RESEARCH ARTICLE

A holistic understanding of inclusion in STEM: Systemic challenges and support for women and LGBT+ academics and PhD students

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Abstract

Barriers to equity, diversity, and inclusion remain in Science, Technology, Engineering, and Mathematics (STEM) for historically underrepresented and marginalized individuals. The purpose of this study was to explore the experiences of women and LGBT+ academics and PhD students in the United Kingdom. Specifically, this article examines systemic challenges and support that 82 participants who identified as women and/or LGBT+ academics and PhD students have experienced in their STEM environments and throughout their careers. In this qualitative study, we employed intersectionality theory to frame a thematic analysis of interviews and focus groups. Our findings indicate that the experiences of participants are characterized more by inequities than by support from colleagues, peers, and higher education institutions. Inequities are widespread and inter-sectional, and have a cumulative impact whenever individuals endure multiple and potentially escalating challenges—which include hard-to-spot disadvantages, stereotypes, prejudice, as well as harassment, bullying, and discrimination. Participants' accounts illustrate the benefits of different support mechanisms but also the limitations of initiatives to support marginalized individuals and groups in STEM that are not

systematically embedded across institutions. Based on our findings, we present two conceptual models to better understand systemic challenges and their consequences for women and LGBT+ academics and PhD students in STEM, as well as to inform more holistic support mechanisms to create more inclusive STEM environments. Implications from the study highlight institutional accountability as key to improving climates and transformative change.

KEYWORDS

diversity, equity, inclusion, intersectionality, LGBT+ people, STEM, women

1 | INTRODUCTION

There has been increased attention to equity, diversity and inclusion in Science, Technology, Engineering, and Mathematics (STEM) both in the United Kingdom and elsewhere. Studies and programmes to stimulate students' interest, improve representation, and reduce bias have traditionally focused on women (Blackburn, 2017; Casad et al., 2021). Recently, researchers, schools, higher education institutions, governments, and organizations have started to investigate and address inequities faced by lesbian, gay, bisexual, and transgender (LGBT+)[1] individuals— another excluded group in STEM (Bilimoria & Stewart, 2009; Miller & Downey, 2020; Patridge et al., 2014; Reggiani et al., 2024; Yoder & Mattheis, 2016). Despite these efforts and some success in making STEM environments more welcoming, current demographics in the sector and research literature both indicate that discriminations and barriers to inclusion are still prevalent for both women and LGBT+ people (Advance, 2022; Atherton et al., 2016; Blackburn, 2017; Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry, 2019; Ireland et al., 2018; Ong, 2023).

There are several possible explanations for persistent systemic oppression. The first is the ways inequities faced by women and LGBT+ individuals have been understood and addressed in STEM education research, institutional policies and practices. The lack of intersectional approaches has led to focusing disproportionately on gender disparities between women and men, while ignoring or underplaying the importance of other systems of oppression based on, for example, sexuality, gender identities beyond the gender binary, race/ethnicity, disability, and social class (Bhopal, 2018; Gaston Gayles & Smith, 2018; Miller & Downey, 2020). On the other hand, both deficit discourses and pipeline models have fallen short of interrogating the multifaceted reality of STEM careers, normative values around science and scientists, metrics of success, or the contextual role of organizational policies and practices (Clark Blickenstaff, 2005; Cannady et al., 2014; Harper, 2010). The tendency of looking separately at systemic challenges and support mechanisms to address them has also hampered the path towards inclusive STEM environments, together with the lack of robust empirical evidence on the impact of initiatives focused on minority individuals and groups in the sector (Tsui, 2007).

Leaky pipeline models, lack of intersectionality, and the lack of integrated understanding of systemic challenges and support have contributed to the creation of a supply-side perspective to inclusion of women and LGBT+ people and to the adoption of simplistic solutions (e.g., increasing the numbers of women in STEM education) that do not fundamentally challenge biased ideologies that (re)produce oppression and privilege in STEM (Blair-Loy & Cech, 2022; Heybach & Pickup, 2017; Metcalf, 2010). In addition, there has been disproportionate attention given to the experiences of students at early stages of STEM education compared, for example, to those of PhD students,

postdocs, or academics (Castro & Collins, 2021; McAlister et al., 2022; Yadav et al., 2020). This is a major oversight. PhD students and academics are invested in creating new scientific knowledge, shaping ideas on science and around scientists, and gatekeeping access and progression to STEM education and careers via teaching, recruiting, or mentoring. Ignoring or underestimating their experiences of inequities and/or inclusion has ripple effects on STEM education—which makes focusing on higher education as urgent as the work done in primary or secondary schools.

This study contributes to addressing these gaps. We do so by focusing, through intersectional lenses, on the experiences of 82 participants who identified as women and/or LGBT+ academics and PhD students in STEM at a university in the north of the United Kingdom. We employ intersectionality theory (Collins, 2015; Crenshaw, 1989) to understand and illuminate interlocking systems of oppression and the experiences of individuals who have been historically excluded and understudied in STEM education research. In addition, by focusing both on systemic challenges and support, we reframe the issue of equity, diversity, and inclusion (EDI) in STEM as one that needs to be addressed holistically.

By thematically analyzing data from focus groups and interviews, our study addresses the following research questions: (RQ1) What are the systemic challenges women and LGBT+ academics and PhD students in STEM face?; (RQ2) What are the experiences or workplace features that are perceived by participants as supporting their STEM careers? Based on our findings, we propose two conceptual models to better understand systemic challenges and their consequences for women and LGBT+ academics[2] and PhD students, as well as to inform more comprehensive and effective forms of support. We build and expand on previous models (Bilimoria & Stewart, 2009; Casad et al., 2019; Patridge et al., 2014) by critically illuminating compounded and potentially escalating mechanisms that (re)produce oppression, as well as incremental steps and institutional responsibilities for inclusion. Finally, we outline implications and recommendations for future research, policy and practice.

2 | LITERATURE REVIEW

2.1 | Systemic challenges against women in STEM

The experiences of women in STEM are a longstanding concern for scholars, policymakers, and practitioners. A variety of theoretical frameworks can be found in extant research, although theory is not always employed to guide this work (Gaston Gayles & Smith, 2018)—which makes it harder to challenge inequities. Education research has employed social identity theory to explore women's aspirations, STEM identity, and belonging (Kim et al., 2018; Seyranian et al., 2018). Scholars looked at gender theory and related conceptualizations to examine the ways gendered assumptions are (re)produced (Hart, 2016; Nguyen et al., 2022; Parson et al., 2021). Studies employing intersectionality theory, on the other hand, have explored the experiences of women in STEM navigating multiple and overlapping systems of oppression, particularly women of color (Allen et al., 2022; Castro & Collins, 2021; Harper & Kayumova, 2023; Ireland et al., 2018; Martin & Fisher-Ari, 2021; Prescod-Weinstein, 2020). It is worth noting that, even in the context of intersectional frameworks, far less attention has been focused on investigating oppression on the basis of sexuality, class, or disability—a gap that hinders more nuanced, holistic, and just approaches to inclusion. Moreover, whilst prior studies have identified a wide range of barriers to access, recruitment, retention, and promotion in fields where women have been underrepresented and marginalized, Blackburn's (2017) review of a decade's worth of literature suggests that equity is still far from reach.

The gender gap in academic and student cohorts, which organizations usually measure by contrasting numbers of women and men, remains one of the most visible outcomes of the persisting barriers to inclusion in STEM—with gender ratios becoming progressively unbalanced as careers progress (Anand et al., 2024). According to Education and training statistics for the United Kingdom, in 2019/2020 women made up 46% of PhD students across all STEM fields. However, the figures are significantly lower in some specific STEM areas, with women accounting for just 26% of PhD students in engineering and technology, 28% in mathematical sciences, and 36% in physical sciences (International evidence and statistics team, 2021). Based on HESA (Higher Education Statistics Agency)

data analyzed by Advance HE, more than half (56.3%) of academic staff in SET (Science, Engineering, and Technology) fields in the United Kingdom were men. Women in SET made up only 24.2% of the professors and 29.3% of the senior management roles (Advance, 2022). Despite the limited availability of intersectional data, disparities become even starker when looking at intersections between gender and race/ethnicity: of all professors across the United Kingdom, only 0.6% identified as Black women. Notably, data were unavailable or incomplete for transgender, non-binary, or genderqueer individuals.

Deficit discourses and leaky pipeline models have been employed to explain and address the under-representation of women in STEM (Clark Blickenstaff, 2005; Heybach & Pickup, 2017). While these conceptions provide compelling calls to action that keep inspiring policies and initiatives for gender equality, they also present significant shortcomings that have come under increased scrutiny. The idea of a STEM pipeline rests on problematic, simplistic, and potentially misleading assumptions. This includes emphasis on the supply-side, disproportionate focus on early educational experiences if compared to postgraduate education and/or the experiences of researchers and academics in STEM higher education, the tendency to homogenize career paths, and the lack of intersectional approaches (Cannady et al., 2014; Metcalf, 2010). Deficit discourses reinforce normative and stereotypical assumptions about women and STEM careers (Heybach & Pickup, 2017; Martin & Fisher-Ari, 2021), and they position underrepresented and marginalized groups as the problem to be solved rather than focusing on the systems that perpetuate oppression. These approaches fail to properly address the influence of circumstances, systemic bias, and normative STEM cultures. As an example, women's empowerment programmes are a common deficit discourse-driven intervention that organizations may deploy to address women's underrepresentation. However, no amount of capacity building within individual women will defeat persistent systemic sexism.

Prior research has investigated stereotype and prejudice as contextual factors that contribute to chilly climates for women in STEM with detrimental effects on interest, performance, and sense of belonging (Conefrey, 2001; Moss-Racusin et al., 2018; Shapiro & Williams, 2012). Women of color, Black women in particular, experience the "double bind" of racism and sexism (Allen et al., 2022; Ireland et al., 2018; Ong, 2023), epistemic oppression and marginalization (Prescod-Weinstein, 2020), language-based racialisation (Harper & Kayumova, 2023), and other forms of harassment and discrimination. Surveys exploring the experience of LGBT+ individuals in physics and the physical sciences found that women, non-binary, and gender-nonconforming individuals reported higher discomfort rates than men, resulting from the interlocking oppression of heteronormativity, gender-based stereotypes, and sexism (Atherton et al., 2016; Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry, 2019). While studies focused on disabled individuals in STEM remain limited, a recent research project commissioned by the Royal Society in the United Kingdom found that women experienced negative career impacts due to compounded effects of disability, caring responsibilities, stigma, and the lack of flexibility and support (Careers Research & Advisory Centre, 2020).

