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Wellness in STEM Pathways: Exploring the Challenges and Supports for Historically Underserved STEM Undergraduates Beyond Grades

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ABSTRACT

Historically underserved STEM undergraduates face interconnected barriers that affect academic success and well-being. This exploratory survey study investigates: (1) What challenges compromise historically underserved students' wellness, and what resources help them cope? (2) How do students perceive institutional practices as supporting or hindering their well-being? Findings show Black, Indigenous, People of Color (BIPOC) students often feel excluded in predominantly white spaces, and gender-marginalized students report similar isolation. Identity-based organizations are key emotional and social supports. First-generation students struggle to meet academic demands but benefit from transition programs and advising, while low-income students face financial barriers to enrichment. Participants report limited confidence in institutions' commitment to equity, underscoring the need for coordinated, campus-wide, wellness-focused reforms within the United States.

Keywords: academic persistence, equity in higher education, historically underserved students, STEM education, wellness

INTRODUCTION

The persistence and success of historically underserved students in science, technology, engineering, and mathematics (STEM) fields remains a pressing concern in higher education (National Academies of Sciences, Engineering, and Medicine, 2016; Jehangir et al., 2023; Hansen et al., 2024). Despite institutional efforts to diversify the STEM workforce, students from historically underserved groups such as Black, Indigenous, and People of Color (BIPOC), women, transgender students, first-generation students, and low-income students continue to face systemic barriers that undermine both their academic success and their overall well-being (Thiem and Dasgupta, 2022). While research has consistently shown that these students are underrepresented in STEM disciplines, face higher attrition rates, and experience unique challenges related to their identity and institutional context (Hurtado et al., 2011; Ong et al., 2011; Garibay, 2015; Cherng et al., 2024), less is known about their holistic wellbeing. Understanding the experiences of these students particularly through the lens of holistic wellness is essential for developing more equitable and supportive STEM learning environments.

In this study, we conceptualize wellness as a multidimensional construct encompassing physical, emotional, social, intellectual, occupational, and environmental dimensions (Swarbrick, 2006; Johnson, 2024). Within the STEM education context, wellness extends beyond individual health to include how students experience belonging, validation, and access to resources across these dimensions. Although equity work in STEM education has primarily focused on academic outcomes such as course performance, retention, and degree attainment, these outcomes are closely intertwined with wellness. Challenges in one wellness domain often cascade into others since financial strain can limit access to learning resources; social isolation can inhibit collaboration; and emotional distress from navigating exclusionary environments can diminish academic engagement and persistence (Means & Pyne, 2017; Brown et al., 2024). A wellness-centered framework therefore allows us to examine not only the barriers underserved students face, but also how they endure and resist these barriers within interlocking systems of power (Salazar et al., 2024).

This study aims to deepen our understanding of the barriers faced by historically underserved students in STEM, as well as the institutional practices and supports that can foster a more equitable educational environment. Drawing

on both quantitative and qualitative data, this study explores the experiences of historically underserved students pursuing STEM degrees at a large research university in the Southeastern United States. Specifically, it highlights the intersections of identity, institutional culture, and wellness. The findings offer important insights for policymakers, educators, and administrators seeking to address inequities in STEM education and promote the holistic success of all students, not just in academic achievement, but instead in well-being across all its dimensions.

Theoretical Framework. This study draws on Swarbrick's (2006) eight dimensions of wellness to conceptualize student well-being as a holistic, dynamic process. Rather than viewing wellness as limited to physical health or mental health alone, this framework encompasses eight interconnected dimensions: physical, emotional, social, spiritual, intellectual, occupational, financial, and environmental (Swarbrick & Yudof, 2014). These dimensions are mutually reinforcing, suggesting that wellness is not experienced in isolated compartments but unfolds through complex interactions across students' personal, academic, and institutional contexts (see Table 1). This comprehensive framework has been increasingly adopted within higher education settings (e.g., Anderson, 2016; Johnson, 2024) to better understand how STEM student success is shaped by the interplay of wellness dimensions.

Accordingly, students encounter a range of academic, financial, social, and emotional pressures that interact across wellness domains. Physical wellness, such as maintaining sleep, nutrition, and movement, underpins cognitive function and stamina. Emotional wellness, which includes coping with stress and cultivating healthy relationships, is essential for navigating academic and social demands. Social wellness emphasizes the development of meaningful relationships and reliable support networks, particularly for students who may feel excluded based on race, gender identity, income, or first-generation status. Spiritual wellness involves a sense of purpose and meaning, which may influence students' motivation, resilience, and goal-setting. Intellectual wellness aligns closely with the mission of higher education, emphasizing curiosity, creativity, and the pursuit of knowledge. Occupational wellness includes satisfaction and meaning derived from academic work, research, employment, or internships. Financial wellness, often strained by tuition, debt, and limited resources, can directly affect academic focus and emotional health. Environmental wellness concerns the quality and accessibility of physical spaces, including classrooms, housing, and study areas, and how these impact student comfort, safety, and engagement.

