

Belonging as Practice: Peer Mentorship, Cultural Healing, and Radical Self-Care Among Black Women in Graduate Science and Engineering

Dr. Christina Anlynette Alston, University of Colorado Boulder

Director, Office of Graduate Access and Retention, Graduate School Chair, Commission on Diversity
Equity and Inclusion, ASEE Secretary, National Society Black Engineers, Denver Professionals

Lien Amin, University of Colorado Boulder

Belonging as Practice: Peer Mentorship, Cultural Healing, and Radical Self-Care Among Black Women in Graduate Science and Engineering

Abstract

Black women in STEM graduate programs at predominantly white institutions face persistent barriers to belonging, including racial isolation, gendered microaggressions, and limited access to culturally affirming mentorship. This study examines how participants describe their sense of belonging before and after participation in a year-long, cohort-based Sista Circle intervention designed to strengthen belonging. Using a qualitative-dominant mixed-methods design, we analyzed pre- and post-program reflections from 16 Black women and nonbinary science and engineering graduate students. In vivo coding preserved participant language. Quantitized thematic frequency analysis was used descriptively to examine 16 Black women and nonbinary STEM graduate students descriptively to examine changes in the presence of belonging-related constructs across time. Participants' descriptions shifted from conditional and externally mediated belonging before the program to relationally grounded, culturally affirming, and institutionally situated belonging after participation. Across post-program reflections, participants more frequently described emotional support, peer mentorship, cultural healing, and radical self-care as mechanisms through which belonging was built and sustained. Overall, findings suggest that culturally embedded counterspaces can support meaningful improvements in belonging for Black women in graduate science and engineering contexts and offer a replicable framework for equity-centered graduate support programs.

1. Introduction

Black women remain underrepresented and marginalized in science and engineering master's and doctoral programs, especially at predominantly white institutions (PWIs) [1], [2]. Prior research shows that Black women in science and engineering often navigate racialized and gendered microaggressions, isolation within departments, limited access to affirming mentorship, and pressure to succeed in environments that often fail to recognize their humanity, expertise, and intellectual contributions [1]-[4]. In graduate education, belonging is shaped through relational and structural conditions such as advisor accessibility, peer recognition, departmental climate, opportunities for intellectual participation, and the availability of culturally affirming spaces in which students can ask for help, be vulnerable, and remain visible without heightened risk [5]-[7]. When these conditions are absent, graduate students may experience disconnection, stress, and increased vulnerability to attrition [6], [7]. On the national level, graduate student engineering participation remains low for Black students. For example, in 2023, ASEE engineering enrollment data indicated that Black students represent approximately 1.4% of master's and 2.1% of doctoral enrollments [4]. These low enrollment rates shape everyday training conditions, where students may experience isolation within labs, departments, and professional networks. At the same time, women's representation in engineering doctorates remains comparatively low overall; national indicator reporting shows women earned about a quarter of doctoral degrees in engineering in 2019 [4].

In this study, belonging is defined as a dynamic, culturally mediated perception of being accepted, valued, and relationally safe within an academic environment [5], [7]. Relational safety refers to the sense that one can speak honestly, seek support, express uncertainty, and show emotion without anticipating dismissal, stereotype confirmation, or interpersonal penalty [5]. This definition is critical in graduate STEM programs, where belonging is produced through repeated

interactions that signal whether students are expected to contribute, whether their presence is protected, and whether their full identities can remain intact within the institution [1], [5], [7].

This study is grounded in Black feminist thought, a knowledge tradition that treats Black women's lived experiences as legitimate sources of theory, analysis, and critique while attending to the interlocking operation of racism, sexism, and other forms of structural power [8]. In this paper, "thought" refers not to individual opinion but to a body of scholarship and epistemological commitments that center lived experience, collective care, self-definition, and accountability to Black women's knowledge-making [8], [9]. Black feminist thought is appropriate because participants engaged in a program that created conditions for Black women in science and engineering graduate education to interpret institutional life, name harm, and cultivate forms of belonging that were culturally and politically meaningful.

2. Program Context

Boulder Black Blossoms (BBB) is an institutionally funded program that supports graduate students in science and engineering disciplines at the University of Colorado Boulder. The program operates on a cohort model and supports up to 16 students per year. The program affirms Black women in academia and supports belonging and retention. BBB is grounded in the premise that Black women's experiences must be recognized, affirmed, and supported within academic and professional spaces. The program's commitment to inclusion calls upon individuals of all backgrounds to actively contribute to a more equitable and supportive environment. BBB is designed to be inclusive, with the long-term goal of strengthening collective knowledge practices that support graduate student persistence. Allies and advocates are also welcomed into the program, ensuring that support is multidimensional and rooted in shared responsibility for institutional change.

Monthly Sista Circle meetings served as the program's primary pedagogical anchor. Program structure was sequenced intentionally across the academic year to mirror developmental processes described in the literature on counterspaces and affinity-based learning communities [5], [6]. Early sessions emphasized identity affirmation and trust-building; mid-year sessions focused on boundary setting, voice, and professional navigation; later sessions centered reflection, self-realization, and leadership continuity. Participants gathered in a protected environment centered on confidentiality, collective care, and honest reflection. Meetings typically included shared food, check-ins, guided prompts, facilitated discussion, and time for participants to connect their academic experiences to questions of identity, wellness, and future leadership. Topics included navigating predominantly white departments, mentoring relationships, imposter syndrome, professional visibility, emotional exhaustion, boundary-setting, and rest. The aim was to create a space where participants could interpret graduate school together, receive affirmation, exchange practical knowledge, and rehearse more sustaining ways of moving through the institution [8], [9].

The structure of Boulder Black Blossoms intentionally extends beyond a traditional Sista Circle format. Participants also engaged in activities such as leadership retreats, science communication and literacy workshops, home gatherings, cultural dance experiences, collaborative social events, and service opportunities such as Habitat for Humanity. The program design conceptualizes belonging as something developed through repeated relationship-building encounters rather than produced through a single intervention.