In comparison to research on stereotype and prejudice against women in STEM, less work has been done to uncover and address incidents of bullying and harassment—despite news articles, reports, and studies suggesting that these are systemic problems rooted in organizational climates and fields that, like STEM, are historically dominated by men (Aycock et al., 2019; National Academies of Sciences, Engineering, and Medicine, 2018). Moreover, research has consistently shown links between bias, discrimination, and outcomes for marginalized groups in STEM (Ireland et al., 2018; Wright & Delgado, 2023) and, therefore, is vital to achieve a systematic understanding of the professional and institutional practices and policies that enable and (re)produce such inequitable patterns.

It is worth noting that by starting our literature review with an overview of systemic challenges against women in STEM, we do not wish to suggest that gender is necessarily the most salient among the "interlocking systems of oppression" (P. H. Collins, 1986, p. S20) that shape the experiences of our participants nor that identifying as a woman in STEM carries the same meaning or material consequences for individuals and groups who have different access to power and privilege. In addition, and whilst we recognize the impact of studies focused on gender inequalities in STEM on scholarship and practice, we would like to acknowledge that the relative lack of intersectional approaches or the frequent exclusion of gender identities beyond the gender binary has often limited prior research.

2.2 | LGBT+ academics and students in STEM: Marginalized, underrepresented, and understudied

In comparison to research focused on women, less is known about the experience of LGBT+ individuals in STEM—a gap that is compounded by the lack of basic demographic data around sexuality and gender identities, including those of transgender, non-binary, and gender non-conforming people (Freeman, 2020). The dearth of research and initiatives in this area has been a major oversight, as studies have revealed significant bias and disparities that affect the career trajectories of LGBT+ people both in the United States and the United Kingdom, including homophobia, transphobia, heteronormativity, and exclusionary behavior (Atherton et al., 2016; Bilimoria & Stewart, 2009; Cech & Waidzunas, 2011; Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry, 2019; Mattheis et al., 2019; Patridge et al., 2014; Reggiani et al., 2024). In STEM fields, these challenges are exacerbated by normative cultures of objectivity that reinforce the idea that identities should be dismissed as irrelevant in education and work environments, as well as discourage discussion of inequities, inclusion, and social justice—all subjects which are often not covered within STEM curricula (Cech, 2013). Studies have found that STEM departments are usually perceived as more hostile by LGBT+ students and academics when compared with humanities and social science (Linley & Nguyen, 2015; Patridge et al., 2014). Whereas Hughes (2018) found that LGBQ college students in the United States were less likely to be retained in STEM when compared to their non-LGBQ peers.

Previous research employed different theoretical frameworks to explore LGBT+ experiences, including queer theory, intersectionality theory, and campus climate. Studies focused on coming out, disclosure, and visibility along with their contradictory outcomes and implications on wellbeing, navigating careers, and STEM identities (Bilimoria & Stewart, 2009; Patridge et al., 2014; Reggiani et al., 2024; Yoder & Mattheis, 2016). By using national-level survey data from STEM-related professional societies in the United States, Cech and Waidzunas (2021) found that there are significant disparities between LGBTQ and non-LGBTQ STEM workers when it comes to career opportunities, and experiences of professional devaluation and social exclusion. Existing literature offers a limited understanding of the experiences of STEM academics and students whose identities are underrepresented within the LGBT+ umbrella and/ or those who experience multiple and compounded systems of oppression, e.g., queer[3] people of color and/or queer people who are disabled. This reflects limitations in queer research in higher education, which has traditionally centered on White, cisgender, middle-class, and able-bodied individuals (Lange et al., 2019; Renn, 2010).

LGBT+ research in higher education has started to adopt more intersectional approaches. In STEM, Leyva et al. (2022) explored the experiences of Black queer students and highlight the ways whiteness and cisheteropatriarchy in STEM shape experiences of erasure, invisibility, and exclusion. Climate surveys promoted by STEM professional organizations in the United States and the United Kingdom found that transgender and gender-nonconforming staff and students experienced more hostility and exclusionary behaviors, and they were more likely to consider leaving their workplace or learning environment (Atherton et al., 2016; Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry, 2019). Whereas Miller and Downey (2020) described the compounded effects of isolation, lack of accessibility, and lack of intersectionality on queer students with disabilities.

2.3 | Support for underrepresented and marginalized academics and doctoral students in STEM

Addressing inequities that affect women, LGBT+ individuals, and other historically excluded individuals and groups is imperative for higher education institutions and organizations committed to EDI principles. Both diversity, and the ways diversity is treated and represented by institutions and in the curriculum, contribute to shaping climates and perceptions of belonging of underrepresented and marginalized academics and students in STEM (Bilimoria & Stewart, 2009; Martin & Fisher-Ari, 2021; Winkle-Wagner & McCoy, 2018; Wright & Delgado, 2023). Prior studies

also argue that removing barriers to inclusion is essential for innovation, resilience, and economic growth (AlShebli et al., 2018; Hofstra et al., 2020; Ruiz-Jiménez et al., 2016).

To improve EDI in STEM, there has been no shortage of initiatives both in the United Kingdom and other countries. Yet, as highlighted by Tsui (2007), empirical evidence that goes beyond descriptions of programmes remains limited. The lack of intersectional approaches further diminishes the transformative potential of initiatives to support excluded individuals and groups (Armstrong & Jovanovic, 2015). Additionally, compared to undergraduate students or academic staff members, there has been less attention paid in the existing literature to more robust support mechanisms for doctoral students, postdocs, and early career academics (McAlister et al., 2022; Yadav et al., 2020). This is a significant gap given that these represent particular points of attrition in academic careers, especially for women (Goulden et al., 2011; Martinez et al., 2007)—and most likely for other underrepresented individuals although research is still limited. Many PhD students work within their institutions and many are also future or aspiring academics—thus people who contribute, or will contribute, to shaping teaching, research, and working cultures (C. C. Hughes et al., 2017). It is worth noting that technicians and other non-academic staff are also overlooked in the literature—thus perpetuating a narrow view of what constitutes STEM in the context of higher education.

Prior research highlighted the benefits of welcoming campus climates, supportive advisor/supervisor relationships, positive interactions with peers and faculty members, and institutional recognition as significant supporting factors for doctoral students in STEM (Casad et al., 2021; McAlister et al., 2022). Supportive individuals in leadership positions and role models have been identified as beneficial to underrepresented and marginalized academics (Drury et al., 2011; Lee, 2022). In addition, mentoring, affinity networks, and networking opportunities—which are often not readily accessible to excluded individuals in STEM—have been discussed as key to retention rates and success for both students and academics (Griffin et al., 2010; King & Upadhyay, 2022; Xu & Martin, 2011).

By considering support available to women and LGBT+ PhD students and academics as experienced by our participants, in this study we reassess factors identified by prior literature systematically, intersectionally, and with an anti-deficit outlook. A critical issue with several support mechanisms outlined in the literature and implemented in higher education institutions is that, by following pipeline models and/or approaches inspired by deficit discourses, they seem rather geared towards "fixing" individuals and increasing diversity rather than addressing structural barriers to inclusion. This overlooks the important organizational issues implicated in inequities in STEM (Fox, 2008; Hart, 2016). Moreover, too often the burden of understanding, addressing, and eliminating inequities falls on already oppressed individuals—who then suffer the personal and professional consequences of cultural taxation, advising, service, emotional labor, and other forms of "invisible work" (Porter et al., 2018; Social Sciences Feminist Network Research Interest Group, 2017). These shortcomings might be explained, in part, by the complexities and difficulties of institutional transformation (Fox, 2008). Yet, both research and practice suggest that authentic and intersectional inclusion needs adequate and long-term commitment and resourcing from institutions, including addressing entrenched organizational mechanisms and STEM cultures that (re)produce oppression and exclusion.

3 | THEORETICAL FRAMEWORK

By centering on the experiences of women and LGBTQ+ PhD students and academics in STEM, the study aims to illuminate the systemic challenges and support they have encountered in their educational and professional trajectories. Therefore, we employ intersectionality to frame this study (Collins, 2015; Crenshaw, 1989) as this critical theory provides an analytic lens to examine the experiences of individuals and groups within the interlocking systems of oppression that determine both social inequalities and privilege. Due to the scope of this study and the characteristics of our sample, we particularly focus on gender and sexuality, as well as on the ways they intersect with each other and with other social categories of intersectionality.

3.1 | Intersectionality origins and rationale

Rooted in the work of Black feminism, the U.S. legal system, and anti-racist scholarship, intersectionality theory focuses on interlocking systems of oppression to address injustice and discrimination (Collins, 2015; Crenshaw, 1989). Intersectional approaches center the historically erased voices of individuals and groups that experience compounded marginalization; therefore, engaging with Intersectionality enables studies to capture the complexities of social life at the intersection of multiple oppression and privilege (Choo & Ferree, 2010; Moradi & Grzanka, 2017). As both critical inquiry and praxis, intersectionality theory is underpinned by an "ethos of social justice" (Collins, 2015) and is committed to transformative action that resists and challenges discrimination.

Since Malcom et al. (1976) introduced the concept of the double bind in science—a concept related to intersectionality but which specifically refers to the unique marginalization of women of color in STEM due to their overlapping experiences of sexism and racism (Ong, 2023)—intersectionality theory has been employed in science education to address the experiences of students and academics from multiple marginalized groups. Extant literature has explored, for example, the implications of gender, race, and science for women of color who are students or academics in a variety of STEM disciplines (Castro & Collins, 2021; Harper & Kayumova, 2023; Ireland et al., 2018; Prescod-Weinstein, 2020). By progressively widening its applicability, scholars have used intersectionality theory to better understand the experiences of LGBT+ students and academics in STEM at the crossroad of sexuality, gender, race/ethnicity, disability, and other social categories (Leyva et al., 2022; Miller & Downey, 2020; Reggiani et al., 2024). As demonstrated by this multifaceted body of work, employing an intersectionality lens is key to addressing not only the experiences of marginalized and underrepresented individuals, but also the structures, ideologies and power relations that underpin hostile STEM environments.

3.2 | Intersectionality as analytical framework

In operationalising intersectionality as an analytical framework, we aim to illuminate the "concrete social relations" (Anthias, 2013) that both organize and operate through social categories and groups. Among the categories of difference that are the subject of analysis of intersectionality, we particularly focus on gender and sexuality in ways that link individual experiences with the STEM ideologies, practices, and institutional arrangements that historically determine inequitable opportunities for women, LGBT+ people, and other marginalized groups. We engage with intersectionality theory in non-additive, situated, and reflexive ways. When exploring academic cultures and individuals' experiences, our aim is to be counter-hegemonic and to contend with ideologies of neutrality, objectivity, and meritocracy that justify and (re)produce oppression and privilege in higher education and STEM (Bhopal, 2018; Seron et al., 2018).

