Journal for STEM Education Research
https://doi.org/10.1007/s41979-024-00116-1

RESEARCH ARTICLE

"It Just Makes It Feel Like You're Not Alone": A Qualitative Study of a Social Support Group for High-Achieving, Low-Income STEM Majors

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Accepted: 5 January 2024

Abstract

The higher education community continues to pursue solutions to the alarming number of science, technology, engineering, and math (STEM) undergraduates leaving their degree programs. This qualitative study investigated the experiences of 12 STEM scholarship recipients in a near-peer-mentored social support group at a large Midwestern university. The goal of this study was to investigate the scholars' challenges and supports prior to and while participating in a weekly peer group through the lens of the Phenomenological Variant of Ecological Systems Theory model. This case study triangulated the experiences of the peer group participants using pre-group individual interviews, peer leader reflections, and a focus group. The pre-group interviews revealed that the participants experienced challenges associated with the rigor of their courses, self-imposed pressure, and unsupportive relationships. Supports for their persistence prior to the peer group included their internal drive to achieve their goals and supportive relationships, particularly with family. The focus group revealed that the peer group provided a non-academic space to connect with peers, facilitated sense of belonging, and normalized their struggle as STEM majors, broadening their perception of science identity. Paradoxically, although participants highlighted personal disclosure as key to promoting social support, they indicated their greatest challenge in the peer group was discomfort with sharing.

Keywords Undergraduates · Social support · Persistence in STEM · Sense of belonging

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Introduction

Many students who begin undergraduate programs in science, technology, engineering, and math (STEM) fields do not complete them (National Center for Science Education and Statistics [NCSES], 2019; President's Council of Advisors on Science and Technology [PCAST], 2012), and fewer students in STEM programs persist relative to those from non-STEM programs (NCSES, 2019). While enrollment in STEM fields is increasing, many groups such as women, racial and ethnic minorities, and low-income students are less likely to stay in those majors (Chen, 2009). Consequently, these groups remain underrepresented among STEM degree recipients (Anderson & Kim, 2006; Griffith, 2010; National Center for Science and Engineering Statistics [NCSES], 2020; NSB, 2019). This has prompted numerous studies investigating factors contributing to this gap and ways to bolster degree completion (Cabrera et al., 1993; Chen, 2009; Estrada et al., 2016; Griffith, 2010; Riegle-Crumb et al., 2019).

Previous studies have examined large national datasets and found evidence of racial and ethnic inequality in persistence in STEM compared with other fields (Estrada et al., 2016; Riegle-Crumb et al., 2019). Estrada et al. (2016) proposed reasons why underrepresented minority (URM) students leave STEM more than white or Asian students and asserted that a lack of institutional accountability is among the most problematic causes. While primarily white institutions (PWIs) have no requirement to monitor the backgrounds of those entering, leaving, or completing their degree programs, Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs) are focused on Black and Hispanic student success (Boncana et al., 2021; Gomez et al., 2018). HBCUs produce 18% of STEM degrees earned by Black undergraduates (National Science Foundation [NSF], 2020), and HSIs produce 46% of the STEM degrees earned by Hispanic and Latino undergraduates (NCSES, 2019). Students at HBCUs experience a racially affirming environment with a focus on communalism, faculty-student relationships, and asset-based pedagogies that support persistence of Black students (Boncana et al., 2021; Williams & Taylor, 2022). Similarly, Gomez et al. (2018) examined the practices of institutions with exemplary STEM persistence rates and found that the exemplary Hispanic-Serving Institutions (HSIs) demonstrated a deep knowledge of students, receptivity to improvement, diverse faculty and relationships with regional community. It should be noted that an institution must enroll 25% Hispanic/Latino students to be classified as an HSI and not all HSIs utilize best culturally relevant practices. When deep culturally and context-dependent approaches to STEM education are enacted at HBCUs and HSIs, they promote persistence of STEM students to graduation. If STEM programs at PWIs wish to match these successes with marginalized students, it will be essential to develop institutional programs and structures that emulate this focus on culture and context. Estrada et al. suggested "creat[ing] strategic partnerships with programs that create lift," (Estrada et al., 2016, p. 4). Such programs are meant to provide more structured support for students who are traditionally underrepresented in STEM. We suggest, in the absence of institutional culture and structures, smaller programs may help buffer students from institutional deficiencies by providing a supportive community within the institution. The National Science Foundation (NSF) Scholarships in STEM (S-STEM) program is an example of a program that provides financial and other types of support (e.g., academic and psychosocial) to promote students' persistence. The case study presented below focuses on scholars' participation in the social support component of an S-STEM program. The purpose of the study is to explore how participation in the peer group supported students through the challenges of being a STEM major.