Closely tied to both social and emotional wellness is the concept of belonging. Drawing from Yuval-Davis (2006), we define belonging as the emotional investment individuals make in their connection to people, places, and institutions. In this study, belonging is considered a multidimensional outcome of wellness;

consequently, serving as a marker of whether institutional conditions allow students to feel valued, supported, and able to thrive. Belonging is thus not simply a byproduct of inclusion efforts but an essential dimension through which wellness manifests in the everyday lives of historically underserved students. By using this lens, institutions can move beyond narrow definitions of achievement and consider how campus policies, practices, and cultures either support or undermine student well-being. A wellness-centered approach enables institutions to design more equitable systems of support that attend to the whole student, ultimately fostering environments in which all students can thrive academically, personally, and professionally.

Table 1. Descriptions of wellness dimensions (Adapted from Johnson, 2024)

Wellness Dimensions	Description	Example
Physical	Maintaining a healthy balance of exercise, rest, and nutrition.	An undergraduate chemistry student ensures they get enough sleep and eat balanced meals to stay focused during long lab sessions.
Emotional	Managing emotions, handling stress effectively, and fostering meaningful relationships.	A biology student joins a campus support group to cope with the pressures of exams and research deadlines.
Social	Building relationships, fostering a sense of belonging, and creating a reliable support network.	An engineering student participates in study groups and STEM organizations to connect with peers and gain academic support.
Spiritual	Finding meaning, purpose, and personal values that guide one's life.	A physics student reflects on how their research contributes to advancing scientific knowledge and benefiting society.
Intellectual	Engaging in lifelong learning, developing critical thinking, and enhancing problem-solving skills.	A computer science student attends coding workshops and seeks mentorship to expand their programming skills.
Occupational	Gaining satisfaction and growth from academic	A chemistry major finds fulfillment by contributing to a

	work, internships, or research experiences.	research project that develops sustainable materials.
Financial	Effectively managing current financial responsibilities and preparing for future financial stability.	An engineering student creates a budget to manage tuition, books, and living expenses while saving for graduate school.
Environmental	Living and working in safe, healthy, and inspiring environments.	A biology student chooses to study in outdoor spaces or well-ventilated labs that promote focus and well-being.

LITERATURE REVIEW

Historically underserved students in STEM higher education face persistent systemic barriers that create significant challenges to their well-being and academic success (Thiem and Dasgupta, 2022). Student wellness is increasingly recognized as critical to persistence and equity in STEM (Cherng et al., 2024). However, existing research has yet to fully examine how students from these backgrounds navigate and resist such adversity or how institutions are addressing the underlying structural inequities. This literature review addresses this gap by synthesizing research on systemic barriers and their impacts on student wellness, student-led strategies of resilience and resistance, and institutional efforts toward structural change. In doing so, the review highlights the importance of holistic, structural approaches to fostering wellness and inclusion in STEM education.

Systemic Barriers and Their Impact on Wellness in STEM. Navigating student life in STEM higher education can be particularly challenging for students from historically underserved groups, including BIPOC (Black, Indigenous, and People of Color), gender-marginalized (women and transgender individuals), first-generation, and low-income students (Mena, 2022; Sotomayor et al., 2022; Nicolazzo, 2023; Tichavakunda, 2024). These groups often encounter challenges that extend beyond academics and deeply affect their sense of well-being and persistence. Structural and cultural barriers in STEM disciplines shape how students perceive their sense of fit and their long-term trajectories. Archer et al. (2015) found that students' decisions to pursue chemistry degrees were heavily influenced by their perceptions of belonging and career relevance. Those who did not see themselves fitting into the culture of chemistry or doubted the applicability of the degree were less likely to persist (Avargil et al., 2024). Similarly, Madsen et al. (2019) explored how stereotypes affect women and underrepresented minority students in engineering, revealing that negative assumptions about competence contributed to psychological burdens, self-doubt, and exclusion.

These barriers are reinforced by microaggressions and biased interactions, ultimately reducing students' sense of belonging and increasing attrition.

For instance, Callahan et al. (2021) highlight how non-white women in biomedical doctoral programs experience structural violence, including microaggressions and exclusionary practices, which hinder academic progress and mental health. Their study emphasizes that such marginalization is systemic and not merely interpersonal. McGee and Martin (2011) foundationally demonstrate how stereotype threat and persistent institutional biases shape the academic experiences of Black women in mathematics and engineering, reinforcing feelings of isolation and the need for resilience beyond what is sustainable. For first-generation and low-income students, Stephens et al. (2012) show that cultural mismatches between students' interdependent values and the independence emphasized by higher education create feelings of alienation. These mismatches negatively impact academic performance and highlight a need for more inclusive institutional cultures. Nguyen and Benet-Martínez (2013) found that bicultural low-income students with strong social support experienced better psychological adjustment and academic outcomes, demonstrating how identity and systemic barriers intersect with wellness. Together, these studies point to a pressing need to understand how systemic inequities diminish student well-being and persistence (Miller and Markowski, 2023; Hunsu et al., 2023; Rockwell and Kimel, 2025).