With regards to our first research question, to illuminate systemic challenges we focus with intersectional lenses on some of the key social processes through which social categories and interlocking systems of oppression are (re)produced and justified, namely disadvantage, stereotype, prejudice, and discrimination (Fiske, 1998). In the context of the study, these processes constitute systemic challenges insofar as they are (and are interpreted as) manifestations of overlapping institutional cultures and practices that determine inequities across individuals and groups in STEM fields.

When addressing our second research question, we embrace an anti-deficit outlook, and a "dialogical" and "transgressive" conceptualization of inclusivity (DeLuca, 2013). While interventions to promote full inclusion must incorporate processed-centered and systemic models to intersectionality that address the interlocking configurations of institutional oppression (Choo & Ferree, 2010), support mechanisms are insufficiently theorized and understood in extant literature. To contribute to filling this gap, in this study we propose individual support, compliance, good practice, and inclusion as systemic and process-centered categories to critically engage with the experiences or workplace features that our participants found supportive throughout their STEM journeys.

Additional information on the ways we operationalize intersectionality in the analysis of data are provided in the methodology section. Examples and definitions of the systemic challenges and systemic support we employ in the study are provided in Tables 2 and 3, respectively, along with references to extant literature.

When discussing identities, particularly gender and sexual identities, it is important to note that we do so from the post-structural perspective offered by queer theory; therefore, we understand identities as multiple, fractured, situated in time and space, unstable, and historically constructed (Butler, 1990; Sedgwick, 1990). Intersectionality theory and queer theory benefit from each other (Fotopoulou, 2013). On the one hand, queer theory challenges normative and essentialist assumptions, and problematises the ways identities are constructed and performed. As argued by Davis (2008), on the other hand, intersectionality theory helps connect methodologies inspired by anti-essential and non-normative conceptualizations of identity with critical approaches that manifest the material consequences of oppression based on social categories like gender, sexuality, or race/ethnicity.

4 | METHODOLOGY

4.1 | Study context, approach, and researchers' positionality

The study is set in the context of a University located in a major urban center in the north of the United Kingdom. Similar to the rest of the higher education sector in the United Kingdom, whilst there is better diversity among PhD cohorts and early-career researchers in STEM, individuals from historically excluded groups are underrepresented in senior academic roles and leadership positions. The student and staff populations are predominantly White. Data regarding sexuality of staff and students are incomplete—which makes it harder to address inequities with a fully intersectional approach.

The research questions cover both challenges and support as perceived and/or reported by participants—which provides more nuanced insight into education and academic cultures that shape STEM environments where, together with exclusionary behaviors, participants find agency, resist oppression, negotiate inclusion, and navigate identities on their own terms. This approach allows for a more unique and impactful contribution that goes beyond the silo approaches in extant research.

By undertaking this qualitative study, we do not aim for generalization of results. Rather, our methods seek to capture the breadth and interpret the experiences of women and LGBT+ academics and PhD students in STEM. Results from the study have been used to provide recommendations and design initiatives to improve EDI both at the institution where the study took place and in the sector.

The authors identify as LGBT+ and/or women in higher education with expertize in both social sciences and STEM. Our lived experiences of oppression and privilege inform the ways we relate to and interpret participants' accounts. We employed (self)reflexivity to address our positioning towards the study and, perhaps more importantly, to interrogate our research practices—particularly the ways we engaged with participants and co-constructed counter-hegemonic knowledge (Hesse-Bibber & Piatelli, 2012; McDonald, 2013).

4.2 | Data collection and participants

Data for the study were collected between November 2019 and March 2020 by conducting semi-structured interviews and small focus groups with a total of 82 academics and PhD students who are women and/or LGBT+ in STEM (5 participants were doing STEM research but not based in a STEM faculty/department at the time of the study). The choice between focus groups and interviews was given to include participants who wished to join the study, but were not comfortable with focus group settings. In total, 13 participants opted for an interview. Exploring the experiences of both academics and PhD students helps addressing gaps in extant research and illuminates

STEM trajectories in higher education more comprehensively. Participants were recruited online, on campus, with the help of existing networks, and snowball sampling. Our recruitment strategy aimed at collecting a range of experiences that allowed for comparison across gender, sexuality, and other intersectional categories.

Interviews and focus groups lasted for approximately 1 h and were conducted by the first and second author. In developing the interview protocol, we placed equal emphasis on questions to elicit information on the participants' perceptions of systemic challenges; supportive experiences and workplace features; and how participants navigated their careers. Questions included, for example: What are your perceptions of the working/research culture for women (or LGBT+ people) in STEM at the university?; How does that compare to your previous experiences either working at or studying in other institutions? What challenges, if any, did you face along your journey into your career in STEM?; Who or what supported you? While all our participants were from the same university at the time of the study, during interviews they shared their overall experiences of studying and working in STEM. Therefore, findings broadly highlight the experiences of women and LGBT+ academics and PhD students at the University, but also their experiences, for example, at national and international conferences and in other universities where they previously studied or were employed both within and outside of the United Kingdom. A full comparison, however, between different contexts is beyond the scope of this study.

Apart from ensuring variability in our sample, intersectionality was incorporated and operationalised into the research design by formulating in-dept, open-ended questions that featured both direct and indirect prompts for participants to share how they identified, articulate their lived experiences, or reflect on how different factors and interlocking systems of oppression might contribute to inequities (Windsong, 2018; Zhang et al., 2021). Participants were invited to discuss, for example, what gender identity and sexual identity meant to them, or what other social identities might contribute to shaping their professional trajectories. These questions, which are framed by both and intersectional and post-structural perspectives, allowed participants to elaborate on their identities and lived experiences on their terms and explore how gender identity and sexuality might intertwine with other systems of oppression and/or privilege.

Participants were also given the option to engage with reflective writing in case they wanted to follow-up, add, or clarify ideas and responses given during focus groups or interviews. No further prompt was given, so that participants could shape their reflection freely, and 7 academics and 5 PhD students voluntarily decided to take part in this additional data collection exercise.

Among the participants, 38 worked as academics and 44 studied and conducted research as PhD students. Seventy-one participants identified as women (including one trans woman), 10 as men, and one as non-binary/gender queer. Regarding their sexual identity, 56 identified as heterosexual/straight, 24 as LGBT+, and two preferred not to say or did not respond. Amongst the LGBT+ participants, four identified as a gay woman/lesbian, nine as a gay man, six as bisexual, and five preferred to self-describe. Table 1 shows a comprehensive overview of participants' characteristics.

4.3 | Analysis

Interviews were transcribed, checked for accuracy, fully anonymised, and then thematically analyzed. Pseudonyms for participants have been assigned by the authors and used when appropriate. Our approach to thematic analysis was both recursive and reflexive, and it entailed in-depth immersion in the data (Braun & Clarke, 2006). We also incorporated elements of template analysis (Brooks et al., 2015), a flexible approach to thematic analysis that features hierarchical relationships between codes and facilitates collaborative coding. As with most qualitative research, generalization is not the goal of this study. However, our participant group ($n = 82$) roughly corresponds to the 10%–15% of the known total population which satisfied criteria for inclusion in the study at the university where the project took place, hence, there is sufficient representation to ensure adequacy, depth, and validity of the dataset for the purposes of thematic analysis (Braun & Clarke, 2022).

TABLE 1 Participants' characteristics.

	n	%
Role		
Academic	38	46
PhD student	44	54
Career stage[a]		(of all academics)
Early-career	9	24
Mid-career	17	45
Senior-career	12	31
Prefer not to say/no response	0	0
Age		
20–29	33	40
30–39	25	31
40–49	10	12
50–59	8	10
Prefer not to say/no response	6	7
Gender identity		
Woman	71[b]	87
Man	10	12
Non-binary/genderqueer	1	1
Prefer not to say/no response	0	0
Sexuality		
Bisexual	6	7
Gay woman/lesbian	4	5
Gay man	9	11
Heterosexual/straight	56	68
Prefer to self-describe[c]	5	6
Prefer not to say/no response	2	2
Race/ethnicity[d]		
Asian, Asian British or other Asian background	6	7
Black, Black British or other Black background	2	2
Mixed background	3	4
White British or other White background	71	87
Prefer not to say/no response	0	0
Disability[e]		
Disabled	21	26

TABLE 1 (Continued)

	n	%
No known disability	55	67
Prefer not to say/no response	6	7
Social class		
Working-class	22	27
Middle-class	50	61
Prefer not to say/no response	10	12

[a]Information about career stage was collected only from academics.

[b]Including one trans woman.

[c]This includes: asexual, bisexual/gay man, hetero/bisexual, queer, questioning/straight-ish.

[d]Categories (e.g., White British or other White backgtound) are derived and adapted from the British census.

[e]Participants could report having one or more disabilities. It is worth noting that the percentage of participants identifying as disabled is higher than that reported by the institution or in the sector.

Consistent with our reflexive approach to thematic analysis and intersectionality theory, the research team aimed for trustworthiness at each step of the thematic analysis by following best practice as outlined by Nowell et al. (2017). After becoming familiar with the whole dataset and reviewing notes taken during data collection, the first and second author developed an initial set of a priori and theory-driven codes together. Then, they independently coded the same sample of interviews to compare coding choices, review labels and definitions for each code, address discrepancies, and add additional codes. They began to identify themes, and the process was repeated until consensus was reached and no new themes were generated. To increase the trustworthiness of the analysis, each version of the codebook was shared with and vetted by the rest of the research team and the project advisory board, which included academics both in STEM and social sciences.

The research team critically engaged with methods of intersectional research. As illustrated by Bowleg (2008), there are inherent challenges in the analysis of intersectionality data—particularly given that, more often than not, participants do not explicitly articulate intersectionality but rather offer implicit narratives about their experiences in ways that are "seemingly un-measurable and un-analyzable" (p. 322). For this very reason, intersectional theory challenges positivist and reductionist paradigms and points towards critical, interpretative, and destabilizing interrogations of multiplicity (Grzanka, 2018). Building on Bowleg's insight, our analysis went through several steps to examine and interpret intersectional data. First, we made sense of personal narratives via overlapping codes (e.g., sexism, homophobia, racism, etc.) to analyze intersecting oppression and privilege, as well as to identify intersectional constructions and outcomes. Then, while refining our codes iteratively and identifying themes, we made sense of participants' individual accounts within the systems of structural inequities existing against women and LGBT+ people in STEM. It is the responsibility of researchers to show the intersections (Bowleg, 2008), and it is in this spirit that we conducted the analysis and present the findings in this article.

