

Critical Pathways: How Targeted Programs Shaped the Academic Journeys of Women of Color in STEM and What's at Stake

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Abstract

The recent changes in federal support for broadening participation and diversity, equity, and inclusion (DEI) initiatives within academia may have long-term impacts. As part of a larger research project, 20 interviews asked women to share stories of their STEM journeys in academia. Interview prompts included questions such as: In what ways have your unique multiple identities been assets or presented unique opportunities or challenges in academia? Can you share experiences where you felt like your identity was supported and celebrated in the academy? The women who participated in the interviews represented a range of career stages, STEM disciplines, and racial/ethnic identities. For example, two were completing their PhD, while all others had earned a PhD in a STEM field (e.g., engineering, public health, physics). Most were faculty (assistant to full professors), including two department chairs and a Dean; 17 participants identified as women of color. Across these journeys, programs specifically intended for women and/or underrepresented groups played important roles in supporting participants' success, which interview analysis grouped into four interrelated themes: belonging/community, structural access/opportunity, material support, and, in some cases, turning points. At the undergraduate level, participants described targeted scholarships, summer research programs, and student organizations that supported persistence in STEM. At the graduate level, fellowships, traineeships, and cohort-based mentoring programs facilitated access to resources, networks, and professional socialization. For postdoctoral scholars and early-career faculty, professional development workshops, ADVANCE programs, and cohort hiring initiatives fostered community while expanding access to professional and leadership networks. Mid- and senior-career faculty described grants supporting students, as well as leadership development and mentoring networks, as critical mechanisms for sustaining careers and giving back to subsequent cohorts. Many of these programs operated at national or cross-institutional levels, enabling individuals who were isolated within their departments or disciplines to find community and opportunity. The paper concludes by considering what may be lost as many of these programs have recently been discontinued or changed.

Introduction

There have recently been large changes in the national landscape regarding diversity, equity, and inclusion (DEI) initiatives in higher education in the United States. In January 2025 Executive Order 14151 aimed to “end radical and wasteful government DEI programs” [1]. This was followed by a February 2025 Dear Colleague letter from the U.S. Department of Education which indicated that race-based initiatives such as scholarships, programming, and activities could violate Title VI [2].¹ Ultimately, federal funding that supported a wide range of DEI activities has been cancelled [3],[4],[5]. This represents a significant change from previous support for broadening participation initiatives at the federal level. The impacts of these changes may be especially significant in science, technology, engineering, and mathematics (STEM)

¹ The February 14, 2025 Dear Colleague Letter was subsequently challenged in federal court, and its enforcement was enjoined in part and later vacated by a U.S. District Court in 2025 [54]. While the letter itself is no longer in effect, it contributed to uncertainty and institutional responses during the period relevant to this study.

fields where the diversity of graduates [6] and the workforce [7] continue to leave many women and people of color underrepresented, particularly among faculty [8],[9],[10],[11].

In this research, we reiterate the importance of DEI-related programs in supporting women of color in their journeys to doctoral degrees and beyond in STEM by examining how women of color in STEM describe the role of programs explicitly designed to broaden participation. The study is applied in nature, drawing on 20 interviews conducted prior to recent federal policy changes as part of a broader ADVANCE research project. The paper is not an evaluation of specific federal or institutional policies; rather, it seeks to inform ongoing debates about the potential consequences of dismantling or constraining such programs by centering the lived experiences of those who directly benefited from them. The paper begins with historical background, followed by the research questions motivating this work, the research methods, results, and finally discussion which speculates on the impacts of recent federal and state changes.

Background

In the United States attention on the lack of women in STEM fields began around World War II, when women began being actively recruited into STEM due to labor shortages [12]. This grew into additional national security concerns with a lack of sufficient STEM workforce during the Cold War. The Society of Women Engineers (SWE) was founded in 1950 and offered its first scholarship in 1959 [13]. In the 1970s feminist advocacy expanded attention on women's low representation in high paying STEM jobs [14]. The 1970s are also when national groups began considering minoritized racial and ethnic groups in STEM [15] and a number of professional societies were founded including the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) in 1973 [16], the Society of Hispanic Professional Engineers (SHPE) in 1974 [17], and the National Society of Black Engineers (NSBE) in 1975 [18]. Student chapters of these groups offer important communities of support and inspiring professional role models for engineering and STEM students. Private groups also started providing funding such as the GEM Fellowship Program in 1976 [19] and the Clare Boothe Luce Program for women in STEM in 1989 [20].