3. Literature Review

Belonging has been widely defined as the perception that one is accepted, respected, included, and supported within an educational environment [7]. In graduate education, belonging is shaped by departmental climate, peer networks, advisor relationships, access to informal knowledge, and opportunities to participate meaningfully in the intellectual life of a program [6], [7]. For Black women in STEM, these processes unfold within institutions where racism and sexism often intersect, making belonging more fragile and conditional than general graduate belonging frameworks sometimes capture [1], [2], [10]. Studies of Black women in STEM show that success often occurs alongside isolation, surveillance, overwork, and the need to continuously prove competence [1], [2]. McGee and Bentley describe this as “troubled success,” a condition in which Black women may achieve academically while carrying profound emotional and relational costs [1]. Related work on women of color in science and engineering higher education shows that participants often seek or create counterspaces because mainstream academic environments do not consistently provide recognition, safety, or affirmation [11]. These studies suggest that belonging in graduate programs cannot be understood only as satisfaction or social comfort. It must also account for whether students can remain intellectually present, culturally intact, and emotionally supported in institutional spaces that have historically not been built for them [12]. Although prior research has documented the importance of counterspaces for women of color in STEM, much of this work focuses on undergraduate populations or informal peer networks [13]. Fewer studies examine structured, institutionally supported spaces designed specifically for graduate Black women in science and engineering, particularly within research universities [6], [13]-[15]. As a result, less is known about how intentionally designed Sista Circles shape graduate-level dimensions of belonging.

3.1. Emotional Support

Emotional support is a core dimension of belonging that centers the recognition, validation, and affirmation of a person’s emotional experience during times of stress. Communication research defines emotional support as messages that acknowledge feelings, legitimize distress, and convey care in ways that reduce isolation and self-doubt [15]. Emotional support prioritizes understanding, validation, and shared meaning-making in response to harm. Within studies of Black women’s friendship and peer networks, emotional support often unfolds through both individual validation and collective framing. Prior research reports that group members engage in explicit validation “*that was not okay*,” empathy, humor, and collective witnessing [16]. These practices affirm emotional reality while reducing self-blame. In the context of Black women in STEM, this work critiques narratives that place responsibility on individuals to endure structural harm [17]. This perspective suggests that emotional support within affinity spaces may serve as a counter-space practice that addresses harm collectively rather than reinforcing individualized coping expectations. Drawing across this literature, emotional support refers to communicative acts within the Sista Circle that recognize and affirm members’ emotional experiences during disclosures of academic, racialized, or gendered stress. It operates at the level of interaction.

3.2. Peer Mentorship

Peer mentorship in doctoral education refers to a reciprocal relationship among students who share similar academic status and use ongoing interaction to support each other’s academic progress and professional development. In higher education research, peer mentoring is defined as

a helping relationship between individuals of similar age or experience who engage in both career-related and psychosocial functions [18]. Career-related functions include sharing information, advising on decisions, and providing task-oriented feedback. Psychosocial functions may include encouragement and affirmation, but they remain tied to performance and development. Cornu further describes peer mentoring as a form of mutual mentoring in which members alternate roles as mentor and mentee depending on context and expertise [19]. This reciprocal structure distinguishes peer mentorship from hierarchical faculty mentorship.

Research on Black women doctoral students shows that peer mentorship can function as a strategy for navigating racialized and gendered academic spaces. In one study, Black women used peer relationships to exchange institutional knowledge, interpret unspoken norms, prepare for milestones, and strategize about navigating faculty interactions [13]. Importantly, the peer mentorship described in their work centered on academic survival and advancement. Participants used the group to clarify expectations, refine plans, and hold one another accountable for progress.

In our study, peer mentorship is defined as semi-structured peer interaction among graduate students that advances doctoral persistence, academic skill development, and professional socialization. It involves three observable elements: 1) members exchange concrete information related to program requirements, funding, publication, networking, or career pathways [13], [18], 2) members engage in goal-linked accountability, such as reporting progress on writing, exams, or proposals, and providing direct feedback on work products [13], [19], and 3) leadership remains fluid. Participants alternate between advising and receiving guidance based on topic expertise rather than formal status [19].

3.3. Cultural Healing

Cultural healing has emerged as a collective response to gendered anti-Black harm. Healing occurs in spaces intentionally designed for Black individuals to gather, name harm, and generate meaning together [12]. Community-engaged healing models describe the creation of “sacred spaces” that support embodied and collective restoration [20]. Within applied examples, scholars describe these settings as containers where Black women can express themselves without surveillance or performance pressures [21]. This structural protection is central to the healing process. It allows participants to shift from managing dominant expectations to engaging in self-definition and communal care [8]. Participants in dance- and somatic-based programs report increased comfort in their bodies and an expanded sense of personal agency following participation [21]. These findings suggest that healing involves more than cognitive reframing. It also requires practices that help participants regulate stress and reconnect with embodied experience. Studies of Black women’s affinity-based circles and storytelling show that participants describe these spaces as sites of safety, belonging, validation, and shared racial–gender pride [8]. Taken together, the literature suggests that cultural healing involves three interrelated processes: 1) protected communal space, 2) embodied and culturally resonant practices, and 3) shared narrative meaning-making that affirms identity. These processes tend to operate simultaneously rather than sequentially [16], [17]. Sacred environments enable participants to engage in embodied practices and storytelling without penalty. Embodied and narrative practices, in turn, reinforce identity validation and collective care. In the context of graduate science and engineering programs, cultural healing may serve as a protective and restorative mechanism.

3.4. Radical Self-Care

Radical self-care is often discussed in Black feminist work as a political practice [22]- [24]. Self-care for Black women has been defined as a form of resistance because it interrupts routine exposure to racialized and gendered harm and rejects the expectation that Black women should remain endlessly productive, emotionally available, and unaffected [24]. This framing treats self-care as intentional and strategic. It focuses on choices that protect one's time, body, and dignity within systems that normalize overwork and dehumanization. Recent scholarship has made these practices more concrete by centering rest and embodied regulation. In Hill's dance-and-wellness project, participants engaged in movement, somatic, nature-based activities, and structured reflection as forms of resistance that encouraged participants to redefine rest in their lives [21]. Additionally, routine documentation of emotional shifts before and after activities shows movement from stress and fear toward contentment, optimism, and empowerment over time [21].