Student-Led Strategies for Navigating and Resisting Challenges. While the structural barriers in STEM are significant, students are not passive recipients of these challenges. Many develop strategies for resilience, identity development, and community building. Despite institutional shortcomings, students actively navigate these environments. Callahan et al. (2021) and Stephens et al. (2012) both illustrated how students cope with exclusionary practices and mismatches in values. Strategies include seeking informal networks of support, adapting to institutional norms while preserving cultural values, and resisting marginalization through peer-led initiatives. Identity formation also plays a critical role in STEM persistence whereby Rodriguez et al. (2019) explored how first-generation college students in engineering drew upon their cultural backgrounds as funds of knowledge to develop their identities. These narratives of belonging and resilience offered motivation and continuity through academic challenges. Estrada et al. (2016) demonstrated that institutional recognition such as faculty support and validation reinforced students' science identities and positively impacted persistence. Carlone and Johnson (2007) developed a framework of competence, performance, and recognition to explain how successful women of color in science develop a strong science identity. Their findings indicate that consistent recognition from mentors and peers bolsters persistence, whereas lack of recognition leads to disengagement. McGee and Martin (2011) similarly

emphasize that resilience alone is not sufficient; sustained support and recognition are essential for marginalized students to thrive.

Furthermore, social support is a foundational element of student well-being whereby Jenkins et al. (2013) found that first-generation students experience higher rates of depression, but that social support from family, friends, and institutions significantly reduces these challenges. O'Keeffe (2013) similarly emphasized the value of peer connectedness, especially among undergraduate women in STEM. Strong peer relationships fostered belonging, motivation, and academic engagement. Hurtado et al., (2011) demonstrated that undergraduate research experiences significantly improved minority students' self-efficacy, sense of belonging, and aspirations for STEM careers. However, access to such experiences is unequal given that Ong et al. (2011) noted that institutional biases, limited mentorship, and exclusionary practices often limit women of color from engaging in these transformative experiences. These studies collectively underscore that while student strategies are powerful, they are often in response to unequal conditions that require institutional change (Shortlidge et al., 2024).

Institutional Responses and the Need for Structural Change. In response to the well-documented barriers and student strategies, some institutions have implemented programs aimed at addressing inequities and fostering more inclusive learning environments. Counterspaces offer one such model whereby Johnson Jr et al. (2025) found that these environments provide mentorship, cultural affirmation, and emotional support for women of color in STEM. Espinosa (2011) similarly demonstrated that counterspaces help build academic confidence and community, particularly for women navigating exclusionary environments. Charleston et al. (2014) emphasized that institutions must go beyond symbolic inclusion to offer culturally relevant curricula, robust mentorship, and policies that directly address racialized and gendered barriers. Hazari et al. (2013) also showed that students who feel competent, recognized, and able to express their interests in physics are more likely to persist. Recognition from peers and faculty, as well as access to meaningful disciplinary engagement, proved critical to student success. Institutions must design programs and cultures that validate students' multiple identities and provide equitable access to the resources that foster STEM identity development (Ruttenberg-Rozen et al., 2021; Choi, 2023; Cameron, 2023).

Ultimately, the literature reveals a complex landscape in which systemic barriers compromise student wellness and academic persistence, particularly for students from marginalized backgrounds (Choi, 2023). In response, students employ powerful strategies of identity development, social support, and resilience. Yet these strategies are often deployed in spite of institutions, rather than because of them. While some programs and counterspaces have shown promise, comprehensive institutional change remains necessary to promote equity and wellness in STEM (Ruttenberg-Rozen et al., 2021; Choi, 2023; Camerson, 2023).

This exploratory study aims to add to the existing literature by conducting surveys to investigate the wellness experiences of historically underserved undergraduate students pursuing STEM degrees. It seeks to identify the challenges they encounter across the wellness dimensions and the resources they use to address these challenges. The following research questions guide this investigation: (1) How do historically underserved students in STEM describe the wellness-related challenges they face and the resources they draw upon to support their academic experience? (2) How do students perceive their institution's current support and practices as supporting or hindering their well-being across wellness dimensions?

RESEARCH METHOD

To address the study's two research questions, we employed an exploratory mixed-methods design (Creswell and Clark, 2007), integrating both quantitative and qualitative data collected through a survey administered to undergraduate STEM students at a large research-intensive university. This approach allowed us to examine both the prevalence of wellness-related challenges and the nuanced ways in which students interpret and navigate them. This section is organized into three parts. First, we describe the participants and the recruitment strategy used to obtain a sample of historically underserved students. Second, we outline the development of the survey instrument, which was informed by prior interview data and theoretical models. Finally, we explain our analytical approach, including the statistical and thematic techniques used to explore student experiences across the dimensions of wellness. Data were collected between March and May 2022 during the Spring semester. All study procedures were reviewed and approved by Stanford University's Institutional Review Board (Protocol #IRB-61366). Participation was voluntary, and students provided informed consent before beginning the survey. No personally identifying information was collected, and all data were stored securely on password-protected servers in accordance with institutional data-protection guidelines. Participants were entered into a raffle to win one of two $100 gift cards as an appreciation for their time. The incentive was not tied to course grades or participation credit. Of the 140 students who began the survey, 98 were retained for analysis. Forty-two responses were excluded because participants did not complete any substantive survey items. No imputation was performed, as these records lacked sufficient data for inclusion. For the remaining data, item-level missingness was minimal (<5%) and handled via pairwise deletion during statistical tests