Broadening participation actions at the US National Science Foundation have been traced to 1972 [21]. The NSF has been active in supporting scholarships and other programs to recruit, retain, and contribute to the success of all individuals in STEM, recognizing that some groups are participating at levels below their representation in the US population. One of the earliest funded programs was in 1991 with the start of the NSF Louis Stokes Alliances for Minority Participation (LSAMP) which supported efforts to recruit and retain racial and ethnic groups underrepresented in STEM in undergraduate and graduate education [22]. Another influential program was the 1998 Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) [23]. In 1998 the NSF started the Minority Graduate Education (MGE) program to increase STEM doctoral enrollment among underrepresented minorities [24]. It evolved over time into the NSF Alliances for Graduate Education and the Professoriate (AGEP) which had a stated goal of "increasing the number of historically underrepresented minority faculty in STEM". The earliest request for proposals (RFP) available through the NSF website was from 2001; the most recent RFP from 2021 is archived and appears to have been discontinued in 2025

[25]. The latest award in December 2024 was administratively terminated in April 2025.

The NSF's ADVANCE program, launched in 2001, focused on gender equity in STEM academic positions [26],[27]. Initially, individual grants and fellowships were awarded (including leadership-focused), but these were phased out by 2006. The most persistent activity was institutional transformation grants. More recent efforts aimed to foster systemic changes through partnership grants, networks, and discipline-level projects. In all, evidence points to the ADVANCE program benefitting the career progress of women and women of color in STEM. This extended beyond the programs funded, as the conditions and culture of STEM, change theories, and effective practices were widely disseminated. Unfortunately, the ADVANCE program was terminated in 2025.

Undergraduate research is believed to be another high-impact practice in broadening participation in STEM [28]. The NSF Research Experiences for Undergraduates (REU) RFP in 2003 stated that student recruitment and selection should discuss “the efforts to be made to attract members of underrepresented groups (women, minorities, and persons with disabilities). In addition to increasing the participation of underrepresented groups, another goal of the program is to involve students in research who might not otherwise have the opportunity....” [29]. The REU program started in 1987, but it is unclear when broadening participation became one of the goals of the program as earlier RFPs were no longer available online. As of this writing (January 2026) the RFP for the REU program still shows the 2023 document which includes broadening participation verbiage [30], but guidance from the NSF [31] indicates “Investigators wishing to address goal seven — expanding participation in STEM for women and underrepresented groups — must ensure that all outreach, recruitment, or participatory activities in NSF projects are open and available to all Americans. engagement activities aimed at these characteristics cannot indirectly preference or exclude individuals or groups based on protected characteristics.”

The NSF's 2006-2011 strategic plan specifically called out broadening participation goals [32]. In 2018 the NSF's Strategic Plan formally embedded broadening participation as a core agency-wide priority, stating it was a “universal commitment across all NSF directorates” [33]. James and Singer [21] identified the number of NSF awards per year that included the term “broadening participation”, ranging from the first in 1995 (appears to be n~2), and then steady growth from 2002 to 2015 (n~190). From 2017–2022 under the American Innovation and Competitiveness Act (AICA), the NSF awarded over 3,200 grants totaling \$3.3 billion through programs explicitly focused on broadening participation in STEM [34]. At its peak the NSF's Broadening Participation Portfolio included over 30 programs supporting underrepresented groups, minority-serving institutions, and geographically underserved regions, such as NSF INCLUDES, AGEP, CREST, S-STEM, TCUP, and many more [35].

Outside the NSF, other federal agencies have also supported an array of broadening participation programs including the US Department of Energy (e.g., a 10-week STEM research internship for undergraduate or graduate students aimed at increasing representation of minorities and women in energy related fields) [36], NASA [37], and the US Department of Agriculture [38]. Overall, federal funding was a significant contributor to programs supporting broadening participation.

Individual institutions also create and support an array of programs aimed at recruiting and retaining diverse students in STEM. Legislation at the state level has been important in DEI activities in higher education. In 2023 the *Chronicle of Higher Education* began tracking anti-DEI legislation at the state level [39]. As of December 2025, 19 states have signed one or more of these bills into law, while 19 states have had no such bills introduced. Florida, Utah, and Iowa were among the first states to ban DEI funding, offices, and/or training at public colleges and universities. Thus, local context may be increasingly important.

Research Questions

This paper explores the following research questions, which guide the organization and interpretation of the results:

- RQ1: What programs and opportunities aimed at women and/or underrepresented groups do women at the PhD level and beyond identify as significant supports across their academic journeys in STEM?
- RQ2: How do participants describe the ways these programs shaped their experiences, decisions, sense of belonging, and persistence in STEM?
- RQ3: Based on these narratives, what potential consequences do participants' experiences suggest regarding the curtailment of broadening participation initiatives?