As outlined in the theoretical framework, in coding self-reported perceptions and incidents of systemic challenges we build on and operationalize both intersectionality theory and concepts developed by previous studies to understand mechanisms through which oppression, privilege, and social categories are (re)produced (Caprariello et al., 2009; Fiske, 1998; Kanter, 1977; Spencer et al., 2016; Stangor, 2016; Steele, 1997). In particular, we employ *disadvantage*, *stereotype*, *prejudice*, and *discrimination, bullying, and harassment* as primary (i.e., broad) codes to organize and label the challenging experiences reported by our participants. Albeit support is undertheorized when compared to challenges, we similarly refer to extant research (Fox, 2008; Hart, 2016; Rowe, 2008; Tsui, 2007; Walton et al., 2013) to define *individual support, compliance, practice*, and *inclusion* as primary codes to label

experiences of support. In addition, we identify a number of emergent subcodes that represent repeated patterns within the data and nuanced the ways primary codes manifest.

A sample of codes, along with brief definitions of systemic challenges and systemic support, references, and exemplary quotes, can be found in Tables 2 and 3. It is worth noting that, when developing the themes presented in this article, our analysis is not restricted nor informed exclusively by this sample of codes. Also, whilst in the data there are multiple findings, for the purpose of this article we focus on overarching themes that better encompass the scope of the primary codes employed to classify systemic challenges and support.

5 | FINDINGS

5.1 | RQ1: What are the systemic challenges women and LGBT+ academics and PhD students in STEM face?

5.1.1 | Overview

After coding, in addressing the first research question we found that instances of systemic challenges were roughly four times more common than those of support. This indicates that, overall, the experiences of our participants were characterized by inequities rather than support from colleagues, peers, and institutions. Among the four primary codes *disadvantage* was the more prevalent, followed by *prejudice*, and *discrimination, bullying, and harassment*. *Stereotype* was often discussed in relation to, or compounded with, prejudice; possibly due to the difficulty in disentangling these two mechanisms solely on the basis of participants' perceptions.

Three themes were identified to illustrate with an intersectional lens the overlapping and compounded challenges reported by the academics and PhD students we interviewed: *Disadvantage: Navigating being underrepresented and marginalized; Stereotype and prejudice: "I'm not a scholar in his mind"; Discrimination, bullying, and harassment: personal and career consequences*. The first theme highlights less immediately tangible challenges—i.e., challenges that are rooted in practices and policies that foreground disparities for participants by granting, for example, inequitable access to opportunities and support. The second theme captures interactions through which women and LGBT+ PhD students and academics face exclusion more explicitly via the normative assumptions that exist in STEM environments. The third theme focuses on more distressing experiences of hostility against participants.

5.1.2 | Disadvantage: Navigating being underrepresented and marginalized

When participants described institutions where they studied or worked, lack of diversity featured prominently. This is because, despite initiatives and societal changes, the number of women, people of color, and other historically excluded individuals in STEM remain low in the United Kingdom, particularly among senior academics and leaders (Advance, 2022). As a result, several participants reported that they were "the only woman" in their group or "one of the only few" in their department, and the majority of LGBT+ academics and PhD students shared that they did not know any other LGBT+ individual.

Lack of diversity affected participants' sense of belonging, particularly those facing intersectional inequities. For Sai, a gay PhD student from Southern Asia, being the only LGBT+ person of color in his department felt isolating, as if he could not "talk to anyone about anything" nor bring his whole authentic self to his studies—a discomfort which was compounded by the lack of education and awareness around issues of intersectional oppression (e.g., the combined effects of homophobia and racism) amongst his peers. In the case of George, a White, British, gay, early-career academic in Engineering, a similar feeling of uneasiness was elicited by observing gender unbalance in a department where he worked before his current post:

TABLE 2 Systemic challenges: Sample of primary codes, subcodes, and exemplary quotes.

Primary codes	Subcodes	Example
Disadvantage Policies and practices that create education and academic cultures in which particular groups benefit from or are hindered by differing opportunities and/or expectations	**Working culture** (e.g., differing expectations or differing opportunities)	*It was much easier for new guys - even though I had been here for a few months - to integrate. … They were being offered much - like oh do you want to go for a beer? I was a woman, they wouldn't even dare [to invite me].*
	Lack of support	*Coming back [from maternity leave] was really difficult because [instead of support] I got given even more work than when I had left. I didn't understand why this was happening.*
	Lack of diversity, visibility, and representation	*Most of the staff were old white men.*
Stereotype Oversimplified generalizations about groups of people (Stangor, 2016)	**Stereotype threat** (Spencer et al., 2016; Steele, 1997)	*You go to a conference and it's all middle-aged men. … You can [find yourself] thinking: God, I'm the only woman here, they're all going to think I'm a stupid girl.*
	Tokenism (Kanter, 1977; Laws, 1975)	*They rang me up to ask me: Do you want to be on the panel? Because we need a woman. It's nice to know that you want me for my talents.*
Prejudice "Any attitude, emotion, or behaviour towards members of a group, which directly or indirectly implies some negativity or antipathy towards that group" (Brown, 2011, p. 7)	**Sexism**	*I've had male students stick up their hands in a lab for help. I go towards them. They put down their hand and wait for the male colleague.*
	Homophobia	*When [a fellow student] found out I was gay, he was like: Why are you gay? You can get a woman.*
	Racism	*I've experienced some racism … I have had comments about my race and where my parents come from.*
Discrimination, bullying, and harassment Unjust, abusive, or harassing treatment someone receives. It may often, but not solely, be related to someone's identities or characteristics.	**Bullying** (Einarsen et al., 2003)	*[The person bullying me] would use the fact that I did have caring responsibilities and responsibilities outside of work to manipulate me in front of others, to undermine me, or to make me feel disadvantaged in group scenarios.*
	Gender-based violence (A. Collins, 2014; Kirkner et al., 2022)	*There were times when it was very apparent … that they were – I don't know how you want to say it – sexualising me, ogling me, whatever terminology you want to use. I've had male students do that with me.*
	Discriminatory practice (that might be direct or indirect)	*"I've had work taken off me and given to a guy when … I needed some time out to deal with [my child]. … That happened another time further down the track… I'd found this new opportunity with an industry partner and got it started and then it … got taken out of my hands and given to this other guy."*

TABLE 3 Supportive policies and practices: Sample of primary codes, subcodes, and exemplary quotes.

Primary codes	Subcodes	Example
Individual support Subtle and often unconscious behavior enacted by supervisors, colleagues, and peers that create support for individuals.	**Micro-affirmations** as defined by Rowe (2008)	*[My supervisor] was really friendly. Really open. I always felt … at ease, and able to be open about how I was feeling about different things.*
Compliance Forms of support that are basic and/or compulsory. For example, policies and actions in fulfillment of requirements set out by legislation or sector-wide agreements.	**Celebrating diversity**	*We've got the high-profile, centrally-organised international Black History Month…. These [initiatives] are good and worthwhile for seeing different perspectives.*
	Gender-balance	*I am well aware [that] in the department … we have a very good gender balance. We have a lot of [academics who are women] compared to other places I go to.*
Practice A form of support that, albeit not fully embedded, is systemic enough to produce a more equitable, diverse, and inclusive environment in certain departments/laboratories/areas within HEIs.	**Championing**	*The group leader is really good. He'll build links…. He'll push us into applying for grants. And he'll help us, he'll introduce us to people.*
	Mentoring	*People who have been my line managers and mentors have been really good at presenting opportunities and maybe encouraging me to go for those opportunities. But that's not institutional.*
	Pockets of good practice	*My supervisor is pretty good, he's very flexible, he knows my circumstances, he allows flexibility. … The [wider working] culture is definitely not set up to allow it.*
Inclusion Evidence of fully embedded, consistent equity where good policy and practice are the standard and systemic support is in place.		*[At one university, during] one of the first meetings with your supervisor there's a form to fill in. It's got a load of questions on it: Is there a disability or long-term health condition that may affect your ability to study? What is it? How can we help? Have you told disability and wellbeing? Also, what are your pronouns?*

We only had two academics [who were women]. If you weren't just a cis[gender], straight man, you kind of felt a bit: "Oh ok, maybe I shouldn't do anything or say anything because you're not even accepting of women by not employing any, why would you be accepting of anyone gay?".

Being part of one or more excluded groups in STEM had further implications. Women noticed that not being "one of the guys" limited their access to opportunities, as illustrated by two mid-career and senior-career academics Alice and Fiona:

Alice: [I have noticed] senior figures socialising only with a couple of the guys in the group and therefore bonding with them and supporting them more. … They're more comfortable with them maybe. … To the detriment of others.

Fiona: I feel similarly. … When you don't feel included in those [informal conversations], it takes you longer to see what the strategic moves are next. … It takes you longer to see where the opportunities are.

Senior male academics creating stronger professional connections with younger men if compared to women might seem, at first, inconsequential—one might think they simply feel more "comfortable" with people who look like them. However, through further discussion with Fiona and Alice, it became clear that this lack of opportunities was a systemic disadvantage rather than just a trivial circumstance. Not only had they observed this pattern in all the universities in which they had worked or studied, but they realized how not being included in informal networks made navigating early stages of STEM careers harder for people who have less "in common" with those who occupy powerful positions in STEM fields in the United Kingdom—usually White, straight, cisgender, middle-class men.

Possibly as a consequence of having more limited access to mentoring and networking—which are both key in career progression, particularly at early stages (King & Upadhyay, 2022; Xu & Martin, 2011)—participants reported that the women they encountered in their fields were often employed in teaching roles rather than research-focused academic positions. Women academics also shared that, similarly to other marginalized individuals in their institutions, they were more likely to be involved or tasked with pastoral care, outreach initiatives, and committee work than their men colleagues. While they recognized the importance of these activities, participants were frustrated by realizing that this additional work was less valued than publications, citations, research funding, and high-profile collaborations—i.e., the normative, and often biased, metrics of what constitutes academic success in STEM (Davies et al., 2021; De Los Reyes & Uddin, 2021).

The difficulties of navigating systemic disadvantage were amplified by a lack of support. This included insufficient supervision and mentoring, which are both recognized by prior research as significant sources of support for academics and PhD students (Griffin et al., 2010; McAlister et al., 2022). Experiences of maternity leave represented another particular pinch point along career trajectories. Not only were policies and good practice applied inconsistently across institutions and departments, but discussions also indicated that the teaching and administrative workload of those on maternity leave were commonly distributed amongst other academic staff, rather than allocated to specific maternity cover. This led to resentment amongst colleagues, and feelings of guilt in the women taking leave. For example, Lucy, an academic in Science, decided to hide her latest pregnancy and keep working after giving birth to all of her children:

> I just did it, because there's a pressure that you've got to perform. … You cannot put a break in an academic career. This is what I recognised … Returning after two months with my [first child] because obviously, you don't get any maternity [leave] during PhD. You've got to return.