Positionality. Our research team approaches this project through a reflexive, justice-centered lens. Grounded in Milner's (2007) framework on researcher positionality, we understand the importance of critically situating ourselves in

relation to the communities and contexts we study. This includes ongoing reflection on how our experiences, assumptions, and access to power shape the research process. Patel's (2015) call to interrogate colonial structures in knowledge production further informs our commitment to methodologies that resist deficit framings and instead center equity, resistance, and justice. We recognize that our motivations for engaging in this research are shaped by both personal experiences within STEM and our collective observations of systemic inequities that persist across higher education. These include, but are not limited to, barriers related to race, gender, class, disability, and nationality. Our team brings a range of lived experiences navigating STEM environments, and we are attentive to how these experiences whether of privilege, marginalization, or both shape our research questions, interpretations, and commitments. Rather than viewing ourselves as neutral observers, we acknowledge that we are embedded within the structures we critique. In alignment with Milner's (2007) emphasis on reflexivity and Patel's (2015) critique of extractive knowledge systems, we have designed this study to center the voices and expertise of those most affected by exclusionary practices in STEM. This includes rejecting ideas that pathologize students and instead focusing on institutional conditions and the strategies students use to thrive despite them. By grounding our work in these principles, we aim to produce research that not only highlights systemic barriers but also contributes to meaningful change in STEM education by amplifying the voices and knowledge of historically underserved communities.

Participants. This study was conducted at a research-intensive, land-grant flagship institution in the Southeastern United States. As of Fall 2021, the undergraduate student population at the university was 49.5% women and 50% men, with 81.5% identifying as White (National Center for Education Statistics, 2021). Approximately 13% of students received Pell Grant funding, and an estimated 11% were first-generation college students. Survey participants were recruited through faculty members who taught introductory and upper-division STEM courses. These instructors were asked to disseminate study information to students enrolled in their courses. Students were invited to complete an online survey via Qualtrics and were entered into a raffle for a $100 prize as appreciation for their time. A total of 140 undergraduate students initiated the survey; however, only 98 responses were included in the analysis. Forty-two responses were excluded due to missing data, as those participants did not respond to any substantive items. Little's MCAR test was conducted to examine the pattern of missing data. The test for means resulted in a chi-square = 586.440, df = 591, p = .545, suggesting that the data were missing completely at random. Separate tests for covariates and correlations showed consistent results. Therefore in our analyses, we employed listwise deletion (complete case analysis) for handling missing values. A demographic breakdown of the analytic sample is presented in

Table 2. Following precedents in the literature (Vincent-Ruz et al., 2024; Yik et al., 2025), we created binary indicators for historically underserved student groups. Students were coded as gender-marginalized if they identified as women, non-binary, or transgender; as BIPOC if they identified as Latinx, Black, Indigenous, or multiracial; and as low-income based on institutional financial aid criteria (i.e., family making less than $85,000 a year due to the institutional financial aid markers of the institution). This threshold aligns with the institution's Office of Financial Aid definition for need-based aid eligibility and approximates the upper limit for Pell Grant qualification during the 2021–2022 academic year. It also follows precedent in higher education research that uses comparable brackets to define economic disadvantage (Goldrick-Rab, 2016). Finally, students were considered first-generation if neither parent or guardian had earned a bachelor's degree. The combination of these indicators (gender-marginalized, BIPOC, first-generation, and low-income) allowed us to identify patterns among students who are historically underserved in STEM and to examine wellness outcomes across intersecting dimensions of identity and structural marginalization.

Table 2. Demographic characteristics of survey participants

Full demographics		Binary demographics	
	n (%)		n(%)
Gender		Gender marginalized	
Men	27 (27.6%)	Yes	71 (72.4%)
Women	69 (70.4%)	No	27 (27.6%)
Additional Group*	2 (2%)		
Race		BIPOC	
White	84 (85.7%)	Yes	11 (11.2%)
Asian	3 (3.1%)	No	87 (88.7%)
Hispanic	2 (2.0%)		
Black	2 (2.0%)		
Additional Group**	7 (7.1%)		
First-generation student status		First-generation student status	
Yes	5 (5.2%)	Yes	5 (5.2%)
No	92 (94.8%)	No	92 (94.8%)
Family income		Low family-income	

$0-$10,000 per year	1 (1.2%)	Yes	21 (24.7%)
$10,000-$40,000 per year	5 (5.9%)	No	64 (75.3%)
$40,000-$85,000 per year	15 (17.6%)		
$85,000-$165,000 per year	32 (37.6%)		
$165,000-$205,000 per year	19 (22.4%)		
More than $205,000 per year	13 (15.3%)		

Note: *One student identified as a transgender man and another identified as non-binary/genderqueer. **Students identified as American Indian or mixed race (having more than one racial identity). Thus, percentages may exceed 100% because some students selected more than one racial or ethnic identity. All students who identified with at least one racially or ethnically minoritized group were coded as BIPOC for binary analyses.