Radical self-care also navigates how Black women in PWIs manage stereotypes and white standards of professionalism through identity negotiation and self-protective strategies such as code-switching [22]. Their analysis emphasizes how workplace norms can pressure Black women to suppress authenticity and manage others' comfort. Similarly, research in STEM and other high-status fields describes how Black women develop resilience strategies to persist in exclusionary environments, while also highlighting the limits of resilience as a sufficient response to systemic conditions [23]. These studies suggest that radical self-care differs from over-adaptation or survival-based coping. Instead, it emphasizes protecting one's capacity and authenticity through deliberate limits, recovery, and refusal of harmful expectations.

In this study, radical self-care centers what an individual chooses to do to protect their well-being within oppressive environments, even when done in the presence of others. Radical self-care refers to intentional, self-directed practices (e.g., boundary-setting, rest, embodied regulation) enacted as resistance to institutional norms that demand overwork, identity suppression, and emotional labor from Black women [24]. Radical self-care shows up when participants describe concrete changes they make to protect their time, bodies, and sense of self while navigating PWI and science and engineering expectations [22], [23], including embodied recovery practices such as rest, somatic grounding, or movement-based regulation [21].

3.5. Research Gap

Current frameworks for graduate belonging often overlook the specific mechanisms of cultural healing and radical self-care as essential components for persistence among Black women in STEM. This study addresses this gap through qualitative narratives and thematic frequency analysis that examine how culturally embedded practices shape belonging in a PWI setting.

4. Purpose and Research Questions

The purpose of this study is to examine how participants describe their sense of belonging before and after participation in a year-long, cohort-based Sista Circle intervention designed to strengthen belonging. Guided by a qualitative-dominant mixed-methods approach, this study addresses the following research questions:

- 1) How did participants describe their sense of belonging in graduate science and engineering before and after participating in Boulder Black Blossoms?,
- 2) What dimensions of belonging were most visible in participants' reflections before and after the program?
- 3) How did participants describe changes in peer mentorship, emotional support, cultural healing, and radical self-care across the year?

5. Methods

This study used a qualitative-dominant mixed-methods design to examine how participation in a culturally grounded Sista Circle program shaped Black women's sense of belonging in STEM graduate programs at a predominantly white institution. The design was qualitative-dominant because the primary analytic goal was to understand participants' experiences, meanings, and descriptions of belonging in their own words. Quantitative summaries served as a secondary analytic tool to examine patterned changes across time in the coded qualitative data [25]. Participant narratives were necessary for interpreting how belonging was described, experienced, and sustained across the program year.

5.1. Researcher Positionality and Reflexivity

Author 1, the program founder and lead facilitator, is a Black woman from the Southern United States who has navigated predominantly white institutions throughout her entire academic trajectory. With over 20 years of experience in STEM engagement and a research background centered on Racial Battle Fatigue, Author 1 designed the BBB as a 'scholar-practitioner' deeply acquainted with racialized and gendered barriers in science and engineering [26], [27]. Her role as the Director of the Graduate School's Office of Graduate Access and Retention as well as faculty affiliate in Engineering Education at the University of Colorado Boulder provided critical institutional access and necessitated a high degree of day-day relationship building with STEM graduate students. This dual role influenced the study's design by prioritizing Sista Circle methodology [6]. To ensure reflexive rigor, Author 1 engaged in "back-talk" with the data, purposefully questioning whether her professional goals for student retention or her personal history with racial isolation were overshadowing the participants' authentic voices [28]. Author 2, also a Black woman and graduate student, served as the lead data analyzer. Her proximity to participants as a current graduate student provided an additional layer of insider insight during coding. By documenting analytic decisions through memoing and an audit trail, the authors maintained transparency while honoring the Black feminist commitment to centering the marginalized voice as the primary authority of its own experience [29].

5.2. Participants

Sixteen individuals who self-identified as Black, African American, or multi-racial participated in the year-long BBB program. Fifteen individuals self-identified as woman and one individual self-identified as non-binary. All participants were master's or Ph.D. students in science and engineering programs at the University of Colorado Boulder. They represented a range of science and engineering departments and approximately one-third of participants were first-year doctoral students. Prior to participating in the program, all participants signed an informed consent. While participants were compensated for their time in the program overall, no additional compensation was provided for participating in the research component. All sixteen participants completed both pre- and post-program surveys, ensuring consistency in the data set.

5.3. Data Collection

Qualitative data were collected through a modified version of the Sista Circle Instrument, administered via Qualtrics before and after program participation [14]. Participants responded to three open-ended reflective prompts. The pre-program prompts were:

- 1) Audre Lorde was quoted as saying, "*Caring for myself is not self-indulgence, it is self-preservation and that is an act of political warfare* [11]." As Black women in doctoral programs, what does this quote mean to you?

- 2) Sense of belonging relates to feeling or being connected to and valued by people and communities. Consider relationships with peers, faculty, and other members of the campus community. Who and what are your connections?

The post-program instrument included the two pre-program questions and the following prompt:

- 3) What have your experiences been as part of this Sista Circle? What has been your experience of being in community and in conversation with other Black women in doctoral programs? All responses are welcome.

Participants were encouraged to respond in whatever format felt most authentic (writing, voice, or video submission) and accessible to them. No written statements were received. All responses were submitted in video or audio format. Each participant selected a secluded setting where they felt comfortable. All sixteen participants completed both the pre-program and post-program instruments and responses lasted 10-15 minutes each, providing a total of 7.6 hours of data (combining pre and post data).

5.4. Data Analysis

Data analysis followed a multi-stage process designed to preserve participant voice while enabling analytic synthesis. First, all audio data were transcribed verbatim. In vivo coding was then applied to retain participants' original language, a method widely used in critical qualitative research to prevent researcher-imposed abstraction from erasing participant meaning [29]. Next, codes were grouped into higher-order themes through iterative comparison and constant reflection. The decision to organize themes around four belonging dimensions (peer mentorship, cultural healing, emotional support, and radical self-care) was theoretically driven [29]. To strengthen analytic rigor and transparency, thematic frequencies were calculated for each dimension at both time points. Converting qualitative themes into frequency counts is an established content analysis practice that allows researchers to examine patterns of change without reducing narratives to decontextualized numbers [25]. Counts were aggregated across participants, resulting in one pre-program and one post-program total per construct. The unit of analysis was therefore the construct ($n = 4$). Finally, percent change was calculated from pre-program to post-program to determine growth or decrease in each belonging domain.