Although she was eventually able to find better support as she became a more senior academic—Lucy's perception of external pressure to perform was amplified by her working-class background, which overlapped with sexism to determine lack of recognition in the early stages of her career and feelings of not fitting into the idea of who is traditionally deemed to be a scientist.

The experiences of Lucy and other participants align with existing data, highlighting the lack of support that is tailored to address interlocking systems of oppression. PhD students and early-career academics from working-class backgrounds expressed concerns about the financial uncertainty caused by short-term contracts—which impact women and other marginalized and underrepresented groups disproportionately (Ivancheva et al., 2019). Whereas disabled participants described discrepancies when it came to securing support. If some were able to get reasonable adjustments, others had to "fight for everything" and confront ableist expectations—which led them to seriously consider whether to leave academia and science altogether.

5.1.3 | Stereotype and prejudice: "I'm not a scholar in his mind"

Participants seemed to agree that stereotypes around gender roles and identities were still widespread and contributed to shaping attitudes, judgments, behaviors, and professional cultures in STEM. These views often emerged while interacting with colleagues and peers. As noted by Camila, an early-career academic identifying as a

gay woman/lesbian, women were cast as the "weak gender" or "expected to have a motherly persona". Others had to contend with the normative idea that all women must want to have children, or that having career ambitions is unwomanly, particularly for those with a family and children.

The compounded effect of the lack of diversity and persistent stereotypes made participants, women in particular, prone to issues of stereotype threat—i.e., hyperaware and fearful about how their appearance, behaviors, and performance might or might not fulfill those very stereotypes (Spencer et al., 2016; Steele, 1997). Hannah, a White early-career academic in Engineering, shared:

> I sometimes feel that in my job I need to be extra "absolutely fine" because if I am struggling it's because I am female - I hate that these narratives are even in my head, particularly when I am in a department with high female representation.

If stereotype threat among women in STEM is well discussed in the literature, especially in settings where gender unbalance is particularly stark, Hanna's experience highlights that working in departments that were more inclusive did not shield participants from this predicament.

Apart from the strength of stereotypes in STEM education around the traits a scientist should possess, this finding might be foregrounded in systemic disadvantage that shapes women's careers towards teaching or coordinating rather than research-intensive academic roles. Another possible explanation for high awareness of negative gender stereotypes is that gender represented the only or the most salient social identity through which many of the women who participated in the study experienced oppression.

LGBT+ and/or disabled PhD students and academics also reported issues of stereotype threat as they feared that, upon disclosing their identities, they might be negatively judged on "all the stereotypes that surround a certain label" or become "the figurehead" for ableist assumptions. Participants expressed particular frustration when recalling times when they felt their contribution was perceived as tokenistic, for example when invited to sit on panels and committees. Being treated as a token had implications for efficacy, self-esteem, and belonging, given that, for example, it left individuals wondering whether they got an opportunity or a role just because of who they were rather than because of their talent.

Sexism was the most common form of prejudice reported by participants. Bias was often conveyed through microaggressions that expressed denigrating, negative, or normative assumptions. Women felt they were not taken seriously during conversations. A PhD student was routinely told that she did not "look like an engineer" at conferences, whereas another was subjected to "period jokes" every time she looked slightly upset or annoyed. Violet, a PhD student, explained:

> Sometimes you can be looked at as a silly little girl. I've published seven papers now [with] my research group.... There have been insinuations [from other students] that I've tagged on to a man because he's the lead author.

Since Violet managed to be successful despite systemic disadvantage against women in STEM, suggesting that her success must have been thanks to a man was meant to overtly diminish and invalidate her achievements. It is worth noting that, although our study does not specifically focus on earlier stages of STEM education, participants often recalled being the target of sexist microaggressions during their undergraduate studies and/or in secondary/high school.

In addition to sexism, heteronormativity contributed to shaping the experience of students and academics who identified as LGBT+. Heterosexuality was routinely assumed, creating additional pressure on participants who had to ponder whether to disclose their sexuality or whether it was safe to do so. Lack of visibility, particularly of LGBT+ role models in senior or leadership positions, created further discomfort (Lee, 2022; Reggiani et al., 2024). That was compounded by what other studies have identified as masculine gender norms/expressions, hypermasculinity, or "bro culture" in STEM (Miller & Downey, 2020; Yoder & Mattheis, 2016). As Diego, a White, gay, mid-career academic in Engineering, puts it:

> *It's a very male environment. ... I would say primitive. I didn't feel discrimination but you would see that people were surprised: "Oh! Gay? Oh my god"... [Then] we had the first gender-neutral toilet. One of the colleagues said: "No, no, you know there is no need because I identify as a woman."*

Diego articulated that occasional incidents of homophobia and transphobia were, most likely, accentuated by lack of awareness, education, and initiatives around LGBT+ issues and identities in his faculty—which is a broader issue of disadvantage discussed by several of our LGBT+ participants.

Women and other people of color experienced additional stereotypes and prejudices in predominantly White organizations, such as STEM departments in the United Kingdom. Simone, a Black woman who came to the United Kingdom to complete her PhD in Engineering, discussed how being a woman of color in STEM felt to her:

> *Before you talk you have to be sure that what you're saying is correct. ... It makes you [feel] on edge. ... Socialising is another issue because sometimes you just feel that people may judge you first on your colour and not necessarily by your intellect. It could really make you just withdraw.*

Suffering from interlocking systems of oppression painfully reminded participants of systemic inequities in their fields. Mei, an early-career academic from East Asia, shared that when talking informally to a speaker during an academic conference she was suddenly asked about her nationality. The speaker continued by concluding that she must have stayed in the United Kingdom thanks to marriage. Mei was left in shock after the conversation and the realization that, due to the overlapping effects of sexism and racism, "I'm not a scholar in his mind. I'm just somebody who's staying here because of finding an English man."

A number of participants seemed to cope with the insidious nature of stereotypes and prejudice by distancing themselves from their gender identity—a strategic pattern explored by Block et al. (2019). Many confessed that they did not want to be seen as a woman, reflect on their gender identities, or put any other identity label on themselves; they just wanted to be scientists. These aspirations are understandable, and the onus of fixing injustice should not fall solely or necessarily on oppressed individuals. However, as discussed elsewhere (Bhopal, 2018; De Los Reyes & Uddin, 2021), endorsing biased ideologies of meritocracy, concealing the work of power and privilege, and ignoring intersecting inequities only risks perpetuating oppression and the status quo.

5.1.4 | Discrimination, bullying, and harassment: Personal and career consequences

Data highlight the multiple ways through which even apparently benign interactions are underpinned by stereotypes and prejudice that reproduce normative values and unequal hierarchies of power. The analysis offered by Alice, a senior academic in Engineering, clearly illuminates this reality:

> *One thing that really annoys me is the prevalence of people going. ... How many kids have you got? Wow, I don't know how you do it. You're amazing. ... It sends all the wrong signals. ... It's like I'm an exception.... The expectations that sit behind all of that [is] that men are the ones with careers ... and women are managing to produce careers despite [the odds].*

Apart from disadvantage, stereotype, and prejudice, at times the "odds" stacked against women and LGBT+ individuals in STEM took the shape of behaviors and practices that were perceived as discriminatory by participants. Younger women and/or those identifying as early-career academics were routinely asked to take notes, arrange meetings, "make the tea," or assumed to be administrators rather than academics. Vee, a non-binary/genderqueer and disabled PhD student, was misgendered behind their back by a peer and reported that their gender was not always correctly registered in different university systems.

Around one-quarter of participants reported that they suffered and/or witnessed bullying in their careers. Bullying manifested with a range of behaviors and, according to participants, motivations included competitive academic cultures, frustration, and hostility motivated by sexism. While the outsets might not have been always obvious to participants, as defined by Einarsen et al. (2003) bullying was typically prolonged over time, it escalated and intensified in nature and involved an imbalance of power—which often reproduces similar inequities existing in STEM fields. Anja, a PhD student in Science, described:

> I was the only woman for quite some time. ... From the get-go, I didn't integrate into the group fully. That was apparent in my first week. I got a red flag, and I got verbal abuse that nobody else got, and I got isolation, and I got full-on aggression then, and I got blamed and set up for something, and made to look stupid. ... The person that was my bully was [more senior than me] I found that really hard because I felt like no one else could see it. I felt like it was in my head, and no one else would validate it to me.

Anja's case illustrates the severe consequences that bullying can have on wellbeing and careers: not only was she distressed, but bullying also resulted in losing opportunities to network and conduct experiments. Additionally, Anja's story highlights the complex and insidious ways in which bullying manifests in STEM environments where disadvantage (e.g., being the only one), stereotype, and prejudice (e.g., not being taken seriously) are unchallenged and normative conceptions around science and scientists are (re)produced.

Some academics and PhD students disclosed episodes of sexual harassment and gender-based violence. Frequently, incidents involved derogatory, unwanted, and hostile comments that made participants feel "sexualised," "ogled" at, and "disgusted." At conferences, many recalled experiencing or witnessing men approaching women to ask for personal information, phone numbers, or social media accounts rather than having professional conversations. Others were stalked and groped. Fewer participants discussed sexual harassment and gender-based violence when compared to bullying. However, these incidents were sufficiently prevalent to be a systemic challenge. To the point that, according to a senior academic in Science: "[sexual harassment] is something that definitely every single woman in my department has suffered as far as I know. ... Most women that I've spoken to said that that exists."

In most cases, participants never formally reported cases of bullying and/or harassment. Their decision was often motivated by fear, minimization, or mistrust in institutional reporting mechanisms—which, as shown by the literature (Ahmed, 2021; Kirkner et al., 2022), often do not take complaints seriously and put victims of harassment through further and very distressing emotional labor and trauma without adequate support. At times, participants were actively discouraged from proceeding with a formal complaint and pressured to agree to settle things informally, usually by distancing themselves from harassing individuals or working groups. One participant, for example, reported that the informal solution to the complaint she had wanted to raise formally was to remove her from a research project, yet the more senior man who was bullying and harassing her was allowed to continue to build his career on that project. Apart from resulting in underreporting—with students and those in the life and physical sciences less likely to report, according to Aguilar and Baek (2020)—this approach often puts victims of harassment at a further disadvantage with disruptive effects on their research, collaborations, and careers.

5.2 | RQ2—What are the experiences or workplace features that are perceived by participants as supporting their STEM careers?

5.2.1 | Overview

If compared to systemic challenges, when addressing the second research question we found that instances of support were more evenly distributed between three of the four primary codes we employed (*individual support, compliance, practice;* see Table 3). Notably, within data there is almost no example that could be coded as fully

embedded inclusion—a finding which is perhaps not surprising but no less concerning when considering decades of research and interventions to improve equity, diversity and inclusion in STEM.