Instrument Development. To address Research Question 1, we first conducted a qualitative interview study to better understand the experiences and needs of historically underserved STEM students at the institution (Wang et al., 2024). Themes from this interview phase directly informed the development of the student survey. Specifically, interview data guided the creation of response options for previously open-ended items. For example, in one question about sources of academic advice, students were provided with options such as academic advisors, peers, family, and student organizations categories that had emerged prominently from the interviews. The interview questions also drew on the Diverse Learning Environments (DLE) model (Hurtado et al., 2012), which emphasizes the role of institutional climate, structural diversity, and educational practices in shaping student experiences. Items were designed to reflect wellness-relevant constructs such as belonging, emotional strain, financial stress, and engagement with identity-affirming spaces. For example, students were asked whether they had participated in cross-cultural dialogues, identity-based student organizations, or culturally responsive mentoring programs. These experiences were selected to reflect the multiple dimensions of wellness articulated in our theoretical framework (Swarbrick, 2006; Johnson, 2024), including emotional, social, spiritual, and environmental wellness. The survey included mostly Likert-scale and multiple-choice items, with additional opportunities for open-ended responses. The instrument was refined through iterative feedback from the research team, STEM instructors, and undergraduate STEM students from diverse backgrounds. This process helped ensure accessibility, clarity, and alignment with the wellness dimensions.

Data Analysis. To address Research Question 2, we began with exploratory data analysis to assess response variation and ensure quality. Histograms were generated for all survey items to determine which variables showed sufficient variability for meaningful analysis. For most Likert-scale questions, we collapsed

responses into binary categories: agreement (agree or strongly agree) versus non-agreement (neutral, disagree, or strongly disagree) because we were mainly interested in whether people generally agree or don't agree with the statements, rather than the exact level of agreement. By combining these categories, we highlight the important difference between positive responses and neutral or negative ones. This decision was made to simplify interpretation and improve statistical power when analyzing patterns across demographic groups. Next, we conducted chi-square tests and Fisher's exact tests to examine whether responses to key items varied significantly by demographic group (i.e., BIPOC, gender-marginalized, low-income, and first-generation status). All analyses were conducted using SPSS (version 29), with a significance threshold set at $\alpha = .05$. We also analyzed responses to open-ended survey questions using a deductive coding approach grounded in our theoretical framework. Codes were derived from the eight dimensions of wellness (Swarbrick & Yudof, 2014) and from themes identified in the prior interview study. For instance, in response to the prompt asking students to explain their participation in extracurricular activities, responses were coded into wellness-related categories such as financial support, community/socialization, or absence of participation due to emotional or time-related barriers. Coding was conducted by two researchers who independently coded all responses, then met to resolve discrepancies and reach consensus (Ornek, 2008; Elliott, 2018). We then used chi-square tests to examine whether the frequency of wellness-related codes differed across demographic groups.

RESULTS

This section addresses the study's two research questions by examining (1) the wellness-related challenges experienced by historically underserved students pursuing STEM degrees and resources helpful in addressing these challenges, and (2) the extent to which these students felt supported by their institutions in overcoming such challenges. Using both quantitative and qualitative data, we organized our findings by key dimensions of wellness drawn from Swarbrick's (2006) framework. This structure highlights how various aspects of student well-being are shaped by students' identities and institutional experiences.

Emotional Wellness. Emotional wellness includes managing stress, maintaining mental health, and feeling psychologically safe.

BIPOC students reported significantly higher rates of emotional challenges. When asked about campus diversity, 91% of BIPOC students described the student body as "not at all" or "somewhat diverse," compared to 44% of non-BIPOC students, $\chi 2(1, N = 90) = 9.39$, $p < .01$, Cramer's $V = .31$ This lack of diversity contributed to discomfort and exclusion, and in turn psychological safety; e.g. only 46% of BIPOC students feeling comfortable attending institution-hosted events

versus 82% of non-BIPOC students, $\chi 2(2, N = 98) = 7.397$, $p < .05$, Cramer's V = .28. Additionally, only 18% of BIPOC students compared to 76% for non-BIPOC students reported that harassment is not tolerated on campus, $\chi 2(2, N = 98) = 14.319$, $p < .01$, Cramer's V = .38. These patterns underscore how emotional wellness of BIPOC students is challenged more compared to non-BIPOC students because of an institutional climate perceived as more unwelcoming and unsafe to them.

Similar concerns were reported by gender-marginalized students. Fifty-five percent reported that the student body was "not at all" or "somewhat diverse." 90% felt comfortable working with peers from different backgrounds, compared to 74% of non-gender-marginalized peers, $\chi 2(1, N = 98) = 4.124$, $p = .05$, Cramer's V = .21 Two-thirds of gender-marginalized students did not believe their institution adequately addressed exclusionary behavior regarding gender.

First-generation and low-income students also described emotional strain. Many first-generation students expressed anxiety and a lack of preparedness for college-level work. One student shared in the open-ended responses, "Nothing prepared me for how to study and reach target scores that I desired while in college." Low-income students described stress tied to their inability to participate in campus life. Sixty-seven percent reported being unable to join student organizations due to time and financial constraints, compared to just 5% of high-income students, $\chi 2(1, N = 84) = 9.333$, $p < .01$, Cramer's V = .33

Social Wellness. Social wellness refers to forming supportive peer relationships and a sense of belonging; though related to emotional wellness, emotional is more of an individual/internal state while social wellness specifically focuses on external states.