6. Results

The analysis identified a shift in how participants described belonging before and after participation in BBB. Pre-program reflections often described belonging as fragile or dependent on external validation from departments or advisors. Post-program reflections more often described belonging as culturally affirming and sustained through connections with other Black women graduate students. The descriptive frequency analysis supported this qualitative pattern. References to emotional support, peer mentorship, cultural healing, and radical self-care appeared more frequently in post-program reflections than in pre-program reflections, shown in Table 1.

Table 1.*Counts of Statements Aligned to Belonging Categories Before and After the Program*

Belonging Theme	Pre-Program (theme count)	Post-Program (theme count)	Percent Change (%)	Sample Statement	Interpretation
Peer Mentorship	3	9	200%	<i>I would loveeeee to be a mentor to new blossoms especially first years like I was this year."</i> <i>"BBB has given me the opportunity to pay forward the sense of belonging and empowerment I've received in this immaculate safe space." Blossom offered not only space, but a mirror; reflecting back the power and softness I had forgotten I could hold at the same time.</i>	Shift toward reciprocal, institutionally anchored mentoring.
Cultural Healing	2	8	300%	<i>I now see science not just as equations and experiments, but as something that lives in conversation, connection, and community care.</i> <i>"My cohort has been so important... where your mental health is completely trash."</i>	Greater cultural affirmation and greater connection to pro-Blackness as a programmatic practice
Emotional Support	5	13	160%	<i>"My advisor gives me a holistic sense of care, not only as her advisee but as a person."</i> <i>The act of nurturing ourselves, taking care of ourselves, I think is revolutionary, especially within a society that tries to keep us down.</i>	More vulnerability, empathy, and emotional validation.
Radical Self-Care	4	10	150%	<i>I feel like the expectation for Black women is to overextend yourself and stay strong while doing it. I am no longer doing that!</i>	Community accountability supported more concrete care practices
Overall	14	40			

Across the full set of coded responses, belonging-related references increased from pre- to post-program reflections. The largest increase appeared in cultural healing, suggesting that participants more frequently described belonging through cultural affirmation and greater connection to pro-Black programming after participating in the program. Because these counts are aggregated thematic frequencies, they are used to support pattern recognition rather than statistical inference.

6.1. Qualitative Findings: Changes in How Participants Described Belonging

Qualitative data were drawn from pre- and post-program responses from all 16 participants. Responses were coded using vivo methods and organized into the four belonging constructs. Across participants, post-program reflections were longer, more detailed, and more grounded in specific experiences. Participants described clearer, more sustained, and more relational forms of belonging after program participation.

6.1.1. Peer Mentorship (3 pre → 9 post)

Before the program, participants described peer connections as limited or dependent on departments. Participants often located support networks outside the institution, suggesting that mentoring relationships were not consistently available within their departments. After participation, participants described peer mentorship as reciprocal, ongoing, and embedded within the Boulder Black Blossoms community. Mentorship included both academic guidance and relational support. One participant post-program noted, *“The four of us have developed this community... We'll go to events together... I'm really grateful for the mentorship and friendship.”* After the program, relationships were more deeply rooted: *“Getting to speak with Dr. Alston she shared words of encouragement... I left that session believing I could really go and speak with her in the future.”* Importantly, these relationships extended beyond disciplinary boundaries, reducing dependence on often isolating departmental environments.

6.1.2. Cultural Healing (2 pre → 8 post)

Pre-program responses often reflected a lack of access to culturally affirming spaces within the institution. Participants described seeking cultural connection outside the university, including travel to external organizations or reliance on prior undergraduate communities. Participants often described cultural connection as something they had to seek outside the university. A participant stated, *“I have to drive 45-mins to join an organization called National Society of Black Engineers... we still get to keep in touch and hang out.”* Post-program responses described cultural affirmation occurring within the university through shared activities and program events.

Participants referenced dance, storytelling, and engagement with Black women scholars as meaningful experiences. This shift reflects movement from external or absent cultural connection to institutionally embedded cultural presence. Post-program reflections illustrate how shared rituals, creative expression, and engagement with Black women scholars transformed cultural identity from a source of marginalization into a site of affirmation and strength. *“The dance lesson allowed me to get more into my roots... and how our styles of dance changed as Afro-Latino fusion culture grew.”* These experiences connected participants with ancestral histories and collective joy

6.1.3. Emotional Support (5 pre → 13 post)

Before the program, participants described emotional strain, institutional pressure, and limited access to affirming support within the institution.. Pre-program responses included statements like, *“Care is pushing back against all these systems that don't want us to thrive.”* After participation, emotional support was described more frequently and with greater specificity. After participation, participants described emotional support as shared vulnerability, empathy, and validation within the Sista Circle. Post-program responses demonstrated vulnerability and shared empathy: *“Hearing other people be vulnerable... helped me feel I'm not alone and it's okay to feel these feelings.”* Sista Circle spaces allowed participants to articulate exhaustion, imposter

syndrome, and grief without self-censorship. The normalization of vulnerability helped counter internalized deficit narratives and reinforced shared humanity.

6.1.4. Radical Self-Care (4 pre → 10 post)

Prior to the program, participants described self-care primarily as an aspirational concept. *“I found myself sacrificing personal time and even sleep to keep up with unspoken expectations as a Black woman.”* Following participation, they described concrete behavioral changes, including boundary-setting, structured rest, and collective accountability for wellness. Self-care moved from an aspirational idea to a sustained practice embedded within community. *“The Blossoms made me take care of my emotional and physical health... I now hike, walk, and eat better with other Blossoms holding me accountable.”* These responses indicate that participants moved from recognizing the importance of self-care to describing how they enacted it.