These research questions were explored through 20 interviews with women in STEM fields conducted as part of a larger ADVANCE SPACES grant.

Theoretical and Conceptual Framework

This study is grounded in Critical Race Theory (CRT), which foregrounds how institutional structures, policies, and everyday practices can reproduce racialized inequities, and therefore calls for centering the lived experiences of those who navigate these systems from marginalized positions [40], [41]. Consistent with a CRT orientation, we treat participants' narratives as counterstories that illuminate how opportunity structures are experienced in STEM; particularly the ways that targeted programs, scholarships, mentoring networks, and professional development initiatives can mitigate isolation, expand access to resources, and support persistence across career stages. Intersectionality further informs this inquiry by emphasizing that gender and race/ethnicity are experienced in conjunction with other social identities (e.g., class background, nativity, caregiving), shaping both barriers and supports in distinctive ways [42]. These CRT and intersectional lenses are especially relevant given long-standing critiques that equity initiatives in STEM such as ADVANCE have often centered the experiences of more privileged subgroups (e.g., white women) but have evolved over time toward more explicit attention to intersectionality and institutional context [43]. Together, these perspectives provide the conceptual foundation for examining how women of color describe the roles and meanings of broadening-participation programs across their academic journeys and for reflecting on what may be at stake as such supports are constrained.

Complementing these structural lenses, pathways into STEM fields and academic careers involve a series of decisions, activities, opportunities, and obstacles that unfold over time. Prior research on "critical incidents" and life-course turning points highlights how particular experiences can

redirect trajectories, shape aspirations, or reinforce persistence [44],[45],[46],[47]. In the context of this study, these perspectives inform our examination of whether women- and minority-focused programs are described by participants as pivotal moments within their broader academic journeys.

Methods

This research is a subset of a larger partnership project funded by the NSF ADVANCE program [48]. The grant as a whole was grounded in Critical Race Theory. Among the 11 planned activities in the overall project, one activity focused on collecting counterstories from women about their academic journeys in STEM and involvement in community-engaged research (CER). As part of this activity, 20 interviews were conducted between August 2023 and May 2024 (13 interviews) and May to July 2025 (7 interviews). The first set of interviews was conducted by the author (see positionality below) and the second set of interviews by PhD student Sheila Davis. The human subjects research was reviewed and approved by the University of Colorado Boulder Institutional Review Board (Protocol #23-0344). The informed consent information was emailed to participants in advance of the interviews, and consent was confirmed verbally at the beginning of the interview. Interviews lasted 60 to 90 minutes and were conducted and recorded on Zoom.

The interviews were designed for a counterstories methodology, asking broad open-ended questions to hear about the experiences of these women on their academic journeys in STEM. The specific prompts that often spurred a discussion relevant to the research questions in this paper were: “We are seeking to understand institutional contexts, supports and cultural elements that help retain and promote women and underrepresented groups in STEM. Do you have elements in your journey in higher education that speak to this aim? Were there any communities that have been particularly helpful or supportive during your times as a graduate student, post-doctoral researcher, and/or faculty member?”

After the interviews concluded, the transcript generated by Zoom was transferred into MS Word. The transcripts were then cleaned and de-identified to remove the names of specific individuals, institutions, locations, and other potentially identifying details. Given the sensitive nature of some of the experiences that were shared, particular care has been taken to protect the identities of the participants. This includes generalizing locally distinctive language and reporting all demographics across the entire participant pool rather than coupling multiple personally identifying characteristics together. Clean verbatim quotes are included in the paper.

Data analysis followed an inductive thematic coding approach. Initial codes were generated through close reading of the interview transcripts, with attention to participants’ descriptions of programs, supports, and experiences across their academic journeys. Codes were iteratively refined and clustered into broader categories corresponding to stages of the academic pathway and types of support. Throughout the process, the analysis was reflexive, with attention to how interpretation was shaped by the researcher’s positionalities and the broader study context. Codes captured both program types (RQ1) and the ways participants described program impacts (RQ2), supporting the organization of results by academic stage and impact type.