Only 20% of BIPOC students agreed that their institution was taking adequate action to promote equity and inclusion, $\chi 2(2, N = 97) = 11.234$, $p < .01$,Cramer's V = .34. This perception of inaction led to diminished belonging. On the other hand, identity-related organizations were a helpful resource for social wellness of BIPOC students. BIPOC students were significantly more likely than non-BIPOC students to participate in identity-related organizations, $\chi 2(1, N = 97) = 22.698$, $p < .01$, Cramer's V = .49. One student stated in the open-ended responses, "Identity-related organizations took away the burden of not belonging in some ways."

Gender-marginalized students faced similar struggles. One respondent noted in the open-ended responses, "Walking into a classroom dominated by white cis-men and women can make it difficult to make friends and peers to form study groups." First-generation students also reported barriers to forming social connections, although specific quantitative data were limited.

For low-income students, financial barriers constrained participation in extracurricular activities, impacting their ability to build relationships and feel socially integrated.

Environmental Wellness. Environmental wellness encompasses feeling safe and supported in one's surroundings.

BIPOC students reported discomfort in predominantly white spaces and expressed concerns about unequal access to leadership opportunities. One student stated in the open-ended responses, "When applying to campus leadership positions these white students tend to favor other white students." Others criticized the institution's limited diversity efforts, describing them as concentrated in a small office rather than campus-wide.

Gender-marginalized students echoed concerns. While 79% acknowledged faculty diversity, only 46% viewed the student body as diverse. One student emphasized the need for more women in STEM faculty roles to foster a more inclusive environment. These findings indicate that environmental wellness is shaped by both representation and perceptions of safety.

First-generation students did not experience environmental wellness concerns, indicating that they often felt safe and supported in their surroundings.

Intellectual Wellness. Intellectual wellness includes academic confidence, engagement, and opportunities for personal growth.

BIPOC students who participated in identity-based organizations reported high levels of academic support, with 75% stating these groups contributed to their success. One student explained in the open-ended responses, "With more students of color being in STEM, it encourages me to continue my path."

Gender-marginalized students also pointed to faculty representation as encouraging in the open-ended responses: "Having more female STEM teachers would be very encouraging." However, institutional decisions also negatively impacted intellectual wellness. For example, one student noted in the open-ended responses that identity-based content was removed from orientation due to board member discomfort. This removal limited opportunities for students to connect their personal identities to academic learning.

First-generation students experienced disproportionate academic challenges. Seventy-five percent cited harsh grading as a significant obstacle, compared to 43% of non-first-generation peers. One student reflected in the open-ended responses, "The content was manageable, but the difficulty of the tests posed a significant challenge." Many expressed a desire for more academic advising and transition support. "I want an adviser that will take time to sit and actually help me through everything," one student shared in the open-ended responses.

Financial Wellness. Financial wellness involves managing financial responsibilities and feeling secure in one's economic situation.

BIPOC and Gender-marginalized students within this sample did not experience challenges with financial wellness, suggesting they felt secure in their economic situations.

For low-income students, financial strain was a central challenge. Twenty-four percent reported difficulty affording STEM course materials, compared to 7% of high-income students, $\chi 2(1, N = 85) = 5.150$, $p < .05$, Cramer's V = .23. Twenty-nine percent lacked the time or finances to fully access academic and extracurricular resources (such as participating in organizations, versus 5% of high-income peers, $\chi 2(1, N = 84) = 9.333$, $p < .01$, Cramer's V = .33. Financial considerations also shaped college choice. Sixty percent of low-income students cited financial support as a primary reason for attending their institution, compared to just 13% of high-income students, $\chi 2(1, N = 33) = 7.748$, $p < .01$, Cramer's V = .49.Although we had limited data disaggregated by race, gender, or first-generation status in relation to financial wellness, the pervasive nature of financial strain among low-income students clearly intersects with other dimensions of well-being. These findings collectively demonstrate that historically underserved students in STEM face wellness-related challenges across multiple dimensions and that institutional supports remain uneven. In the following section, we interpret these results and discuss their implications for institutional policy and practice.

Table 3. Student experiences across the dimensions of wellness

Student experiences	Dimensions of wellness affected
Challenges	
● BIPOC students report feelings of exclusion and discomfort due to lack of diversity at their institution.	Emotional, Social, Environmental
● Gender-marginalized students report discomfort in peer interactions and underrepresentation at their institution.	Emotional, Social, Environmental
● First-generation students report challenges in adjusting to college workload and course expectations.	Emotional, Intellectual
● Low-income students report having limited time due to financial obligations and constraints.	Emotional, Social, Intellectual, Financial

Resources	
● BIPOC students report finding value in participating in identity-related organizations and communities.	Emotional, Social, Intellectual, Environmental
● Gender-marginalized students report also finding value in participating in identity-related organizations and communities.	Emotional, Social, Intellectual, Environmental
● First-generation students report value in transitional programs and having academic advisors.	Emotional, Intellectual
● Low-income students report value in more affordable resources at their institution.	Emotional, Intellectual, Financial