Persistence in STEM

Decades of research has explored the factors driving persistence in STEM among college students. In a recent longitudinal, quantitative study of over 20,000 college students at a selective public university with a small population of transfers (< 16%) and lower income students (< 20%), students from low-income and first-generation backgrounds had lower GPAs (Whitcomb et al., 2021). The study noted that multiple factors led to greater academic struggles, where students from underrepresented backgrounds who were also first-generation and/or low-income had even lower GPAs. Quantitative researchers have attempted to model a variety of factors, including financial issues, familial support, academic integration, academic performance, social integration, institutional commitment and fit, and goals to determine which factors play the largest role in persistence (Cabrera et al., 1993). Early models suggested that attrition is based on a combination of student and institutional characteristics (e.g., faculty interactions and peer relationships) (Tinto, 1975). However, these models have been criticized for ignoring structural barriers for those who historically have been excluded and therefore underrepresented in higher education, specifically those from minoritized racial or ethnic backgrounds and first-generation students (Hurtado & Carter, 1997; Museus, 2014). In a qualitative study of 52 Latino and African American STEM majors, Flores et al. (2023) found that participants described experiencing an exclusionary classroom culture, stereotype threat in study groups, and biased treatment based on race and gender.

HBCUs and HSIs have demonstrated success in producing the largest percentages of STEM graduates from minoritized racial and ethnic backgrounds, and therefore their practices are worthy of examination (Gomez et al., 2018; Owens et al., 2012). Boncana et al.'s (2021) study of HBCU presidential leadership styles emphasized that the institutional mission at HBCUs focus on student success and cultivating students' skills. The communalism at HBCUs is in stark contrast to the hierarchical student-faculty relationship and environment of peer-to-peer competition typically found at PWIs (Williams & Taylor, 2022). Specifically, peer-led team learning and value for collective achievement emphasized at HBCUs create the social support necessary for persistence (Williams & Taylor, 2022).

Social Support

Recent literature reviews have explored interventions that leverage social support to cultivate persistence in higher education in general (Mishra, 2020) and in STEM specifically (Pearson et al., 2022). Mishra (2020) found that information-based social capital and social support are critical for persistence. Information-based social capital is the knowledge of the norms of higher education that facilitate success in college. First-generation students may be less familiar with the norms, and thus disadvantaged. Hobfoll and Stokes (1988) define social support as relationships that provide assistance or attachment to a person or group perceived as caring. Social support can compensate for deficits in information-based social capital or complement students' assets by providing information, encouragement, and attachment (Mishra, 2020). Ostrove and Long (2007) noted that students from working class backgrounds were less likely to have a sense of belonging in college to support their adjustment to college and academic performance. Bettencourt (2021) suggests this is because low-income students prioritized their financial and academic obligations over their social connections and that institutions left students to develop their own support systems. Peers, specifically, can help students develop a sense of competence in their academic efforts that promotes persistence (Hilts et al., 2018). In a mixed-methods study of Black and Latino college students at a selective university, Baker (2013) found that despite non-significant effects of peer support on academic performance, students reported that their peers provided emotional support. In a systematic review of academic success in Latino students, Winterer et al. (2020) found that peers helped cultivate STEM identity, sense of community and intent to persist. Similarly, a study of an intervention program for low-income students found that the personal relationships and culture of support overcoming academic struggles was beneficial for students' resilience (Ceyhan et al., 2019).