Participants

All 20 of the participants had earned one or more college degrees in a STEM field (including Bachelor's, Master's, and/or PhD). The STEM fields represented among the degrees and current academic departmental affiliations of the participants included: engineering (civil, environmental, chemical, mechanical, industrial); public health; environmental science; physics and related specialties; mathematics and statistics; biology; chemistry; urban planning. Over half of the women had interdisciplinary training with degrees spanning multiple fields, including some that were outside of STEM. Individuals possessing intersectional underrepresented identities of female and race/ethnicity were recruited, with 17 interviewees non-White women (including African American / Black, Asian, Chicana / Latina / Hispanic, Indigenous, mixed). Other intersectional social identities revealed by the participants included foreign-born (born outside the US and its territories, n=7), foreign-educated (Bachelor's degrees from institutions outside the US and its territories, n=4), mother / parent (n=8), first-generation / low income (n=8), LGBTQIA (n=1), religious affiliation (n=3), and neurodiversity (e.g., one shared that they have dyscalculia). Thirteen of the women had conducted community-engaged research (CER). The interviewees were at different stages in their academic journeys and careers, having earned Bachelor's degrees between 1980 and 2019. Two were interviewed during their PhD studies. Some were currently or had previously worked outside academia after earning their STEM degrees. The current states where the participants resided and worked included 8 characterized as anti-DEI based on having signed legislation into law, 8 pro DEI (no DEI-related bills introduced), and 4 mid (anti-DEI legislation introduced or failed to pass, tabled, vetoed) [39].

Author Positionality

I am a White woman tenured professor in engineering. I am personally very supportive of programs devoted to broadening participation in STEM, given that my participation in such a program was a critical event / turning point in my own journey. In 1987 I participated in a summer program for high school women which paired us with university faculty mentors in STEM fields. This program set me on the path to engineering and becoming a faculty member. I have also had numerous other experiences with programs supporting women on journeys in STEM. In my first year of college, I enrolled in a special section of an introductory engineering course that was promoted for women. I also participated in SWE. It was powerful to see so many women when normally I felt quite isolated in engineering. These college programs were not exclusive and had a few male participants. The university where I was hired after my PhD had an ADVANCE grant that I found helpful on my journey toward tenure. As a faculty coordinator for a summer REU site for a number of years, I also saw the impact of these programs on undergraduate students.

Limitations

A primary limitation is that individuals were not explicitly asked to discuss women or minority focused groups or opportunities that were impactful in their journeys. If these groups or issues had been significant they likely would have been mentioned in response to the open-ended questions posed during the interview. However, many of the faculty focused their remarks on their experiences after their PhD, so potentially impactful programs that they experienced as undergraduates and graduate students were not described. Differences in the timing, locations / institutions, and fields of study among the participants mean that different programs were available and relevant to the participants.

Results and Discussion

The supportive programs described by the participants (RQ1) are presented in roughly chronological order across a typical academic journey (Figure 1). This section begins by reporting programs that support undergraduate college students. Interviews with more senior women often included little or no discussion of undergraduate experiences, instead emphasizing the period after earning their PhDs (e.g., as a faculty member). Within each program, participants' descriptions of how these programs shaped their experiences and trajectories are examined (RQ2), often illustrated through direct quotes. These effects fell into four major types: material support, belonging / community, turning points, and structural access (Table 1). Programs often conferred multiple types of beneficial impacts; Figure 1 highlights the primary impact(s) emphasized in participants' narratives. Integrating these findings, we then reflect on what participants' narratives suggest may be lost as such supports are curtailed (RQ3).

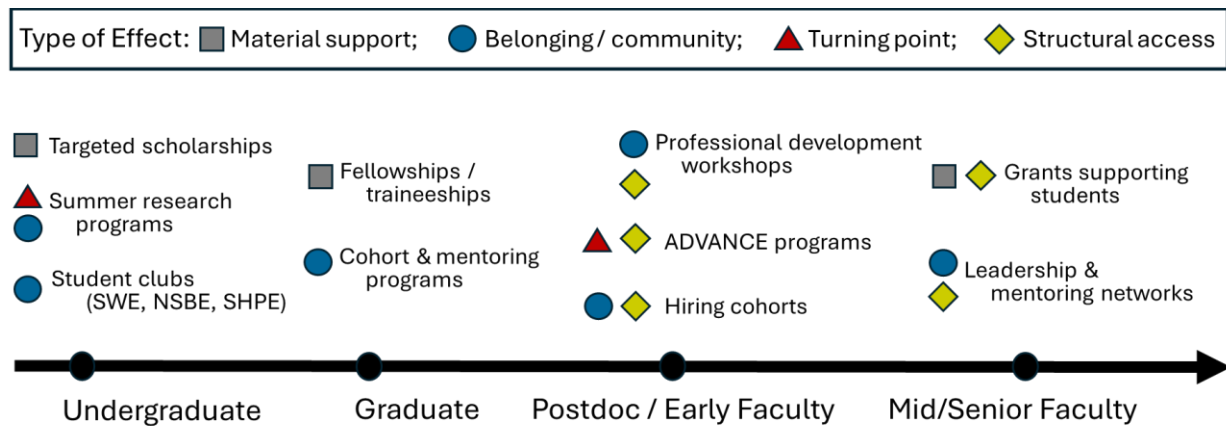


Figure 1. Broadening participation programs described by participants, organized across a typical academic journey (RQ1), with markers showing the primary types of impact attributed to each program (RQ2).