DISCUSSION AND CONCLUSIONS

This study examined the experiences of historically underserved students pursuing STEM degrees through a wellness-centered framework, addressing two primary research questions: (1) How do these students describe the wellness-related challenges they face and the resources they draw upon to address these challenges? and (2) How do students perceive the institutional structures and practices in supporting or hindering their well-being across wellness dimensions? This work intends to expand our definition of STEM equity beyond academic performance and course grades and examine equity in pursuing STEM pathways more holistically involving different aspects of student wellbeing. Guided by Swarbrick's (2006) eight dimensions of wellness, we analyzed both quantitative and qualitative data to explore how students' emotional, social, environmental, intellectual, and financial wellness are institutionally and instructionally challenged as well as supported in pursuit of STEM fields. Addressing Research Question 1, findings highlight how emotional and social wellness of historically underserved students are often strained by exclusion and lack of representation. Students identifying as BIPOC or gender-marginalized frequently described discomfort in predominantly white or male-dominated spaces, along with feelings of isolation in academic environments. These experiences echo previous literature that documents how historically underserved students navigate invisibility and cultural exclusion in higher education (Hurtado et al., 2015; Ong et al., 2011; Weatherton and Schussler, 2021; Markle et al., 2022). In our study, students also reported limited opportunities for safe and affirming engagement across campus, particularly when diversity and inclusion efforts were perceived as confined to a few spaces.

Identity-based organizations such as the Society for Women Engineers, the National Society of Black Engineers, and the Society for Hispanic Professional

Engineers emerged as essential spaces where students cultivated affirmation, mentorship, and a sense of purpose that extended across emotional, social, and intellectual dimensions of wellness. Participation in identity-based communities allow students to connect with peers who shared similar lived experiences, access culturally responsive mentorship, and engage in professional development opportunities often unavailable through mainstream institutional channels (Wofford et al., 2024). For many BIPOC and gender-marginalized students, these organizations served as one of the few spaces on campus where they felt seen, valued, and supported in their academic and personal growth. Research has shown that leadership roles within these groups fostered self-efficacy and confidence in navigating STEM pathways, while collective discussions about systemic inequities provided emotional validation and strategies for resilience (Brisbane et al., 2024). This finding aligns with Vaccaro and Newman (2017), who found that identity-centered student organizations create microclimates of belonging that empower minoritized students to navigate predominantly white institutions with greater confidence and self-authorship. Consistent with their conclusions, our data illustrate that these organizations do more than foster belonging in that they also function as wellness infrastructures by bolstering emotional resilience through affirmation, social wellness through community-building, and intellectual wellness through mentoring and leadership experiences. Extending Vaccaro and Newman's work, our findings suggest that identity-affirming organizations not only buffer students against exclusionary institutional climates but also serve as compensatory mechanisms that sustain holistic wellness where formal university support remains insufficient.

Intellectual and financial challenges were particularly salient among first-generation and low-income students. First-generation students noted difficulties adapting to academic expectations and inadequate preparation. Many emphasized the importance of structured advising and transition programs. This aligns with research by Stephens et al. (2012) and Means and Pyne (2017), who found that cultural mismatch and limited access to academic supports hinder the success of first-generation students. Low-income students, meanwhile, reported barriers to full participation in campus life due to financial strain, which affected their ability to engage socially and academically as seen in prior work with mentorship programs supporting student academic readiness (DeWeese et al., 2023). These findings reinforce calls by Goldrick-Rab (2016) for institutions to address the material constraints that shape student outcomes.

Addressing Research Question 2, our findings suggest that institutional support and practices often fall short in supporting student wellness. While some diversity initiatives exist, many students felt that efforts were inconsistent, reactive, or overly localized. BIPOC and gender-marginalized students expressed skepticism about whether exclusionary behavior was genuinely addressed by their institutions. These concerns reflect previous critiques that representation alone is

insufficient without institutional accountability and structural change (Museus & Jayakumar, 2012; Weatherton and Schussler, 2021). One student specifically noted the removal of identity-oriented content from orientation programming, illustrating how institutional decisions may actively undermine efforts to foster wellness and inclusion. The perception students hold regarding institutional policies and practices is just as crucial as the actual services provided by the institution. If students do not see these institutional structures and actions as beneficial or supportive, it can potentially lead to a lack of engagement, diminished trust, and ultimately, decreased utilization of available resources. As our research suggests, this disconnect may hinder students' overall well-being during their educational journey in STEM (Aarntzen et al., 2023).

Collectively, these findings demonstrate that wellness-related challenges are not confined to individual resilience or academic success alone. Rather, historically underserved students in pursuit of STEM fields navigate overlapping stressors across emotional, intellectual, social, financial, and environmental domains at a higher rate compared to their peers. A key contribution of this study is the use of the wellness framework to map these experiences holistically. By doing so, we offer a novel perspective that integrates equity, identity, and support systems under a shared conceptual lens. This approach moves beyond traditional academic metrics in examining equity in pursuit of STEM pathways and emphasizes that persistence in STEM is deeply interconnected with students' holistic well-being. By centering student wellness, this study invites institutions to rethink how equity is conceptualized and measured in STEM. Our findings underscore the need for sustained, multi-dimensional support that recognize students' full identities and experiences (Shortlidge et al., 2024; Cherng et al., 2024). Institutions committed to equity must consider not only who is present in STEM, but how students feel, live, and thrive within these environments.

