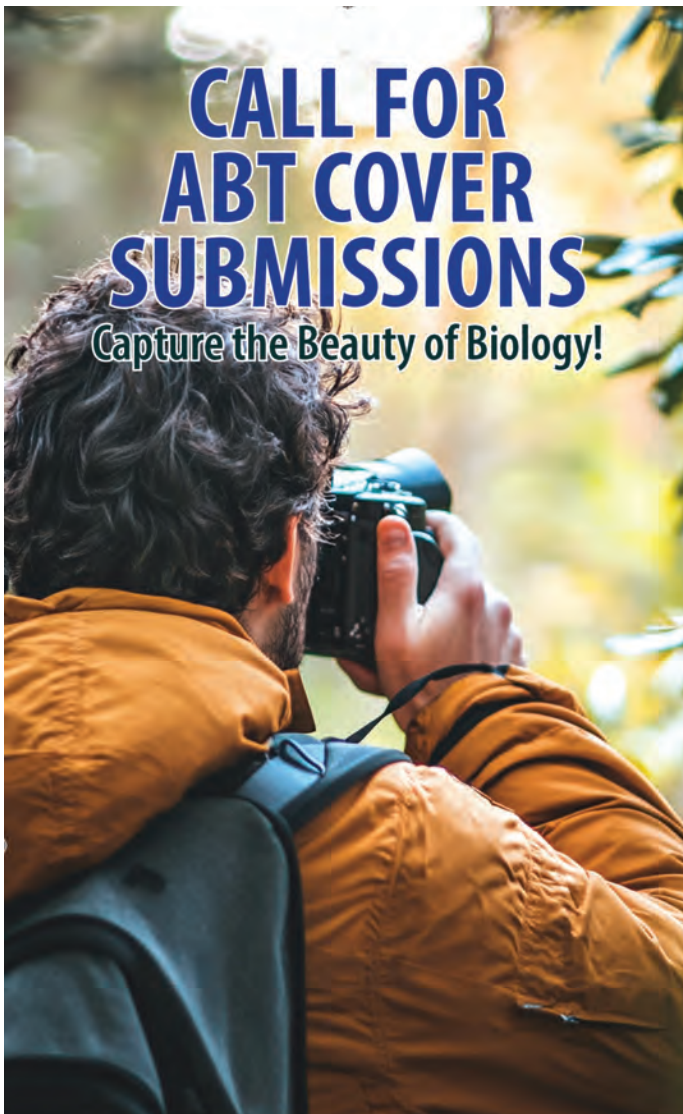
Investing in these strategies is not only essential for advancing gender equity but also imperative for building a diverse and innovative STEM workforce. Diversity in STEM drives creativity, collaboration, and solutions to the world's most pressing challenges (Yang et al., 2022). By taking meaningful action now, higher education can empower future generations of scientists, ensuring that biology classrooms become the launching pad for a more inclusive and equitable scientific community (Cobain et al., 2024; Yang et al., 2022).

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