6.2. Quantitative Patterns of Change

Across all four constructs, the frequency of coded statements was higher in post-program reflections than in pre-program reflections. Peer mentorship increased from 3 to 9 coded statements (200%), cultural healing from 2 to 8 (300%), emotional support from 5 to 13 (160%), and radical self-care from 4 to 10 (150%). Overall, percent increases ranged from 150% to 300%, with the largest increases observed in cultural healing and peer mentorship. These patterns indicate that participants referenced all four constructs more often in post-program reflections. Participants’ post-program reflections also described belonging as more relational, sustained, and community centered. The increase in coded statements across all four constructs aligns with this shift, indicating that participants drew on a wider range of belonging-related constructs in their post-program descriptions.

7. Discussion

The purpose of this study was to examine how participants described their sense of belonging before and after participation in a year-long, cohort-based Sista Circle intervention designed to strengthen belonging. The findings show that participants’ descriptions of belonging changed across the program year. Before participation, participants often described belonging as conditional, externally located, or dependent on spaces outside their immediate graduate environment. After participation, they described belonging as more relational, culturally affirming, emotionally sustaining, and connected to the Boulder Black Blossoms community.

This distinction matters because the study does not make a broad causal claim that BBB alone produced belonging. Instead, the study shows how participants narrated belonging before and after participating in a structured, culturally affirming program. Their descriptions became more specific, community-centered, and grounded in shared practice. For Black women in science and engineering graduate programs at a PWI, this shift is significant because belonging is shaped by more than academic access. It is shaped by recognition, peer accountability, cultural healing, emotional support, and radical self-care.

This study contributes to engineering education and graduate education research by showing how Black women describe belonging within a cohort-based Sista Circle intervention. The findings also complicate individualistic models of graduate persistence. Participants did not describe belonging as something they developed alone through adjustment, resilience, or personal effort. They described belonging as something sustained through relationships, shared

interpretation, and culturally affirming practices that responded to the racialized and gendered conditions of graduate science and engineering.

7.1. RQ1 How did participants describe their sense of belonging in graduate science and engineering before and after participating in Boulder Black Blossoms?

The transition from pre-program to post-program reflections showed a shift from conditional belonging to institutionally situated belonging. Before the program, participants often described meaningful support as something they had to find outside their immediate graduate environment. Findings align with Sankofa Waters's "When and Where We Enter" framework, which emphasizes the importance of spaces that affirm Black women's humanity before they must navigate broader institutional exclusions [30].

After participating in BBB, participants described belonging as more accessible within the university. This shift matters because science and engineering graduate environments often make Black women visible through evaluation while leaving their personhood, wellness, and cultural knowledge unrecognized [31]. BBB addressed this contradiction by creating a recurring campus space where participants could be known beyond productivity, performance, and representation. Recognition became a central part of belonging. For example, one participant remembered the impact of someone greeting her by name during a BBB meeting, *"the fact that someone remembered my name and said 'Hey, Que!' at our second BBB meeting left an impression on me."* That moment was small in scale, but important in meaning. It showed that being remembered, seen, and welcomed can interrupt the isolation that Black women often experience in graduate STEM spaces. The significance of this finding is that departmental belonging cannot be assumed. Formal admission into a graduate program does not guarantee relational safety, cultural affirmation, or a sustained sense of place. Participants' reflections suggest that belonging becomes stronger when institutions provide repeated opportunities for recognition, safety, and meaningful connection [32]. BBB made these opportunities more visible and repeatable across the academic year.

This finding also extends research on Black women's belonging by showing that culturally affirming community can help participants interpret graduate education differently. Participants did not only describe BBB as a source of support. They described it as a space that helped them make sense of their experiences, locate community within the institution, and sustain their sense of belonging over time. This aligns with research showing that Black women's belonging is tied to community, coping, and spaces where they do not have to translate their experiences for others [20], [33]. It also aligns with research showing that marginalized students' belonging depends on broad climate perceptions and everyday interactions that communicate recognition and safety[34].

For Black women in science and engineering graduate studies, belonging is feeling included and having a place where one's presence, intellect, culture, and emotional life can remain intact. BBB did not erase the racialized and gendered conditions of graduate STEM. It provided a structured space where participants could name those conditions, build community, and experience the university as a place where they could be known and affirmed.

7.2. RQ2 What dimensions of belonging were most visible in participants' reflections before and after the program?

The quantitized frequency analysis showed that belonging changed in both frequency and meaning. Participants referenced all four constructs more often after the program, but the contribution of these findings extends beyond the counts. Peer mentorship, emotional support,

cultural healing, and radical self-care each revealed a different mechanism through which participants described belonging in graduate science and engineering.

Together, these dimensions show that belonging was not limited to social connection. Participants described belonging through academic guidance, shared racialized understanding, emotional validation, cultural reconnection, and wellness practices. Graduate programs often separate these forms of support into distinct categories. For Black women in science and engineering, the findings suggest that these dimensions operate together.

7.2.1. Peer mentorship

Peer mentorship shifted from limited or externally dependent support to reciprocal, program-based relationships. Many graduate support models position faculty-student mentoring as the primary source of guidance. Participants' reflections show that peer mentorship served a different function. It helped them navigate academic expectations while also providing racialized understanding, emotional affirmation, and accountability.

BBB made peer mentorship intentional rather than incidental. Participants did not have to depend only on chance relationships, departmental fit, or individual persistence. The program created repeated opportunities for cross-disciplinary guidance and shared accountability. In science and engineering contexts, where Black women may be the only or one of few Black women in their departments, laboratories, or research groups, peer mentorship can reduce isolation and expand the network of support beyond a single advisor or department.

This finding aligns with research showing that Black graduate students benefit from mentoring spaces that address both intellectual development and the racialized realities of graduate education [35]. It also supports the argument that cultural affirming mentoring for graduate students of color involves doing, caring, and being, in addition to technical advice [13]. In this study, peer mentorship helped participants understand graduate school as something they could navigate with others. That shift reframes persistence as a shared practice rather than an individual burden.

7.2.2. Emotional support

Emotional support showed the highest post-program frequency, making it the most visible dimension of change. In white-dominant graduate settings, Black women are often expected to remain composed, competent, and high-performing while managing race-gender stress. BBB created a setting where participants could name isolation, exhaustion, and uncertainty without treating those experiences as individual failure. The statement, *"Hearing other people be vulnerable about the isolation they sometimes feel... helped me feel my experience is shared,"* shows how emotional support changed the meaning of isolation. Isolation became a collective condition that participants could name and address. This shift is important because Black women in graduate STEM may internalize isolation as evidence that they do not belong. The Sista Circle format helped participants reinterpret isolation as a product of institutional and disciplinary conditions rather than a personal deficit.