Pearson et al. (2022) reviewed programs that promoted persistence in STEM by leveraging social support to increase students' sense of belonging. Details on the mechanisms of enacting social support programs is lacking across the literature (Pearson et al., 2022). In a study of lower-income, high-achieving students (similar to those in the present study), Hansen et al. (2023) found that their program, focused on providing cohort-based academic (e.g., advising, professional development, and research experiences) and social support (e.g., summer bridge program, residential learning communities, and peer mentoring), cultivated students' STEM-specific sense of belonging and predicted intent to persist in the major. However, Hansen et al. (2023) do not detail how the social support components were enacted. This lack of detail was acknowledged in Pearson et al.'s (2022) systematic review of 31 intervention programs. Twenty of the programs offered social integration activities and fifteen describe some type of peer mentoring but the studies lacked detail on how these program components were enacted (Pearson et al., 2022). Within the Pearson et al.'s review, only three of the 31 articles describe mentoring programs that went beyond academic mentoring, where mentors focused on building personal relationships (Kendricks et al., 2013; Mondisa, 2018; Oseguera et al., 2019). Specifically, Kendricks et al. (2013), Mondisa (2018), and Oseguera et al. (2019) and all focused on mentoring by or with African American or Black students in STEM. The present study builds upon this limited literature about the importance cultivating a non-academic space for relationship building.

Mentoring can provide an important type of social support in academic settings (Crisp & Cruz, 2009; Holland et al., 2012; Raman et al., 2015; Rockinson-Szapkiw et al., 2021; Zaniewski & Reinholz, 2016). Zaniewski and Reinholz (2016) studied physics undergraduates' success (as determined by GPA) in relation to a near-peer mentoring program. They defined near-peer mentors as "a dyadic platonic relationship between a more experienced student (mentor) and a less experienced student (mentee) at the same institution, with frequent, direct, face-to-face contact" (Zaniewski & Reinholz, 2016, p. 3). Each mentee was assigned a mentor for bi-weekly meetings. Using online reports from participants, the researchers found that mentoring relationships successfully provided mentees with psychosocial and academic support, which aided in normalizing the struggles of the physics undergraduate experience (Zaniewski & Reinholz, 2016). Kuchynka et al. (2022) found that near-peer mentoring of high school students by undergraduate STEM majors had a bigger impact than teachers in promoting social belonging. In a quantitative study of STEM students at two HBCUs, Rockinson-Szapkiw et al. (2021) found that STEM undergrads who were mentored over a year by graduate students experienced an increased sense of community, academic achievement, self-efficacy, and intent to persist. In a study of 116 undergraduate research students participating across 11 universities, Raman et al. (2015) explored the role and actions of mentors for STEM students. The authors proposed six dimensions of mentoring that underpin the socio-emotional aspects of mentoring: safe, prepared, proactive, patient, present, and positive (Raman et al., 2015, p. 366). Undergraduates reported a significantly better overall experience when they were mentored by graduate students rather than by faculty (Raman et al., 2015). Raman et al. (2015) suggest this is because graduate students can generally spend more time with mentees compared to STEM faculty (Raman et al., 2015). These findings suggest that social support (Baker, 2013; Hilts et al., 2018; Mishra, 2020) may be cultivated by engaging STEM students with near-peer mentors (Raman et al., 2015; Rockinson-Szapkiw et al., 2021; Zaniewski & Reinholz, 2016). Raman et al. (2015) utilized a quantitative analysis of survey data, and Zaniewski and Reinholz (2016) utilized mixed-methods with limited self-reported data. The in-depth qualitative approach of the present study was chosen to illuminate the processes through which peer support facilitates persistence.