We identified three themes to articulate the experiences and features that our participants found supportive in their learning and working environments: "*Individual support: benefits and limitations; Compliance: tokenistic inclusion of marginalised individuals and unequal burdens of diversity work; Practice: differences across departments and suggestions for inclusion.*" The first theme focuses on examples of support that is "invisible" and often unrewarded by institutions, but which still has a positive impact on individuals. The second theme highlights how tokenistic compliance to EDI legislation and best practice, which is often achieved thanks to the efforts of already marginalized individuals, is insufficient to remedy inequities when it is not embedded into institutional practices, unresourced, unrewarded, and does not recognize intersectionality. The third theme illustrates that, while there are pockets of good practice in STEM environments which benefit some of the participants, these are not sufficiently shared across departments and more is needed to bring forward authentic inclusion.

5.2.2 | Individual support: Benefits and limitations

The examples of support discussed by participants often highlighted micro-support, or support provided by specific individuals in ways that were not expected of them nor reflective of embedded inclusive practices within the culture of their department. Individual support granted the flexibility to mitigate the obstacles that inevitably arise during doctoral studies and academic careers in STEM. Moreover, it allowed participants to understand and make the most of institutional policies and practices, or find ad hoc solutions. In recalling her experience in-between two periods of maternity leave, Erin, a mid-career academic in Engineering, said:

> I got pregnant again. The day I found out, my line manager saw me in the corridor and said: "What's wrong?" I started crying and she said: "Oh come into my office. What's wrong?" And I said: "I'm pregnant and I had just started getting my momentum". She said: "Okay, it's a good thing". I said: "What's going to happen? Who is going to come and teach my class?" She said: "Well don't worry about that. That's my worry". She just made me feel a bit better.

Having a supportive line manager reassured Erin at a crucial transition towards a mid-career position. However, this kind of support around maternity leave was by no means the norm. Significant inequities were reported, for example, by international PhD students and academics on precarious contracts.

Particular forms of individual support involved micro-affirmation. As defined by Rowe (2008), these were often "ephemeral and hard-to-see" and unconscious. Nevertheless, as argued by Walton et al. (2013), they could be extremely powerful to affirm other people's work and identities, as well as contributing to counteracting the effect of disadvantage and other systemic challenges. Matthew, a gay PhD student in Engineering from a working-class background, described the uplifting effect of the inclusive and gender-neutral language used by his perspective supervisors during a visit to the department:

> They didn't know [about my sexuality] ... They always just had that language where they made things seem normal and neutral and happy [e.g. saying partner instead of girlfriend]. ... It really made me feel comfortable, which in past experiences and other places in general, that's just not been the case.... I remember leaving and thinking, yeah, that would be a great place to work.

Erin's and Matthew's quotes exemplify both the strengths and limitations of individual support. Having supportive line managers, colleagues, and peers can make academics and PhD students feel valued and treated as equals. Nevertheless, positive effects fall short when they are not systematically embedded or equitably distributed

across organizations. To the point that, as a few participants suggested while recalling their career trajectories, they felt "lucky" to have found support that enabled them to progress and thrive. But what about those not "lucky" enough? In the absence of individual support—which relies on the labor of individuals rather than embedded inclusion at the organizational level—women and LGBT+ PhD students and academics, particularly those who face intersectional oppression, are at further disadvantage and risk additional repercussions on their careers and their wellbeing.

5.2.3 | Compliance: Tokenistic inclusion of marginalized individuals and unequal burdens of diversity work

Compliance with EDI legislation, best practices, and sector-wide voluntary agreements represent an increasingly important focus for higher education institutions in the United Kingdom. "Diversity work" has an ambiguous place in institutions (Ahmed, 2012), and is made visible by ad hoc initiatives, policies, and awards—which are often obtained via a wide range of university-wide and/or departmental committees and working groups. Data from our study suggest that compliance was often perceived by participants as insufficient, lacking intersectionality, and tokenistic—given that reality did not match up with published organizational commitments suggesting, for example, that diversity is valued. Moreover, there was no evidence that EDI-related policies and practices were consistently applied.

As a result, even observing basic gender balance—which is, if not a requirement, a longstanding promise made by organizations—was seen as extraordinary rather than the norm. Participants described feeling pleased and reassured to be interviewed for jobs by diverse and inclusive panels, or by the fact they "wouldn't be the first one" in departments or groups. Consistent with Yoder and Mattheis (2016), gender balance/higher number of women was rated favorably also by LGBT+ individuals as a sign of more inclusive STEM cultures.

Initiatives to celebrate diversity and raise visibility, such as displaying a rainbow flag during Pride month and campaigns to increase awareness during Black History Month or Transgender Day of Remembrance, had similar and contradictory effects on participants—as explored more in detail in Reggiani et al. (2024). On the one hand, they felt seen and represented by institutions or learned societies—which is something that is still rare in STEM fields despite increased efforts, particularly from community-based affinity groups and networks. On the other hand, these actions were often perceived as insufficient to address systemic inequalities given that they were not followed up by sustained and resourced projects. Moreover, initiatives to raise visibility for women and/or LGBT+ people in STEM were not unanimously supported by other colleagues and peers, as described by a few PhD students whose small-scale campaign to raise the profile of women in Science was met with backlash.

Participants noted that compliance was often achieved thanks to the unacknowledged contribution of minoritised and disadvantage individuals, who spent a considerable amount of time designing and supporting activities to remove barriers to inclusion. When discussing their experiences of committee work, Roisin and Amanda, two academics, said:

> Roisin: I am involved in [this charter mark framework] … I have seen benefits from it. At the same time, it is also an enormous amount of time.

> Amanda: I find [it] interesting that coming from a department that is very male-dominated, [in] the group that is pulling together [the same charter mark framework] there is probably two or three male members and the rest is female.

As explained by Roisin and Amanda this work is beneficial, and the impact is wider than that produced by individual support. However, it was hard to reconcile this benefit with the fact that women and other marginalized

people were disproportionally tasked with committee work in their departments—which were otherwise not particularly inclusive of people from different backgrounds.

The intellectual contribution and the emotional labor put into EDI work were usually not recognized in meaningful ways, such as through time accounted for within workload model allocations, sufficient funding for the EDI work, or promotion criteria. This put those who engaged in these activities at a further disadvantage if compared to colleagues who avoid EDI-related commitments—despite work towards inclusion being beneficial to education and working cultures, organizational reputation, and innovation.

5.2.4 | Practice: Differences across departments and suggestions for inclusion

When exploring support that goes beyond individual support and/or compliance, participants shared pockets of good practice rather than fully embedded inclusion. Examples usually included both formal and informal mechanisms to provide flexibility at the department-level, as both academics and PhD students recognized that normative academic practices in STEM were not always designed to balance work with caring responsibilities, accommodate reasonable adjustments, and take time off when needed. The emphasis on flexibility might also be explained by the fact that the interviews and focus groups took place before the Covid-19 pandemic, therefore before working from home and flexibility became more popular in the higher education sector.

Line managers, supervisors, and heads of departments were identified as powerful role models who could influence climate, set expectations for collegial and professional behaviors, and determine the level of support available to staff and students. Data also highlight that proactive and responsive individuals in leadership positions were key to the compliant application of institutional policies and practices. Not surprisingly, the amount of purposeful work put into shaping inclusive working cultures, or the lack thereof, created significant differences across departments and groups, as recognized by numerous participants when reflecting on their career trajectories or sharing experiences during focus groups.

Participants found examples of inclusive leadership and good practice in the work of colleagues and peers. Stacey, a PhD student in Science, described the positive impact that a code of conduct had on behaviors and work-life balance in her specific research group. Yet, other research groups in the same faculty did not have a practice of adopting codes of conduct by which research community members were expected to abide. Others discussed the benefits of working in teams where collegiality and championing were the norm, or how they initiated affinity networks and initiatives with the help of likeminded peers and colleagues when other forms of support were unavailable.

Similar to individual support, pockets of good practice were often exceptions rather than the norm across organizations. The discussion around research cultures between Grace and Natalie, two PhD students, well exemplifies these disparities:

> Grace: When we first started, we were given a welcome talk. ... [A senior leader in the department said]: You will be expected to be in out of hours for long hours. A PhD isn't nine until five. If you're not working in the evenings and at weekends you're going to fail. She literally said that. ... Also, there was nothing on mental health [in the talk].

> Natalie: That's really - that's the exact opposite of what we got told [in our department]. [The academic acting in the same leadership role] said: Take you holidays, you have 28 days. ... Some days you maybe will work long hours but then take time off. ... I assumed [that] everybody got the same speech.

As illustrated by Natalie's case, participants were often surprised when they realized that good practice was not standard across departments. This particularly disadvantaged PhD students and early-career academics by

comparison to more senior academics who had already navigated similar challenges across organizations during their careers.

When asked to suggest what more could be done to foster authentic inclusion, participants offered a range of ideas. Many recommended more training to raise awareness around intersecting issues of gender identities, sexuality, and race/ethnicity, particularly for those occupying senior leadership positions. LGBT+ academics and PhD students expressed the desire for more diversity, visibility, and authentic representation of queer identities. Whereas women focused on the necessity of eradicating stereotypes and sexism while ensuring better support to sustain careers for those on maternity leave and/or with caring responsibilities. In addition, participants agreed that pockets of good practice should be shared, resourced, and implemented across departments, faculties, and institutions to determine the systemic changes that are necessary to bring forward full inclusion. And that those working to create more welcoming learning and working environments should be better supported, recognized, and rewarded.

Both academics and PhD students wished that higher education institutions, funding bodies, and learned societies could implement these actions and, in general, do more to demonstrate an authentic commitment to EDI that goes beyond principles and occasional campaigns. Only then it would be possible to create educational and academic settings where, as described by participants, individuals "can be themselves", "people from different backgrounds [are brought] to the table", supported, and able to contribute. And where everybody is accountable for creating inclusive and welcoming STEM communities.

6 | DISCUSSION

6.1 | The compounded effects of inequities: The slippery slope to discrimination

In addressing the first research question, we found a complex tapestry of overlapping challenges that women and LGBT+ academics and PhD students have to navigate in STEM environments where they have been historically excluded. Participants' accounts illustrate that sexism, heteronormativity, and hegemonic masculinity are still pervasive in STEM higher education, and that oppression is both intersectional and systemic—which supports findings in extant STEM education literature (Blackburn, 2017; Miller & Downey, 2020; Yoder & Mattheis, 2016). When compared to non-STEM fields, these issues are compounded by a persistent lack of diversity in students and academics' populations (Advance, 2022). The work of addressing inequities is further complicated by lack of intersectional approaches and biased ideologies of science and meritocracy that, by dismissing social identities as seemingly irrelevant (Blair-Loy & Cech, 2022), conceal the ways power is organized and (re)produce oppression and privilege.