Table 1. Types of impact used to characterize program effects

Impact Type	Definition	Examples
Material support	Tangible financial or resource support that reduces economic barriers or enables participation	Scholarship, stipend, paid research, travel funding
Belonging / community	Social and relational support that reduces isolation and provides validation, mentoring, or peer networks	Cohort / community, role models, mentors, safe spaces, recognition / validation, “not alone”
Turning point	A pivotal experience described as redirecting trajectory, aspiration, or persistence	“changed my life”, critical event, decision to pursue graduate school or leadership
Structural access / opportunity	Institutional or systemic mechanisms that open pathways, resources, legitimacy or advancement opportunities	Cohort hiring, program leadership visibility, grants supporting students, access to networks

Undergraduate – Clubs

Professional societies were described by a number of interviewees as impactful in providing support during their undergraduate experiences. One participant reflected back on her undergraduate experience and stated “the opportunities ... were somewhat limited for female or female identified person[s]. the Society of Women Engineers. That was a good way to connect with other women or female identified people. [And] to just get a sense of what opportunities are out there for internships, externships, or even research. [The] person who was leading the student chapter at my university at the time was the person who connected with me with the [DEID Institution] program for [summer] research. So that's a big one there. ... There was also the Hispanic Society of Engineers that was another good organization.” This quote illustrates the impact of belonging / community and some structural access (connections to internships and research pathways).

The US Military Academy in West Point shut down NSBE, SHPE, and SWE student groups in February 2025 [49]. However, in most cases these clubs can generally continue to function, as they are affiliated with private entities outside the institution. However, their on-campus activities and visibility may be curtailed, or they may lose campus funding (aligned with campuses closing DEI offices and centers). The national professional organizations are stepping up to help student chapters navigate these challenges [50].

Undergraduate – Summer research

One of the Latina interviewees who was an assistant professor discussed participating in a summer research program when she was an undergraduate student that specifically targeted multicultural and underrepresented students. Her faculty research mentor was a male Latino. She spoke passionately about the beneficial impacts of the program.

That, I will say, changed my life. Literally. Not only in getting experience into research in the [DEID] engineering field. And then, later on other types of research. And that's where I met my husband. It literally changed my life. So I think opportunities like these, when you give people of diverse background, just access to researchers, things where they can grow, expand and even socially grow. It's wonderful. I think they did a great job providing the training aspect and being very mindful and, to be honest, kind. With good mentors and good graduate students that are culturally sensitive. ... They did a really good job with people that their first language is not English. They had [graduate] student [mentors] that were either bilingual, trilingual, or have some sense of knowledge or interest or just cultural humility... to work with students that were either Spanish speaking, or that had some ancestry from Mexico or Puerto Rico or other. So I think that cultural sensitivity and openness... And [they] challenge[d] me, as a trainee, to do things that might have seemed a little more advanced. So I appreciated that. They also provided some training for grad school and GRE and things to keep in mind like that. And interestingly, at the time I wasn't very interested in pursuing a graduate degree....

This rich description of the numerous personal and professional benefits of her research experience identifies this as a critical event or turning point, and also highlights belonging / community through culturally responsive mentoring.

Undergraduate – Scholarships

Financial support during college is very important for some students. One of the non-traditional students was earning her second Bachelor's degree in STEM after working and becoming a mom. She was doing really well in her classes but was on food stamps and had to take out loans.

I was applying to scholarships and stuff, and it was like, why am I not getting these scholarships. I was applying to a lot of like "Black women in STEM" scholarships. I was so discouraged for like a year and a half. ... I was so bummed out that I couldn't get any help. I was like, I actually really need help. I have a kid. And I have rent to pay.... And I have over a 3.5 GPA, what is happening? I didn't understand why it was so hard. And then this ... professor... She was what saved me. She got me a STEM scholarship through the [NSF-funded program] that she's a PI on. Finally, to get accepted into some program. Recognize that I've been working so hard. And I think that was really the thing that was discouraging was that I was working so hard doing all these things, and I was looking towards the Black community for help, and I wasn't getting anything. And I was like, well, what the heck don't you guys see in me. So that helped me to keep going.... She was really a lifesaver, too. She was really one of those that was encouraging of underrepresented students and really helping.

The money was really important (material support). But so was the feeling that her intelligence and scholarly success were being recognized. This contributed to feelings of being "qualified" to pursue graduate studies (belonging / validation).