Most of the programs described in the literature on persistence in STEM include peer mentoring components that focus on academic dimensions of college and social integration activities (e.g. field trips and dinners) (Pearson et al., 2022). However, the present study fills several gaps in the literature; first, the program under study enacted peer support intended to support relationship building similar to those discussed in successful mentoring programs (Kendricks et al., 2013; Mondisa, 2018; Oseguera et al., 2019). Second, we trained a peer leader, who was a STEM graduate student, to cultivate social integration and sense of belonging by creating a non-academic space for STEM students. Third, the peer group meetings were held weekly, which is a higher "dose" than other studies report. Finally, we use a qualitative methodology to provide rich descriptions of students' perceptions of the peer group.

Theoretical Framework

The Phenomenological Variant of Ecological Systems Theory (PVEST) builds upon Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 1979) and integrates individuals' perceptions of their experiences, specifically in the context of human development within one's ethnicity and the surrounding culture (Spencer, 1995). PVEST is a theory of human development consisting of five components in a dynamic cycle. The components are as follows: *net vulnerability* (i.e. risk and protective factors associated with varying life outcomes), *net stress engagement level* (i.e., challenges encountered balanced with the support one receives), *reactive coping mechanisms* (i.e., coping strategies utilized to reduce stress in a particular context), *emergent identities* (i.e., repertoire of stable coping responses), and finally the *life stage coping outcome* (e.g., good versus poor relationships) (Swanson et al., 2002). Early work using this framework investigated the cultural and contextual factors of racial and gender identity development in African American youths. More recently, PVEST has been utilized to examine how Black educators experience stressors and supports and how that helps them overcome challenges (Gist, 2018). The overarching aim of our program was to improve students' STEM persistence, which may be thought of as a *life stage coping outcome* as defined in PVEST, by decreasing their *net stress engagement* (Spencer, 1995). Swanson et al. (2002) articulated that the *net stress engagement* component of PVEST is a balance between the challenges people face and the supports they receive. Specifically, "available social support can help a young person negotiate an experience of stress; thus, a support is an actualized protective factor" (Swanson et al., 2002, p. 77). Our study examines a social support group as a mechanism to build resilience in persisting though STEM-related challenges by decreasing their *net stress engagement*. Therefore, we probed the students' self-described challenges and supports to extract from them how the peer group may have protected them through the stress of being a STEM major.

Although we used PVEST to guide the methods of this paper, the means through which the group was designed to provide social support was through fostering community and a sense of belonging. Early work by Bollen and Hoyle (1990) identified two factors related to cohesion to a group: sense of belonging and feelings of morale shared in a group. However, they also found a high correlation (0.90) between the two factors and suggested that they are complementary sources of social support (Bollen & Hoyle, 1990). Specifically, if one feels a sense of belonging, this produces higher morale; and if one shares morale with a group, this cultivates a sense of belonging. In their study of higher education students, Strayhorn (2008a) defined sense of belonging as, "reflect[ing] the social support that students perceive on campus; it is a feeling of connectedness, that one is important to others, that one matters" (p. 305). In his 2018 book, Strayhorn expanded this definition to include "the experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community and others on campus, such as faculty, staff, and peers" (Strayhorn, 2018, p. 29). In a study of Latino/a college students, Hurtado and Carter (1997) found that sense of belonging is related to both cognitive and affective components of how a student relates to others in the college setting and aspects of the environment itself. Strayhorn (2008b) operationalized supportive relationships as a key predictor of satisfaction and achievement for Black men in college. Strayhorn suggests that supportive relationships with faculty and peers help students adjust to college, which enhances their sense of belonging and promotes degree completion (Strayhorn et al., 2016; Strayhorn, 2008b). Sense of belonging is important for students who are minoritized in higher education, including those with disabilities (Vaccaro et al., 2017), people of color (Nunez, 2009; Rainey et al., 2018; Rodriguez & Blaney, 2021), and women in STEM (Johnson, 2012; Rainey et al., 2018; Rodriquez & Blaney, 2021). A scarcity of similar peers and role models, as well as negative stereotypes, contributes to students feeling that they do not belong in their given discipline (Rodriquez & Blaney, 2021; Zaniewski & Reinholz, 2016). The intervention in the present case study was designed to promote community, and although sense of belonging was not directly probed, we can anticipate sense of belonging will emerge as a mechanism by which the peer group promoted community and provided social support.