This interpretation aligns with recent work showing that Black women's belonging is strengthened when community spaces support coping, recognition, and shared understanding [36]. It also echoes research showing that belonging for marginalized students depends on everyday interactions, not only institutional statements about inclusion [16], [17]. In this study, emotional support helped participants remain connected to themselves, their peers, and their academic goals.

Graduate education often treats emotional support as outside the academic mission. Participants' reflections suggest otherwise. Emotional support shaped how they understood their place in graduate school. It also helped build the trust needed for peer mentorship, cultural healing, and radical self-care. For Black women in science and engineering, emotional support operates as part of the infrastructure of belonging.

7.2.3. Cultural healing

Cultural healing showed the largest proportional increase. This pattern indicates that participants described belonging through cultural affirmation, embodied practice, and collective meaning-making. Before the program, participants often described cultural connection as something they had to seek elsewhere. After participation, cultural affirmation became part of their university experience. These findings challenge science and engineering norms that separate intellectual development from culture, body, emotion, and identity. Participants' references to dance, Black women scholars, Juneteenth programming, STEMNoire conference, and Dr. Ibram X. Kendi's anti-racism structured conversations suggest that cultural healing helped them connect graduate identity with Black womanhood, joy, and collective knowledge. Cultural healing therefore operated as more than a wellness activity. It helped participants experience Blackness, womanhood, and scientific identity as compatible rather than fragmented.

French et al. argue that healing in communities of color involves coping, critical consciousness, collectivism, emotional emancipation, and culturally grounded restoration [37]. Adames et al. similarly emphasize that healing from racism-related stress must address structural wounds rather than treating distress as individual pathology [38]. McNeal et al. also frame healing for Black women as embodied and community engaged. Together, these frameworks help explain why cultural healing emerged as a central dimension of belonging in this study.

For Black women in science and engineering, cultural healing offers a way to resist the fragmentation often produced by graduate STEM environments. These environments may ask students to bring their intellect while managing or minimizing other parts of themselves. BBB created space for participants to engage in science and engineering while remaining connected to cultural memory, embodied joy, and collective care.

7.2.4. Radical self-care.

Radical self-care shifted from awareness to practice across the program year. Pre-program responses often described overwork, sleep loss, and the expectation that Black women should remain strong while managing institutional pressure. These descriptions point to a racialized and gendered performance demand. Black women are often expected to endure stress, produce at high levels, and remain emotionally available without institutional acknowledgment of the cost. Post-program responses more often describe boundary-setting, embodied release, rest, and joy. This shift positions wellness as part of doctoral persistence. Participants did not describe self-care as an individual escape from academic work. They described it as a practice that helped them remain whole while continuing to navigate graduate education.

Hughes et al. argue that resilience discourse becomes inadequate when it leaves structural harm intact and celebrates students only for surviving it [23]. Radical self-care offers a different frame. It treats rest, boundaries, embodied regulation, and joy as practices that help Black women remain whole in environments that often reward depletion. Within BBB, self-care became a shared practice supported by community accountability. Graduate education often rewards overwork and frames exhaustion as evidence of commitment. For Black women in science and engineering, that

culture can intensify race-gender stress. Radical self-care helped participants challenge the expectation that they must sacrifice their bodies, time, and emotional well-being to prove they belong. In this study, self-care became one-way participants sustained their belonging rather than depleted themselves in pursuit of it.

7.3. RQ3 How did participants describe changes in peer mentorship, emotional support, cultural healing, and radical self-care across the year?

The four constructs were closely interrelated. The interrelatedness of the four constructs suggests that belonging functions as an interconnected process. Emotional support made radical self-care actionable, while cultural healing made peer mentorship more meaningful. This aligns with Washington et al.'s concept of community uplift capital, where participants' aspirations were fueled by a collectivistic orientation [33]. This challenges the individualist nature of STEM graduate education, suggesting that Black women's persistence is a communal achievement rather than an isolated one.

Participants described peer mentorship as a source of both guidance and emotional support, because these relationships allowed them to speak with other Black women who understood the expectations and pressures of graduate science and engineering. For example, the statement *"hearing other people be vulnerable... helped me feel I'm not alone"* shows how emotional support shifts interpretation from individual struggle to shared experience. Similarly, *"I am no longer doing that [sacrificing sleep]"* reflects a transition from awareness to action in self-care. Emotional support helped participants translate self-care from awareness into action.

These experiences show that participation in BBB supported participants in drawing on and deepening the cultural wealth they already brought with them, which strengthened how they understood and sustained their sense of belonging across the year. The participants in this study experienced support as interconnected, with each theme reinforcing the other [13], [16], [24], [34].

7.4. Practical implications in the current political climate

These findings have direct implications for practice, especially in a period when diversity, equity, and inclusion programs are increasingly challenged, narrowed, or removed. Recent policy scholarship argues that diversity equity, and inclusion should be treated as structural work required for equitable institutions [38]. The central contribution of this study is that BBB supported participants in recognizing, using, and sustaining the cultural wealth they already brought with them [33], [39]. They described using the program to interpret their experiences, connect with others, and develop practices that supported their well-being. The present study shows that intentionally designed, culturally grounded programs can create conditions which Black women graduate students can draw on their strengths, experience greater connection and affirmation, and sustain themselves more fully within graduate education.

For science and engineering graduate education, the implication is clear. A stronger sense of belonging cannot be outsourced to individual advisors or assumed to emerge from representation alone. Institutions that want to support Black women need recurring, structured, year-long spaces that combine mentoring, community-building, healing-centered programming, professional development, and opportunities for embodied joy and reflection. A single networking event or workshop is unlikely to produce the kind of multidimensional change shown here.