Participants observed inequities consistently throughout their STEM education and careers, but their accounts of challenges varied. This was, in part, motivated by their experiences of intersectional oppression and privilege. White women for whom gender identity was the most salient system of oppression focused primarily on challenges motivated by sexism and gender stereotypes, whereas women of color had to contend with the combined effects of sexism and racism—a double bind which, as discussed in extant literature (Castro & Collins, 2021; Ireland et al., 2018; Ong, 2023; Prescod-Weinstein, 2020), resulted in unique experiences of microaggressions, harassment, and othering. Echoing what is discussed by Leyva et al. (2022) in the context of an historically white institution in the United States, the experiences of LGBT+ participants of color were shaped in unique ways by intersecting homophobia and racism in STEM environments that, in the United Kingdom, are still predominantly white and heteronormative. Participants who identified as disabled, particularly LGBT+ PhD students and academics, had to navigate additional complexities around (in)visibility and whether disclosing one or more of their identities was safe in STEM fields characterized by systemic biases (Miller & Downey, 2020; Reggiani et al., 2024).

By employing a process-centered approach to exploring, with an intersectional lens, the mechanisms that (re) produce social categories and oppression (Anthias, 2013), findings from this study highlight that challenges were not only differently experienced by participants but also differently understood. Even though they experienced

feelings of isolation and discomfort, for example, PhD students and academics found it difficult to explicitly identify and label the ingrained disadvantages they encountered in their STEM journeys as examples of systemic oppression. In comparison, they were more readily aware of overt forms of stereotype, prejudice, discrimination, bullying, and harassment. This might be because these incidents are more frustrating and distressing, and are more obviously linked to biased ideologies and injustice.

By considering together two groups that are historically marginalized in STEM fields, our intersectional analysis reveals patterns in the ways intersecting systems of oppression (e.g., sexism, homophobia, racism, or classism) operate for women and/or LGBT+ people. Firstly through disadvantage, that makes it more difficult to achieve traditional and normative measures of academic success and thus positions excluded people as less competent, less accomplished, and less deserving to advance in their careers. Overlapping stereotypes and prejudice around groups and individuals, particularly on who or what characteristics an ideal scientist should possess (Hart, 2016; Parson et al., 2021; Prescod-Weinstein, 2020), normalize, reinforce, and justify inequities, epistemic injustice, and the status quo. As well as leading, in some cases, to overt issues of discrimination, bullying, and harassment—which, although understudied, appear to be pervasive (Aycock et al., 2019; National Academies of Sciences, Engineering, and Medicine, 2018).

Based on our findings, and in addition to the themes we identified to illustrate them, we designed a conceptual model (Figure 1) of systemic challenges and their consequences for women and LGBT+ academics and PhD students in STEM. In comparison to models developed or tested by prior studies (Bilimoria & Stewart, 2009; Casad et al., 2019; Patridge et al., 2014), ours focuses on systemic oppression rather than on individuals. This is coherent with our application of intersectionality theory and our anti-deficit approach. While identities, internal experiences, or particular interactions are key to individuals' trajectories, a holistic understanding of injustices and transformative interventions should focus on the institutional mechanisms that (re)produce inequities in STEM education and academic environments.

By employing the metaphor of a slippery slope to discrimination, we do not simply describe that women and LGBT+ PhD students and academics in STEM endure oppression because they do not fit or perform the normative definition of the ideal scientist—which is something documented by extant research, including our own (Bilimoria & Stewart, 2009; Blackburn, 2017; Cech & Waidzunas, 2021). Rather, we aim to highlight the dynamic, nuanced, and potentially escalating nature of systemic oppression. This is because we found that incidents that are often dismissed as minor or inconsequential (such as being asked to take notes or make the tea) are part of the same academic
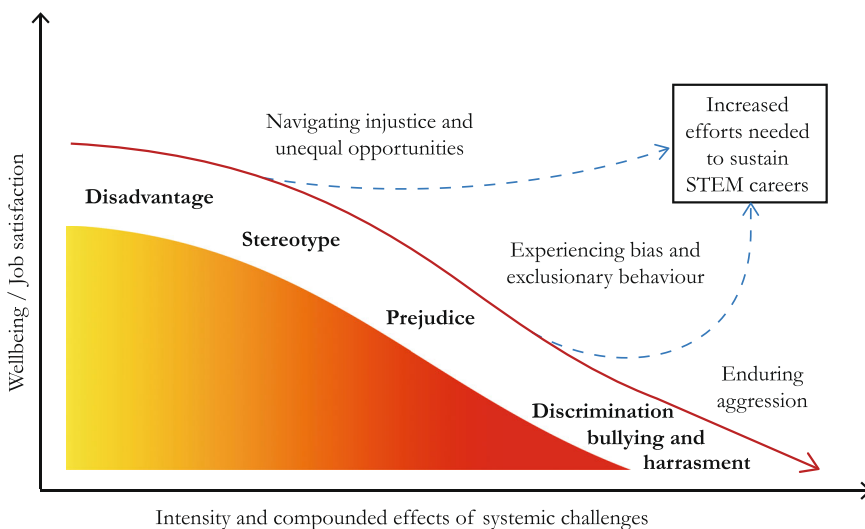
FIGURE 1 Conceptual model of systemic challenges and their consequences for women and LGBT+ academics and PhD students in STEM. STEM, Science, Technology, Engineering, and Mathematics.

climates in which outright exclusionary behaviors, discrimination, bullying, and harassment are enabled. Participants' accounts showed that more distressing experiences do not appear in isolation. On the contrary, they were usually foregrounded into multiple disadvantages and stereotypes that are pervasive in STEM academia (and, in part, in STEM education more broadly (Kim et al., 2018; Martin & Fisher-Ari, 2021) and that represent precursors of exclusion.

Challenges manifest in ways that are intersectional and contextual. Therefore, in proposing our model, we do not suggest that oppression will be experienced in the same way by everybody or that it manifests linearly. The order in which we include different challenges, instead, highlights the cumulative impact of systemic inequalities whenever individuals endure multiple and escalating challenges. Participants' narratives suggest that, as individuals slide down the slippery slope to discrimination, they are more at risk of being distressed and dissatisfied—which is consistent with findings from prior models and studies. The presence of systemic challenges also meant that extra effort and emotional labor were required to sustain STEM careers. This labor, which is often invisible, is detrimental to wellbeing and belonging and has an impact on the ability of participants to thrive in their fields (Cech & Waidzunas, 2011; Ong, 2023; Reggiani et al., 2024)—even for accomplished and successful individuals.

The application of our model should be guided by intersectional frameworks. Women and or LGBT+ individuals in STEM may face more, or less, steep slippery slopes according to the unique intersections between interlocking systems of oppression, privilege, and the support mechanisms to which individuals have access.

It is worth noting that our model does not measure the impact of different challenges on individuals—this could be tested by future studies. Whilst our findings are particularly focused on the effects of sexism and homophobia due to our sample of participants, our work offers a lens to understand inequities more broadly and develop intersectional solidarity in STEM education, particularly in higher education. Therefore, the model we propose has significant implications for higher education institutions, funding bodies, and other organizations whose aim is to create more diverse and inclusive STEM communities. We especially highlight institutional responsibility to address the detrimental impact of all disadvantages, stereotypes, prejudices, and discriminations on the careers of women, LGBT+, and other oppressed individuals.

6.2 | The path to more inclusive STEM communities

Regarding the second research question, participants highlighted experiences and workplace features that align with mechanisms recognized in the extant literature as supportive of underrepresented and marginalized individuals in STEM. This includes, for example, micro-affirmations, mentoring, affinity networks, and positive role models (Casad et al., 2021; King & Upadhyay, 2022; Lee, 2022; McAlister et al., 2022). Nevertheless, due to inconsistent application of good practice and inequitable opportunities to access support, women and LGBT+ academics and students in our study often felt that institutions addressed EDI in STEM in a tokenistic manner.

Based on our findings, and by considering both systemic challenges and support, we propose a conceptual model outlining transformative steps to realize more inclusive STEM communities. Figure 2 shows that, in our conceptualization, support mechanisms move from local and ad hoc support (e.g., individual support and compliance) to more systematic interventions (e.g., practice) to remove inequities that would eventually lead to full inclusion and more opportunities for individuals to thrive.

The path to inclusion that we present—which is complementary to the conceptual model of systemic challenges and their consequences, and contributes to filling gaps when it comes to theorizing support mechanisms—highlights that not all interventions are equally able to produce systemic change that is sustained over time. As illustrated by participants, individual support (e.g., micro-affirmations (Rowe, 2008) relies heavily on the good fortune of finding supportive peers, colleagues, or supervisors during career journeys. Whereas compliance, which is often managed by EDI teams and committees that are far from the daily reality of STEM departments and groups, falls short when well-intended policies are introduced without an intersectional framework, adequate resources, measures for success, or monitoring mechanisms (Armstrong & Jovanovic, 2015). This is often misused and mistaken for institutional
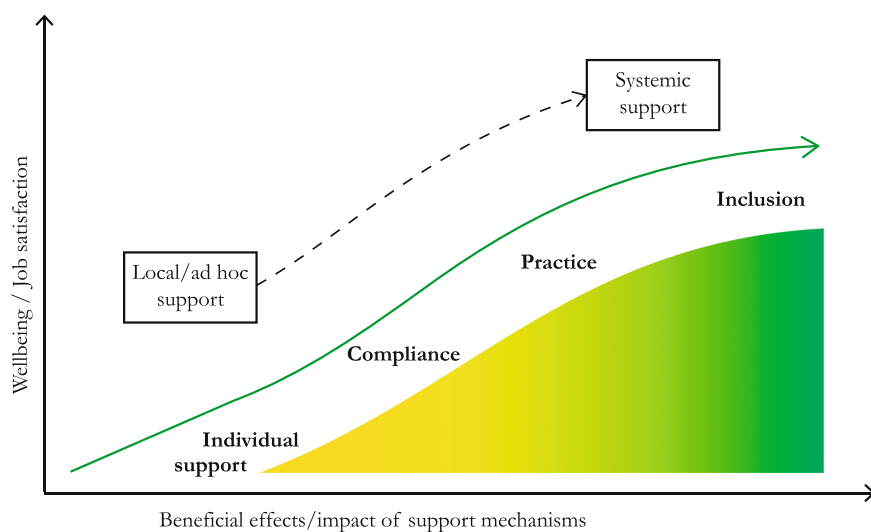
FIGURE 2 Conceptual model of the support mechanisms to create more inclusive STEM communities. STEM, Science, Technology, Engineering, and Mathematics.

accountability, particularly when the act of publishing well-intended policies is incorrectly used by institutions and funding bodies as evidence of inclusive academic cultures. Our findings highlight instead that work to remove barriers to inclusion in STEM is often undertaken by marginalized individuals—who are generally not rewarded for this additional labor. Institutional accountability requires transparent mechanisms for measuring and evaluating the effectiveness and impact of those policies because good intentions are not good enough when it comes to inclusion. If there is no accountability, and despite the ambiguities of diversity work in higher education institutions (Ahmed, 2012), even good practice is often reduced to pockets of good practice that are unequally distributed—which is particularly problematic in the context of mobile, international, and non-linear STEM career trajectories.