Other studies have used similar underpinning theories to study persistence in STEM (Rockinson-Szapkiw et al., 2021). However, the present study is unique because the qualitative inquiry approach deeply probes how students perceive their challenges and supports prior to and after receiving social support. Rather than focusing on developing STEM resiliency (e.g., academic/professional goal setting), as is the goal of other programs (Rockinson-Szapkiw et al., 2021; Zaniewski & Reinholz, 2016), the peer group design was unique because the structure and programming focused only on fostering relationship-building as a form of social support to decrease students' *net stress engagement* and foster greater persistence toward degree completion.

Program Structure

The National Science Foundation Scholarships in STEM (S-STEM) program provides grants to support scholarships for undergraduate students with demonstrated financial need. In 2019, a state-funded university in the Midwestern United States was awarded a $1 million NSF S-STEM grant to support scholarships for academically high achieving, Pell Grant-eligible undergraduates enrolled in one of six designated STEM majors (Biology, Chemistry and Biochemistry, Computer Science, Geology and Environmental Geosciences, Mathematics, Physics). Students were awarded a $5000 annual scholarship[1] through the university financial aid system and were expected to participate in once-per-semester academic advising, monthly professional development opportunities, and weekly peer group meetings (Fig. 1). The

[1] Note: the authors acknowledge that the scholarship amount is low but were required to lower it based on panel review feedback prior to receiving the award. Evaluation results indicated this was an insufficient scholarship to meet the students' financial needs.

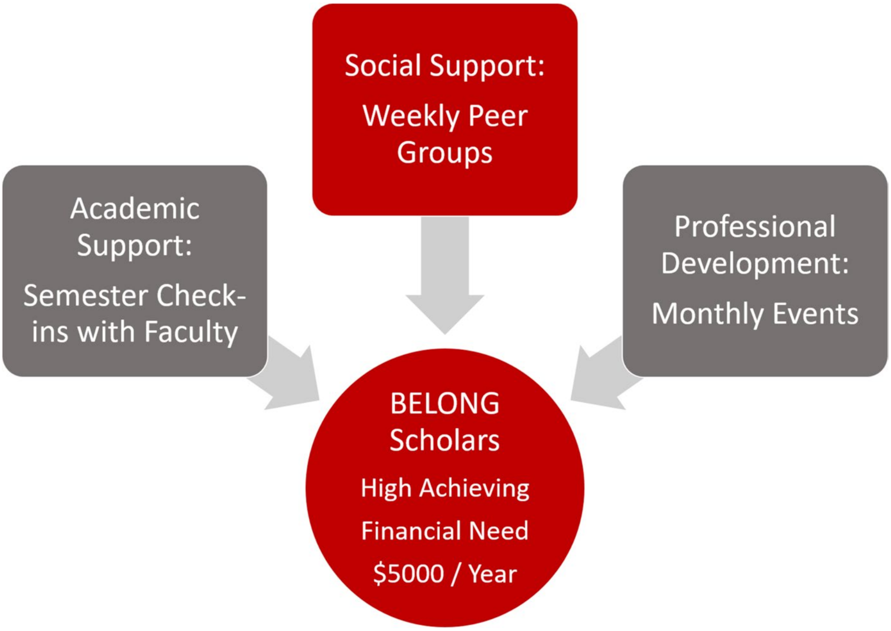

Fig. 1 Components of the S-STEM program

intended purpose of this approach was to increase students' academic, professional, and social support while they pursued their STEM degrees.