8. Limitations and future research

This study was not designed for statistical generalization. The sample is small, site-specific, and centered on one intentionally designed program at one institution. The study also relies on

self-reported reflections and coded qualitative responses rather than validated belonging scales. In addition, the quantitative analysis was conducted at the construct level, which limits statistical power and warrants caution in interpretation. These limitations clarify the scope and type of claim the study makes. This paper offers a contextually grounded account of how one program shaped participants' sense of belonging for a specific group of Black women graduate students in science and engineering.

Future research should build on this work in multiple directions. Longitudinal studies could examine whether these shifts in belonging persist beyond one year and whether they influence retention, advisor relationships, research confidence, or career trajectories. Comparative studies could examine whether similar programs operate differently across institutional types or disciplinary cultures. Mixed-methods work could also combine narrative data with validated measures of belonging, racial climate, mental health, and professional identity. Finally, future studies should continue to theorize cultural healing and radical self-care as central dimensions of belonging for Black women in graduate science and engineering.

9. Conclusion

This research contributes to the fields of engineering education and higher education policy by providing an empirical, mixed methods account for how culturally grounded counterspaces can shape the graduate experience for Black women. While existing literature often focuses on undergraduate belonging or informal peer networks, this study offers a systematic assessment of an institutionally supported intervention tailored to the specific developmental and racialized needs of doctoral-level scientists and engineers. By centering Black Feminist Thought and community cultural wealth, this work shifts the conversation from increasing representation alone to examining how graduate environments can provide structured, restorative community. The conclusions drawn from the study suggest that for Black women in graduate STEM, belonging is a multidimensional construct that requires more than academic integration. The descriptive quantitative patterns and qualitative shifts observed, specifically in the areas of cultural healing and radical self-care, indicate that Black women's persistence is fueled by the capacity challenge resilience expectations that require Black women to endure harm without institutional change. Ultimately, the findings suggest that when institutions invest in parallel institutional geographies like the Boulder Black Blossoms Sista Circle, they provide Black women the necessary infrastructure to activate their existing cultural capital, which may support a sense of belonging that is more durable, local, and sustained.

References

- [1] E. O. McGee and L. Bentley, "The troubled success of Black women in STEM," *Cognition and Instruction*, vol. 35, no. 4, pp. 265–289, Oct. 2017.
- [2] M. Ong, C. Wright, L. L. Espinosa, and G. Orfield, "Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics," *Harvard Educational Review*, vol. 81, no. 2, pp. 172–209, 2011. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=5740b909-e8a0-3761-83b0-39220ec4bc72>
- [3] A. M. B. Holder, C. M. Capodilupo, and D. W. Sue, "Racial microaggressions in the life experience of Black Americans," *Professional Psychology: Research and Practice*, vol. 39, no. 3, pp. 329–336, Jun. 2008, doi: 10.1037/0735-7028.39.3.329.
- [4] Society of Women Engineers, "U.S. enrollments: Higher education, recent updates," Society of Women Engineers. [Online]. Available: <https://swe.org/research/2025/u-s-enrollments/>. Accessed: Feb. 8, 2026.
- [5] D. Palmer and E. Udoh, "Removing the veil of whiteness in qualitative research using Sista Circle methodology," *International Journal of Qualitative Methods*, pp. 1–11, Aug. 2024, doi: 10.1177/16094069241278161.
- [6] J. Poe, J. Reed, and R. Nunley, "New considerations for Sista Circle methodology: Applications in relation to beauty, femininity, and place," *Qualitative Inquiry*, vol. 31, no. 5, pp. 481–491, Jun. 2025, doi: 10.1177/10778004241250071.
- [7] T. L. Strayhorn, *College Students' Sense of Belonging: A Key to Educational Success for All Students*, 2nd ed. New York, NY, USA: Routledge, 2018. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=b505cbb7-a339-37b7-ac9c-26cb88345488>
- [8] P. H. Collins, *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment*, Rev. 10th anniversary ed. New York, NY, USA: Routledge, 2000. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=de311800-e750-3e33-b65f-32d9d433db3a>
- [9] b. hooks, *Sisters of the Yam: Black Women and Self-Recovery*, 3rd ed. New York, NY, USA: Routledge, 2015. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=b811d11c-84c0-3de5-b74f-02d3ce9b818d>
- [10] R. E. Zambrana, R. Ray, M. M. Espino, C. Castro, B. D. Cohen, and J. Eliason, "'Don't leave us behind': The importance of mentoring for underrepresented minority faculty," *American Educational Research Journal*, vol. 52, no. 1, pp. 40–72, Feb. 2015.
- [11] A. Lorde, *A Burst of Light*. Ithaca, NY, USA: Firebrand Books, 1988. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=a0eaca5c-5337-3694-bb1a-6f1c56ce86ee>