Table 4. Summary of the Discussion

Discussion Section	Key Points
Takeaways	● The dimensions of wellness framework can be a novel and nuanced way to approach challenges and solutions faced by students with marginalized identities. ● Wellness dimensions are interconnected; improving one area can positively impact others. ● Various challenges (such as campus climate, financial barriers, academic expectations) and resources (such as identity-affirming organizations) significantly affect multiple dimensions of well-being for historically underserved students. ● Historically underserved students felt that their institution wasn't doing enough to support them through challenges they experience in STEM.
Contribution to the Broader Literature	● Supports existing research showing that exclusion in non-diverse environments impacts student engagement and motivation. ● Highlights the importance of identity-related organizations for social and intellectual engagement. ● Critiques the notion that representation alone suffices without improvements in campus climate and culture.
Recommendations	● Implement targeted policies and initiatives that support the holistic wellness of historically underserved students. ● Enhance support for identity-related organizations to promote inclusivity and well-being for marginalized communities. ● Develop transitional programs and academic advising to bridge gaps for first-generation students. ● Create accessible resources and interventions during class time to accommodate low-income students' financial commitments.

IMPLICATIONS

While the findings of this study provide valuable insights into the holistic experiences of historically underserved students, several limitations should be considered when interpreting the results. First, although our sample was moderately representative of the institution's broader student population, the casual recruitment approach resulted in a relatively small number of participants within each underserved demographic category. This limited sample size may have reduced the statistical power needed to detect additional meaningful patterns and experiences, and it restricts the generalizability of our findings (Rodriguez et al., 2023). Future research should prioritize more intentional recruitment strategies to ensure a larger representative sample, thereby enhancing the reliability and applicability of the results. Second, expanding on the findings about emerging challenges and resources from previous interviews, the survey focused on emotional, social, financial, and intellectual aspects of wellness and did not include as many items addressing spiritual, occupational, and physical dimensions of wellness, which are important areas that can significantly affect students' academic and personal experiences. Incorporating more questions about nutrition, sleep, physical activity, and spiritual practices such as meditation or reflection could offer a more comprehensive view of student well-being. For instance, questions related to the inclusivity and accessibility of campus dining options may influence students' perceptions of belonging and impact their overall wellness. Future studies should consider how these dimensions intersect with institutional resources and supports.

In terms of future directions, additional research should explore how the wellness framework can be operationalized to evaluate the impact of targeted institutional interventions, such as mentorship programs, diversity initiatives, and financial aid reforms (Johnson, 2024). Longitudinal studies tracking the effects of these interventions on academic outcomes and career pathways would provide valuable insights into their long-term efficacy. In light of current political debates surrounding diversity, equity, and inclusion (DEI) initiatives particularly in states where such programs face legal and legislative threats, research should also examine how policy shifts influence the wellness and persistence of historically underserved students. To promote a more inclusive academic environment, institutions should expand access to identity-affirming organizations, increase faculty and staff diversity, and adopt equity-oriented policies and practices (Posselt et al., 2022). Financial aid programs must be strengthened to reduce the economic burden on low-income students, and tailored transitional programs and advising services should be implemented for first-generation students. Embedding the dimensions of wellness framework into institutional planning and support systems can help ensure that all aspects of student well-being are addressed. By doing so, institutions will be better positioned to create environments where historically

underserved students can thrive academically, socially, and personally within STEM disciplines.

Ultimately, this study contributes to a growing body of literature calling for more comprehensive approaches to understanding and addressing equity in STEM education. Rather than viewing academic performance and persistence in isolation for studying equitable STEM education, our findings underscore how wellness across emotional, social, environmental, intellectual, and financial domains is a critical factor in student success, especially for historically underserved populations. Students from minoritized racial, gender, income, and educational backgrounds face a constellation of challenges that extend far beyond the STEM classrooms. These challenges are not only academic, but also emotional and structural, arising from campus climates that often feel exclusionary, unsupportive, or inaccessible. By adopting a wellness-centered framework, this study offers a novel, nuanced, and comprehensive approach to conceptualize and respond to these barriers. Addressing wellness dimensions holistically means recognizing that students' experiences in STEM are shaped by their identities, institutional culture, and the presence (or absence) of support systems. Promoting persistence, therefore, is not just about improving academic resources and/or focusing on instructional practices of STEM courses; instead, it requires cultivating environments in our higher education institutions where students feel safe, valued, and empowered in all aspects of their educational journey. Institutions committed to equity must expand their focus to ensure that every student, regardless of background, has the opportunity to thrive both in and beyond the classroom. The implications of this research extend to policy, practice, and future scholarship. Colleges and universities must rethink their student support infrastructures, embed equity in wellness-oriented programming, and assess institutional structures that may reinforce inequity. Through intentional, student-centered design informed by wellness frameworks, STEM education can become more inclusive, sustainable, and transformative for all students.

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