Peer Group Structure

The peer group was designed to provide a non-academic space facilitated by a near-peer mentor (Griffith, 2010; Zaniewski & Reinholz, 2016) for the participants to build relationships with STEM peers (Dika & D'Amico, 2015) in order to promote persistence. One peer group consisting of all the study participants met weekly during the evening in a common room in a residence hall on campus. Meetings lasted 1.5 h and were led by a STEM graduate student, Zocher. The peer leader received training from Dugas, who has a decade of training in small group dynamics from a licensed clinical social worker and has facilitated dozens of groups for adolescents and young adults focused on mentorship and social support.

The peer leader's training occurred in two phases. In the summer preceding the start of the group, Zocher and Dugas met biweekly to discuss small group dynamics principles such as the processes of norm creation and the stages of small group development. Rather than prescribing specific activities for the group, Dugas helped Zocher articulate the kinds of norms and relationships she would like to see develop in the group, and then they developed opening activities for the first few sessions to that utilized small group processes to support these norms and relationships. This resulted in a plan for the first few weeks that included individual intake sessions for going over group expectations, icebreaker activities that supported casual conversation and low-risk self-disclosure, and teambuilding activities to allow participants to have fun and work toward a common goal together to build a sense of we-ness.

In these sessions, Zocher was also given opportunities to articulate worries she had about things that might go wrong in early group meetings. For example, she shared a concern that everyone would just sit silently and not participate. Dugas would walk through these scenarios, talk through the small group principles at play, and role play different potential approaches for responding to these situations. In the example of group members sitting in silence, interventions that were discussed included using humor, overtly pointing out the norm that was occurring and making a plan with group members, or switching up the structure of the discussion (e.g., using go-arounds) to support broader participation. The purpose of this training process was not to prescribe particular interventions to "correct" negative norms, but rather to help Zocher become more fluent in group dynamics processes so she would have a number of different options at her disposal in any given situation.

The second phase of peer leader training occurred throughout the life of the peer group. Each week following the peer group meeting, Zocher filled out a reflection sheet asking about the main activities that occurred in the group meeting, anything notable or concerning shared by group members, any positive or negative norms that seemed to be developing, and any group members she was concerned about. Zocher and Dugas used this reflection as a starting point for discussion in their weekly meetings. In the case of negative norms or students of concern, they discussed different options for intervention, similar to the approach used in phase 1 (described above). This time was also used to plan activities for upcoming group meetings.

Activities centered on a variety of purposes: supporting students' self-disclosure and relationship-formation, building positive norms of trust and group cohesion, giving group members a chance to talk about challenges and seek/offer support, or simply unwinding and having fun together. One activity, "Strange Trails," served a number of these purposes and was referenced by several participants in the focus group. It was developed to encourage participants to think about their journeys in life and how they got to where they are now. During this group meeting, Zocher shared the lyrics to a song that had been meaningful for her, then asked participants to share their own "strange trails" in their lives. This conversation paved the way for the group to connect over deep and personal stories, as well as self-reflection after the meeting. However, the life of the group also consisted of more informal and lighter activities such as checking in about how midterms were going, a talent show, and building a gingerbread house together. This range of relationship-building activities cultivated the social support environment we describe as "non-academic" because it did not have a prescribed curriculum with a set of skill building activities. Academic-related topics emerged as a consequence of the participants' shared identity as STEM majors.

Present Study

The goal of this study was to investigate ways in which the peer support group reduced students' *net stress engagement* and build sense of belonging. To achieve this goal, we probed students' experiences prior to and during their first year in the BELONG in STEM program. The research questions driving this qualitative investigation were as follows:

1. How do participants describe their supports and challenges prior to entering the BELONG in STEM program?
2. How do participants describe the peer groups as a source of support or challenge on their path to graduation?

Although the BELONG in STEM scholarship program included other components (i.e., professional development and academic check-ins), this study focused specifically on the peer group. Participants' reflections on the other components of the program were investigated in a separate study for which data analysis is complete and a publication is being prepared.