Jobs – Work experience

One of the Latina faculty members got a first job after their Bachelor's degree at a federal government agency. She attributed affirmative action to helping her get that job.

Interestingly, the job they were seeking was specifically under a program for recent graduates who were minorities. So it's one of those somewhat affirmative action type of things. So important. ... if it wasn't for something like that, honestly, I would not have landed the job. Even though I had the qualifications, I graduated with honors, I was confident of my skills. ... but I felt my English was not great. So I was like, how would somebody like me with the skills but not the communication there yet with language land a job? Affirmative action did it.

This example reflects structural access / opportunity (a targeted hiring pathway) that also provided material support through early career employment. After gaining confidence, skills, and experiences working she returned to academia and earned her PhD.

Graduate School – Programs / scholarships

One of the interviewees was just finishing her STEM PhD in 2025. She described that as an undergraduate STEM student she had received an "NIH-funded scholarship to diversify research careers." They paid for her tuition and books, she received a stipend for doing research, and they funded her travel to conferences. The program also included weekly seminars that discussed the process for getting admitted into PhD programs and various ethical issues. The program connected her to a supportive cohort of other students (e.g., "the sense of community was really a plus"), as well as graduate student and faculty mentors at multiple institutions. These elements

provided both material support and belonging / community, with professional socialization that can strengthen persistence.

At the time of the interview, she was looking for an engineering job outside academia back in her hometown. When asked why she wasn't exploring academia she responded, "there aren't a whole lot of those jobs out right now. That [job market] for environmental engineering, it's so hard. The EPA is getting obliterated. Grants are getting [canceled], that EPA grant [that funded my PhD research] got canceled, like that one got defunded. Yeah, it's looking pretty dire.And I'm not flexible on location. I want to be able to pick where I want to live, and that's not something that academia can guarantee me." The combination of multiple challenges she saw within academia made it an option that she was not pursuing.

Another participant had a "fellowship for Native people" during her doctoral studies. A number of the interviewees had been funded as graduate research assistants (GRAs) on projects that included CER. Here they noted that their cultural backgrounds were particular assets, allowing them to relate to community members and more readily build trust. A number of these grants were funding directed to underserved or marginalized communities. The defunding of these grants and discontinuation of these programs represents a loss of material support.

Faculty – Hiring

One professor described that she was hired into her tenure-track assistant professor position in the College with "a cohort that came in of minority faculty and some who were women". One cohort member was hired as a tenured full professor. The interviewee described that among the cohort, two had moved into administrative positions, many became tenured full professors, "but we did lose some of the Black men who came in with us from the tenure track positions." The broader cohort across the College seemed important since she "came into a very problematic department." She was the only underrepresented minority woman in the department. She also noted that there were very few women of color in her technical field when she was an assistant professor, so connecting with other minority women more broadly was helpful. "I look at the current group of the younger or the assistant professors. There's a much larger cohort of underrepresented minority women. And I would say that was not something that I had at the time coming up in the field...." Cohort hiring represents structural access / opportunity while also fostering belonging / community through a broader network beyond one's department.

During an interview in 2024, a tenured professor at a Minority Serving Institution described how her recent Dean had changed the hiring process so that "we're not hiring anybody that we don't for sure know has some experience with DIJB [diversity, inclusion, justice, belonging]. And we're putting that on the application where it's like you have to demonstrate activities. And so now I get to look at somebody's application and see ... did they do anything? No, they're not a strong candidate. I don't say we should interview somebody because they're a person of color or because they're women. I'm interviewing them because they come with a different set of skills and different set of experiences that can relate to our students. that has changed in the hiring." This example reflects practices that were possible within a particular institutional and national context, capturing how leadership-driven hiring criteria can reframe merit by formally recognizing DEI-related experience as professionally relevant rather than peripheral. Curtailing

such initiatives may narrow forms of structural access by limiting the institutional mechanisms that legitimize certain experiences and open pathways to faculty advancement.

Faculty – On-campus programs

A full professor and administrator described how leading an ADVANCE grant at her institution was “particularly helpful” in her journey.

Actually being one of the PIs for our ADVANCE Grant, I think, probably had the largest impact because it gave me and my team a chance to really talk about what are some of the systemic issues that we see, and to fix those systemic issues for the better. And because we had the grant, we had the ear of the Provost. And because we were implementing programs, executing them, getting the data and proving that it's working, I think that probably was the largest impact to help me grow. I probably would never have gone for chair had I not helped bring in speakers for ADVANCE. I definitely probably never would have gotten the visibility or people saying, Okay, her leadership is good, let's ask her to be [campus-level leadership]. Here, the program functioned as structural access / opportunity (e.g., institutional influence and visibility) and, for the participant, as a turning point in her leadership trajectory.