Our findings suggest that everyone has the ability to support colleagues and peers, particularly more privileged individuals (i.e. those who experience less oppression), senior academics, and those in leadership positions. However, removing the causes and remedying the effects of the historic exclusion of women and LGBT+ people in STEM should be, first and foremost, an institutional imperative. This is because only sustained commitment to reimagining working cultures and organizational practices can bring forward authentic transformations (Fox, 2008). Requiring more institutional accountability for action would also shift the onus of EDI work from individuals to organizations—which is only right when considering that inclusion benefits everybody and creates more innovative and resilient STEM communities (AlShebli et al., 2018; Hofstra et al., 2020; Ruiz-Jiménez et al., 2016).

6.3 | The importance of supporting and including PhD students, postdocs, and early-career academics

The experiences of doctoral students, postdocs, and early-career academics in STEM have been understudied (McAlister et al., 2022; Yadav et al., 2020). Overall, our data highlight similarities rather than discontinuities between PhD students and academics, particularly when it came to perceptions and experiences of systemic challenges. This corroborates the idea that exclusionary behavior and biases appear early in STEM career journeys—a parallel with what happens, more broadly, in STEM education (Martin & Fisher-Ari, 2021; Wright & Delgado, 2023). However, our findings suggest that PhD students, postdocs, and early-career academics usually have less access to support mechanisms if compared to mid-career or senior academics who already navigated

similar challenges and gained a more secure career stage. The effects of this lack of support created additional discomfort for our participants, particularly when challenges were compounded by issues of power imbalance, lack of solidarity, or increased precarity in higher education (Ivancheva et al., 2019)—which especially worried those individuals who were from working-class backgrounds and those with caring responsibilities. While a systematic comparison between different career levels is beyond the scope of this study, our results suggest that it is imperative for institutions and funding bodies to provide additional and more meaningful support and include PhD students, postdocs, and early-career academics. This means reimagining doctoral education and pathways to research careers in STEM (both in academia and beyond), as well as reassessing metrics of success and the ways by which research is funded to ensure equality of opportunities.

6.4 | Limitations

The majority of academics and PhD students who joined the study identified as White women ($n = 62$). This shaped our findings by bringing analytic emphasis on gender performativity, gender stereotypes, and sexism. Our sample is representative of the historical underrepresentation of Black people and other people of color in higher education in the United Kingdom, particularly in STEM fields. Although we purposefully recruited a percentage of participants of color that is higher than that of the University in which the study took place, the fact that most of our participants identified either as White British or other White backgrounds limits our ability to fully explore or discuss the experiences of people of color.

Among LGBT+ participants, the majority identified as LGB—which is consistent with demographics in the general population. However, our study and analysis have been designed and undertaken to include a wide spectrum of LGBT+ identities despite the difficulties of recruiting more people who identified with minority or less represented identities under the LGBT+ umbrella (which, in our case, include one trans woman, one non-binary/genderqueer/queer person, and one asexual person). As the data collection for the study ended before the first COVID-19 pandemic lockdown (March 2020), findings from the study do not reflect the possible impacts of the pandemic on our participants.

7 | IMPLICATIONS

Findings from our study raise a number of key issues for researchers, practitioners, and higher education institutions that are invested in understanding inequities and removing barriers to inclusion in STEM.

7.1 | Recommendations for future research

In STEM education research, PhD students and academics continue to be understudied populations. While most of the extant research on EDI in STEM has focused on women, less has been done that includes the experiences of LGBT+ people, and fully intersectional perspectives are lacking.

Our study highlights that significant and insidious inequities exist for women and/or LGBT+ PhD students and academics in STEM. Focusing on two marginalized populations with an intersectional lens enabled us to explore specific, overlapping, and interconnected issues of challenges and support within and across social groups and individuals. Intersectionality is key to better understanding and addressing stereotypes, prejudice, and discrimination in STEM higher education—but fully intersectional approaches are rare in extant literature. Therefore, we would encourage future research to keep widening the focus of intersectionality to incorporate and consider together sexuality, race/ethnicity, disability, social class and other similar categories of analysis. Whilst it is of paramount

importance to create inclusive science environments for children, young people, and teachers at every stage of education curricula, this movement towards equity would be incomplete without an equal focus on academia.

Attention should be paid to exploring and theorizing issues of disadvantage for PhD students and academics in STEM, particularly their long-term effects on career trajectories. This is because addressing early disadvantages would prevent excluded individuals from sliding down what we have conceptualized as the slippery slope to discrimination, thus reducing the chances of dropping out of their courses or abandoning their careers.

We recognize that our participants represent a particular sample within the wider population of women and LGBT+ PhD students and academics in STEM—which limits the generalization of our study results and puts particular emphasis on issues of gender and sexuality. However, our theoretical approach and the choice of considering together two historically excluded groups (with their breadth of experiences) is a step towards 'broadening the boundaries' towards a fuller application of intersectionality (Moradi & Grzanka, 2017). We would recommend future studies a similar approach when deploying intersectionality to design the research and analytical strategy. We also would encourage scholars to make more explicit their epistemological perspective and the ways they regard both identities and social identities. Our application of intersectionality, for example, is foregrounded in a queer theory-inspired understanding of identities which is key to challenging normative and essentialist assumptions.

In addition, we agree that creating more inclusive STEM communities in higher education means, more broadly, reimagining higher education (Davies et al., 2021; Walton et al., 2013). As well as reflecting on the role that these have in both (re)producing and resisting biases that exist in society. Therefore, future research should consider the wider context in which STEM academics and PhD students operate, which includes higher education institutions, research organizations, funding bodies, and industry. More comparative research would help to illuminate to what degree the policies and practices of this complex landscape of organizations are country or discipline-specific—and thus help design the contextual actions that are needed to remove inequities.

7.2 | Recommendations for policy and practice

7.2.1 | Higher education institutions

Based on our findings, we would encourage higher education institutions to re-examine the ways challenges are understood and rethink how support mechanisms for excluded individuals in STEM are provided. The limits of deficit discourses and pipeline approaches have come under increased scrutiny (Cannady et al., 2014; Heybach & Pickup, 2017; Metcalf, 2010)—a concern that we share and that is supported by our findings. In fact, data from our study clearly show that increasing diversity on the supply side of the STEM pipeline without doing the work to create more equity and inclusion is, at best, a limited if not tokenistic effort. Some individuals manage to have successful careers. Nevertheless, they do so despite "the odds" rather than because they have been thriving in their roles without fears of repercussions or disadvantages because of who they are.

The argument we put forward with our models is that, much like when treating a complex illness, addressing early signs of inequities (e.g., disadvantage) and holistic interventions matter in STEM academic environments. Institutions that choose to dismiss these early warning signs should not be surprised to find the existence of serious issues of discrimination, harassment, bullying, or violence—and should be held accountable for them. Intervening when serious incidents of discrimination become headlines, or individuals are at the point of considering leaving their institutions or STEM fields for good is too late.

What does this change look like? By building on prior research and our findings, the path to inclusion that we offer through our model would recommend organizations to move beyond tokenistic compliance, implement more transparent and effective policies and procedures, invest more in staff and resources to design and deliver EDI initiatives, and regularly collect data to assess the success of their strategies. STEM curricula would benefit from including discussion of social identities and social justice (Cech, 2013; Wright & Delgado, 2023). Good leadership

and academic citizenship should be rewarded in meaningful ways, and particular attention should be put to supporting and championing PhD students, postdocs, and early-career academics.

Both higher education institutions and funding bodies have a vital role to play in bringing forward more sustainable, equitable, and inclusive career pathways and academic cultures; moving away from precarity and competition, towards STEM environments where people can bring their whole selves to work. It is worth noting that changing the ways those in leadership and management positions are selected and operate is key to enabling meaningful transformations. When EDI principles are not embedded and practised at senior levels in organizations, this hampers efforts to address inequalities.

7.2.2 | STEM academics, PhD students, and educators

Our work has implications for STEM PhD students and academics, particularly those in more senior positions. Extant research, including our own, demonstrates that STEM is far from a neutral environment. On the contrary, science and who is deemed to be an ideal scientist are social constructions, and significant disparities exist among different groups when it comes to STEM education and careers. It is imperative, therefore, to actively and intentionally focus on improving climates as well as on transformative change. For those who supervise PhD students and early-career academics, in particular, we would recommend they learn more about intersectional oppression and privilege in STEM, on models of good practice, and on providing guidance and support that is tailored to meet the needs of each individual.

Finally, some of our findings indicate issues that are important to create inclusive STEM education more broadly. Stereotypes and prejudices around science or engineering, for example, manifest early for students— therefore, it is key for teachers to intervene as early as possible to counteract them. More inclusive STEM environments in higher education can help children and young people to ignite their interest in science, to identify role models and, more generally, remove barriers to fulfilling their aspirations.

8 | CONCLUSION

By focusing on systemic challenges and support available for women and LGBT+ PhD students and academics in STEM, this study highlights that significant and intersectional inequities remain in STEM higher education. However, inclusion is not out of reach. But it requires a paradigm shift, moving away from simplistic and flawed models to center on the experiences of those who have been for too long erased and silenced despite their great contributions, as well as on the institutions that must be accountable for the work to create meaningful, sustained change.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study can be made available in limited, anonymised form upon valid request after the completion of the project.

ETHICS STATEMENT

All human subjects gave their informed consent before their participation in the research and adequate steps were taken to protect participants' confidentiality. This study was approved by the University Ethics Committee (UEC) (reference UEC19/64).

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ENDNOTES

[1] We employ the acronym LGBT+ as an umbrella term to describe a wide range of sexual and gender identities in an inclusive and intersectional way. We acknowledge the critical debate on labels to categories and describe identities and groups and, when presenting results from other studies, we honor the terminology employed by each author.

[2] We use the term academics to indicate researchers, teaching staff, and faculty members.

[3] We use the term people of color, but we also recognize that collective terms for underrepresented and marginalized groups risk homogenizing the experiences of racism and prejudice. Similarly, we are aware that identity categories drawn from standardized sources (census questions, for example) do not fully reflect the diversity of possible identities.

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