We utilized a case study approach to identify the supports and challenges (Spencer, 1995; Swanson et al., 2002) experienced by the twelve scholarship recipients in this program. Since the goal of the program was to provide social support to promote persistence and successful coping, the case study methodology is ideal for examining the participants' lived experiences in STEM. This approach enabled us to probe students *net stress engagement* in their STEM experience as defined in the PVEST model (Spencer, 1995; Swanson et al., 2002). Given the potential for interview questions to be intrusive, the probing of students' experiences using the terms "supports" and "challenges" maximized students' comfort and enabled them to reveal as much or as little as they preferred.

Methods

Study Design

This qualitative study followed an instrumental case study design (Creswell, 2015). Case studies aim to provide a detailed explanation of a particular group or occurrence rather than making grand generalizations about a phenomenon (Creswell, 2015). This methodology was chosen to amplify the lived experiences of the participants in the peer group. We focused on the contexts of being STEM undergraduate students and participants in the peer group as the key phenomena under study. Other contexts (e.g., geographic location, gender, and ethnicity) likely contributed to students' experiences as STEM students and participants; however, we did not directly probe aspects of students' various identities in this study. Data were collected with approval from the Institutional Review Board (IRB). All students ($N = 12$) from the

Table 1 Participant demographics

Participant pseudonym	Age	Gender	Race	Hispanic/Latino	First generation	Transfer	Major
Andre	20	M	Two or +	Yes	Yes	Yes	Chemistry
Beth	21	F	White	No	No	Yes	Biochemistry
Christina	19	F	White	Yes	No	No	Physics
Dan	20	M	White	No	No	No	Chemistry
Fiona	20	F	White	Yes	Yes	No	Mathematics
Gia	20	F	Two or +	No	Yes	No	Biochemistry
Harold	19	M	White	No	Yes	No	Biology
Helen	24	F	White	No	Yes	Yes	Biochemistry
Nicholas	N/A	M	White	No	No	Yes	Geology
Pascal	19	M	Asian	No	Yes	No	Computer Sci
Shelby	21	F	White	No	No	Yes	Mathematics
Sonia	20	F	Black/AA	No	No	No	Biochemistry

first cohort of the program consented to be interviewed by Zocher and to participate in the focus group.

Participants

Participants for this study ($N=12$) were all recipients of the scholarship and constituted the first cohort of a five-year program. Criteria for acceptance to the program were based on the National Science Foundation (2013) guidelines and included high financial need based on the Free Application for Federal Student Aid (FAFSA), US citizenship, junior academic standing, and a preferred minimum GPA of 3.0. Applicants were selected based on their academic record, two letters of recommendation, and a personal statement by a committee of STEM department chairs. Participant demographics can be found in Table 1. All but one of the participants, a senior, were in their junior year.

The research setting for this study was a mid-sized public, high-research-activity university campus in the Midwestern USA with a total enrollment of over 15,000 and an undergraduate population of over 12,000. The mean undergraduate age at the university was 22, and approximately 51% identified as female. The racial/ethnic general makeup of the university was approximately half White (52%), with large populations of Latino/a (19%) and Black (17%) students, and other ethnic groups of smaller proportions. Additionally, 50% of graduating classes were transfer students. The university is situated in a rural community near a large metropolitan region and has a large population of students with high financial need. Compared with national statistics, this university is considered to have above-average ethnic and gender diversity (McFarland et al., 2019), a higher percentage of first-generation students (48%) and students receiving federal aid (94%) compared with national averages (34% and 83%, respectively) (McFarland et al., 2019). Overall retention rates for

STEM majors for the university (45%) were very similar to the national average of retention of STEM students (40%) (PCAST, 2012).