In contrast, an associate professor noted that the institution where she had her first tenure-track position had an ADVANCE-type program, but it didn't help. She felt that she was “treated like shit” and “abused” but no one helped her. She concluded that the other faculty in her department and individuals on campus were more important than institutional structures.

Faculty – Workshops and Professional Development

National workshops aimed at supporting women and underrepresented faculty were cited as being helpful by a number of the interviewees. When asked to describe communities that were particularly helpful, one of the tenured minority women faculty noted these workshops.

The National Science Foundation was really investing money in minority faculty development, because I remember going to NSF for the first time, figuring out how to ... sit on a panel, how to ask to be on a panel. That was all a minority-focused workshop that someone had funding for. And then someone else had funding to bring a group of new African American female faculty to the Grace Hopper Conference one year, even though we weren't all computer scientists. They brought us out there. Once again, that professional development, just networking. So it was more of those grants that helped me along the way as opposed to a professional society.

She continued,

I'm thinking there's a group of minority women that probably started their careers 10 years before my little cohort started, and that mid-level group is the one that were writing the grants and recommending us to go to different conferences, workshops, and professional development and leadership training. And it was them, giving back to my little group. I think that probably helped the most. And a lot of them are [university] Presidents now. So you know, I think it was just that inner network. So like a grassroots effort to say, Hey, we have to help the ones behind us so that we can keep growing and keeping people in the profession.

This narrative reflects intertwined themes of belonging and structural access, as intergenerational networks of minority women faculty spanning institutions and disciplines created a sense of

community while also opening pathways to resources, professional legitimacy, and advancement opportunities.

Another one of the Black women faculty described that when she was an assistant professor her department chair and Dean would “pay for me to go to ... every different kind of workshop, and so on. There was support to go. And most of those workshops were targeting underrepresented minority faculty.” A Latina scholar mentioned that she connected with other women and women of color through workshops sponsored by ADVANCE, noting that feeling “not alone” was an empowering space.

One of the tenure-track faculty members described participating in a “training institute specifically for junior scholars of color” where she met her first senior female mentor.

Through the training institutes I've been through, like I mentioned the one directed towards minority scholars, I've got to meet people in [different states]. I participate in writing groups, virtual writing groups that are mostly faculty of color. So you get to meet other folks in academia and talk about [issues], I think, especially with younger faculty. We're very open and transparent.

It is unclear if the writing groups she mentioned are formally funded activities or ad hoc groups.

One of the assistant professors indicated that she had participated in a workshop sponsored by the National Research Mentoring Network which she described as “an NIH Funded initiative to promote the diversity of biomedical researchers.” She learned from that workshop the importance of developing a mentoring network across ages, levels, locations, and so on. She also mentioned that they had an online mentoring network, but it was unclear if she had personally participated in that aspect of the program.

A Latina associate professor indicated that her own journey had been lacking in mentors, so she had participated “an AGEP program last year where I got training on how to be a strengths coach”, the I-Aspire Leadership Academy, and the ECO-STEM program. These communities of practice (COPs) gave her a place to feel included and valued. She explained “joining these COPs really gave me a space where I feel like I could say what I wanted to say honestly, and I receive no judgment.... I didn't feel dismissed in any of these spaces. I felt like people were nodding their head like, yeah, okay, I get what you're saying.”

Across these examples, participants described these experiences primarily as contributing to belonging / community (networking and affirmation) and structural access / opportunity (learning how to navigate funding / panels and gaining entrée to professional networks). For many participants, meaningful belonging and opportunity emerged primarily through spaces outside their individual institutions and disciplines. In some cases, travel funding also represented material support that enabled access to these networks.

Faculty – Grants and Support for Graduate Students

A tenured Latina faculty member indicated that an advantage of her multiple identities had been “certain agencies have been very cognizant of the fact that people of color and females are not, we're not given a fair shot when it came to fellowships, scholarships, grants. So I feel that's an

advantage that I frequently take advantage of. I've been very successful in grant writing, and I've been very successful in getting students where they want to be. And so I would say that's an advantage. But the disadvantage of that is the perception that I am only getting these awards because I'm a woman. I am only getting these awards because I'm a person of color. I only got into [prestigious institution] because of affirmative action, which is not true. Right? So, it's ... both good and bad.”