- [12] A. D. Jemal, "Time and place for counter-storytelling as liberatory theory and collective healing practice in academia: A case example of a Black feminist psycho-socio cultural scholar-artist," *Genealogy*, vol. 8, no. 2, p. 69, Jun. 2024, doi: 10.3390/genealogy8020069.
- [13] J. L. Minnett, A. D. James-Gallaway, and D. R. Owens, "Help a sista out: Black women doctoral students' use of peer mentorship as an act of resistance," *Western Educational Researcher*, vol. 31, no. 2, pp. 210–238, Apr. 2019.
- [14] K. M. Collier and M. R. Blanchard, "Historically underrepresented graduate students' experiences at a U.S. majority serving institution: A narrative analysis," *International Journal of Doctoral Studies*, vol. 19, pp. 1–28, Jan. 2024, doi: 10.28945/5243.
- [15] S. M. Davis, "When sistahs support sistahs: A process of supportive communication about racial microaggressions among Black women," *Communication Monographs*, vol. 86, no. 2, pp. 133–157, Apr. 2019, doi: 10.1080/03637751.2018.1548769.
- [16] G. Packard *et al.*, "Emotion regulation within context: Understanding buffering effects on chronic pain and PTSD among Black women who've experienced sexual assault and racism," *Violence Against Women*, vol. 31, no. 15–16, pp. 3958–3978, Dec. 2025, doi: 10.1177/10778012241289430.
- [17] T. Nelson and M. Cherry, "Sister outsider: Superwoman schema, emotion regulation, and psychological distress among Black college women," *Journal of Black Psychology*, vol. 50, pp. 631–658, Sep. 2024, doi: 10.1177/00957984241284985.
- [18] J. L. Terrion and D. Leonard, "A taxonomy of the characteristics of student peer mentors in higher education: Findings from a literature review," *Mentoring & Tutoring: Partnership in Learning*, vol. 15, no. 2, pp. 149–164, May 2007, doi: 10.1080/13611260601086311.
- [19] R. L. Cornu, "Peer mentoring: Engaging pre-service teachers in mentoring one another," *Mentoring & Tutoring: Partnership in Learning*, vol. 13, no. 3, pp. 355–366, Dec. 2005, doi: 10.1080/13611260500105592.
- [20] R. McNeal, M. Harris, and V. Oliphant, "Re-envisioning community engaged healing for Black women," *Journal of International Women's Studies*, vol. 26, no. 3, pp. 1–11, 2024.
[Online]. Available: <https://vc.bridgew.edu/jiws/vol26/iss3/5/>
- [21] C. Hill, "Dance and wellness: The Black Women Dream Project," *Dance Education in Practice*, vol. 11, no. 4, pp. 28–33, Oct. 2025, doi: 10.1080/23734833.2025.2570038.
- [22] V. K. Herrera and B. M. Williams, "'I have to be very intentional about how I communicate': Black women administrators' identity navigation in predominantly White institutions," *Journal of Higher Education*, vol. 96, no. 6, pp. 959–983, Nov. 2025, doi: 10.1080/00221546.2024.2424129.
- [23] R. Hughes, A. Ibourk, L. Wagner, K. Jones, and S. Crawford, "#Resilience is not enough for Black women in STEM: Counterstories of two young Black women becoming a STEM person," *Journal of Research in Science Teaching*, vol. 61, pp. 744–771, 2024, doi: 10.1002/tea.21925.

- [24] M. F. Ward, “‘Metamorphic liberation’: Radical self-care and the biopolitical agency of Black women,” *Kalfou*, vol. 8, no. 1–2, Dec. 2021, doi: 10.15367/kf.v8i1-2.372.
- [25] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. Thousand Oaks, CA, USA: SAGE, 2018. [Online]. Available: <https://research.ebsco.com/linkprocessor/plink?id=38d43fd8-5cbc-3e27-bb78-8500bca2e072>
- [26] C. Alston, F. Mirghassemi, and C. D. Gist, “A course in academic writing as a vehicle for personal growth and transformation,” *Multicultural Perspectives*, vol. 24, no. 3, pp. 138–146, Jul. 2022, doi: 10.1080/15210960.2022.2127396.
- [27] C. Crawford, “How to stop internalizing microaggressions,” *Women in Higher Education*, vol. 29, no. 10, pp. 6–14, Oct. 2020, doi: 10.1002/whe.20900.
- [28] S. M. Davis and M. K. Jones, “Sistah scholars-hip: A Black feminist epistemology praxis for Black women researching Black women,” *Women’s Studies in Communication*, vol. 49, no. 1, pp. 21–40, Feb. 2026, doi: 10.1080/07491409.2025.2558855.
- [29] J. A. Maxwell, *Qualitative Research Design: An Interactive Approach*, 3rd ed. Thousand Oaks, CA, USA: SAGE, 2013.
- [30] M. B. Sankofa Waters, “When and where we enter: Introduction to the special issue,” *Urban Education*, vol. 61, no. 2, pp. 251–254, Feb. 2026, doi: 10.1177/00420859241258194.
- [31] J. S. Dixon, D. Wang, and R. E. Ready, “Discrimination and cognition in midlife Black women: The roles of social support and spirituality,” *The Journals of Gerontology: Series B*, vol. 79, no. 1, Jan. 2024, doi: 10.1093/geronb/gbad201.
- [32] K. Thomas, J. Johnson-Bailey, R. Phelps, N. M. Tran, and L. Johnson, “Women of color at midcareer: Going from pet to threat,” in *Psychological Health of Women of Color*, L. Comas-Díaz and B. Greene, Eds., M. A. Paludi, Series Ed. Santa Barbara, CA, USA: Praeger, 2013, pp. 275–286, doi: 10.5040/9798216002536.ch-014.
- [33] L. F. Washington, R. Winkle-Wagner, and K. Ray, “Closer to my dreams: Exploring Black women’s graduate school aspirations and community uplift through a community cultural wealth and Black feminist approach,” *Journal of Higher Education*, vol. 96, no. 6, pp. 1008–1034, Nov. 2025, doi: 10.1080/00221546.2024.2429977.
- [34] M. N. Inniss-Thompson, S. Leath, and J. N. Harris, “Seeing Black girls in their glory: Cultivating spaces that facilitate Black girls’ psychological safety,” *Journal of Black Psychology*, vol. 50, pp. 259–292, Feb. 2024, doi: 10.1177/00957984241231038.
- [35] S. Fries-Britt and B. Turner Kelly, *Black Women Navigating the Doctoral Journey: Student Peer Support, Mentorship, and Success in the Academy*, 1st ed. New York, NY, USA: Routledge, 2023, doi: 10.4324/9781003394648.
- [36] K. F. James *et al.*, “A qualitative exploration of Black women’s strategies to achieve emotional well-being from symptoms of perinatal mood and anxiety disorders,” *Perspectives in Psychiatric Care*, vol. 2024, pp. 1–14, Dec. 2024, doi: 10.1155/ppc/8674117.

- [37] B. H. French *et al.*, “Toward a psychological framework of radical healing in communities of color,” *The Counseling Psychologist*, vol. 48, no. 1, pp. 14–46, Jan. 2020, doi: 10.1177/0011000019843506.
- [38] H. Y. Adames *et al.*, “Radical healing in psychotherapy: Addressing the wounds of racism-related stress and trauma,” *Psychotherapy*, vol. 60, no. 1, pp. 39–50, Mar. 2023, doi: 10.1037/pst0000435.
- [39] T. J. Yosso, “Whose culture has capital? A critical race theory discussion of community cultural wealth,” *Race Ethnicity and Education*, vol. 8, no. 1, pp. 69–91, Mar. 2005, doi: 10.1080/1361332052000341006.