Many of the faculty discussed benefitting from fellowships and grant programs aimed at broadening participation that supported their graduate students. Programs cited by the faculty included the NSF GK12 program, Sloan Minority PhD program, and the Bridges to the Doctorate Program. As one professor explained, “there was an emphasis on increasing the percentage of underrepresented minorities who graduated from our PhD programs. Our department had never graduated one, and that was also the case of many other departments in the engineering college. And so two of my first PhD students were recruited through [that] initiative. One of them, [DEID name], now Dr. [DEID name], was on a GK12 fellowship....” These grant mechanisms illustrate capacity building through material support and institutional resources that enable sustained participation and advancement.

Women Faculty Leading Community Outreach Programs

It is also significant that a number of the women led outreach and community engagement activities as faculty and in post-doctoral positions. They spoke with passion and pride about these programs. One example (with some paraphrasing):

I always do things if I want to do them. Like, you know, the program [for high school women in STEM] was a lot of fun, you know. I've done different [programs] in different places. I remember I did one at University XX ... It was actually pretty interesting. We went around to high schools across the State to talk to science classes. So kind of to be a figurehead for women in science. And I remember, I forget what town it was, but I remember going in, and the teacher saying, ‘Don't throw anything at her.’ And I had to do like 4 or 5 [classes]. I had my little [prepared lecture on an environmental science topic], and I had to do like 5 science classes in a row. I was glad I did it.

Another faculty member worked with a majority African American neighborhood that was located near campus. This included a community redevelopment area and the faculty member wrote grants to bring revitalization money to the community through the US Environmental Protection Agency, had a partnership to integrate with STEM classes, supported a science night at the school, and similar activities that bridged teaching (via service-learning embedded in university classes, GK12 fellowships to her graduate students), research, and service.

Through their words, it can be inferred that the women derived a number of significant personal benefits from their community outreach activities, including intrinsic fulfillment, sense of professional competence and validation, belonging, and relatedness. Taken together, participating in these activities seemed to bolster their motivation for their academic positions overall, which in turn perhaps contributed to their persistence and success. This aligns with other studies about faculty participation in CER and similar activities [51],[52],[53]. These outreach efforts can be

viewed as both belonging / community impacts and structural access impacts when sustained by institutional or grant infrastructure.

What might be lost?

Earlier the story from a finishing PhD student opting not to go into academia after her degree was shared, where the current funding situation served as a deterrent. One of the Latina faculty members in a non-tenure track position who conducted CER had recently rejected an offer for a tenure track position because it did not come with more support or pay, just more responsibilities and stress given “budget-wise the school and the department were not in a good place, and that was before the Trump administration. All the cuts in Federal grants and things like that....” Together, these narratives suggest that the current funding and institutional environment may deter some women from pursuing academic career paths in STEM..

Synthesizing across narratives, we find that these broadening participation programs functioned as an interconnected ecosystem providing material support, fostering belonging/community, creating occasional turning points, and enabling structural access/opportunity. Monetary constraints for a number of the women were real barriers. Without scholarships or paid research opportunities that had goals to broaden participation in STEM, these women may not have persisted. Beyond the financial benefits, these programs often connected the women to role models, mentors, and a community of peers. They also provided tangible skills that helped build their research skills and motivations to pursue doctoral degrees. For women faculty, DEI programs provided support, skills, and community. And many of these women were involved in community outreach programs to bring STEM to K-12 students, as well as their support of undergraduate and graduate students. These activities provided motivation and bolstered their commitment to academia. Thus, broadening participation activities are an interconnected ecosystem working to build inclusive culture and fostering belonging. Removing any of these elements could have ripple effects across all levels including community awareness of STEM careers, K-12 students being motivated to pursue STEM in college as a step toward STEM careers, undergraduates and graduate students earning degrees, and some opting to pursue careers in academia as researchers, instructors, and faculty.

Conclusions

In this paper, we recounted the stories that women shared about programs and experiences specifically targeting broadening participation that were helpful to them on their journeys. Across narratives, participants described these programs as providing material support, fostering belonging / community, creating turning points, and enabling structural access. This ecosystem of support may be difficult to replace if curtailed. Specifically, these supportive experiences included professional societies / clubs, summer research programs, scholarships and grants (undergraduate and graduate), and targeted leadership and professional development programs. Some of these programs had tangible support like funding and skill development. Often, however, participants emphasized more subtle impacts, including connection to supportive communities, reduced isolation, and access to peers and mentors they could trust when navigating systemic exclusion and microaggressions. In many cases, these supports helped the women persist in working toward their goals. In a few cases, these programs were described as

life-changing, such as redirecting a trajectory toward pursuing a PhD. These stories underscore the value of broadening participation initiatives from the perspective of those who directly benefitted from them. At the federal level and in some states, many of these programs and supports have been removed. It is too early to understand the full effects of these changes. We will likely never know which people were not recruited into STEM and academia, or what contributions to society and our world were lost as a result.

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