Data Collection

All of the scholars in the first cohort of the program ($N = 12$) consented to participate in this study. Triangulation of findings was accomplished via three different data sources: individual interviews with each of the peer group participants at the beginning of the Fall 2019 semester, weekly reflections by the peer group leader, and a focus group interview at the end of their first semester in the program (Carter et al., 2014). The peer group leader (Zocher) was also the researcher collecting data throughout the study. Individual interviews were completed in late August during the first two weeks of the Fall 2019 semester to meet two goals: First, as described above, the interviews were an opportunity for the peer mentor and individual participants to get to know one another and for the peer mentor to establish the expectations for participating in the peer group (e.g., regular attendance is essential for relationship building and the space is intended to be supportive). Second, the interviews provided a pre-program opportunity to gather information about participants' prior challenges and supports as a basis on which the peer mentor could build a strong relationship. For the data gathering portion of the interview, a semi-structured interview guide was followed, including follow-up questions (Table 2). Questions were framed to highlight participants' previous lived experiences of support and challenge in school, particularly in STEM. At the start of the interviews, Zocher obtained consent to participate in the interview and for audio to be recorded. The scholars were compensated $20 for participating in the interview. Interviews ranged from 30 to 75 min in length.

A second data source used for this case study was structured reflections completed by the near-peer mentor following each group meeting. Zocher answered a series of reflective questions to record a general overview of the conversations and interactions between participants. These reflections were discussed each week with Dugas, who has expertise in young adult development and small group processes.

To elicit both shared and individual experiences from the group, data was also collected through a focus group interview attended by all participants during the last week of the Fall 2019 semester. The focus group took place in the same setting as the weekly peer meetings and lasted approximately 1.5 h. Scholars were compensated $30 for participating in the focus group. For facilitation of the focus group, the participants were given the choice of the peer group leader (Zocher) or an alternative researcher who was not part of the program. They unanimously chose Zocher to conduct the focus group. Participants stated they had developed a strong relationship with Zocher and were more comfortable speaking openly with her than someone without a relationship to the group. We selected a naturalistic approach (Guba, 1987) by utilizing a focus group that included all of the peer group participants with the peer facilitator because it was a setting consistent with the peer group under study. Participants were comfortable sharing their perspectives and could build off one another's recollections of their experiences. Although this may not have revealed

Table 2 Interview and focus group protocol

Interview protocol
Tell me about where you grew up
Tell me the story behind your initial interest in science/STEM? • Can you give a specific example? • Tell me more…
What impacted your decision to choose [the university]? • Why did you choose to transfer?
How did you decide on your major? • Who, if anyone, had an impact on your decision?
Can you describe a high point in your undergraduate experience so far?
Can you describe a low point in your undergraduate experience so far?
School can be tough! Who/where do you turn to for support?
Describe your interactions with your peers as an undergraduate • At [the university]? (For transfers, before [the university]?)
What is one difficult decision you've made as an undergraduate so far?
What is the most rewarding part of being a STEM major?
Focus group protocol
What is the most challenging part of being a STEM major?
Describe your interests outside of school
Tell me about your goals for your degree in STEM
Tell me about the proudest moment in your undergraduate education so far
What was a high point during the peer group this semester?
What was a low point during the peer group this semester? • What was it about this event that made it a low point for you? • Did other people see this event differently? (Was this not a low point for others? • Other low points for other members?
What was a turning point in the group? • Turning point: a distinct event, activity, conversation, etc. when you felt a shift in your individual experience in the group OR for the group dynamic as a whole • What was it about this event that made it a turning point for you?
In what ways have you felt supported by the group? • Can anyone provide a specific example or tell a story?
What were some ways that you would have liked to be supported in this group that you did not experience this semester?
What was one way in which you have felt challenged by this group? • Can anyone provide a specific example or tell a story?
What is one way you see this group differently now than you did at the beginning of the semester? • Can anyone provide a specific example or tell a story?
In what ways has this group affected you beyond the group itself? • Can anyone provide a specific example or tell a story?
What is one way you see yourself differently now than you did at the beginning of the semester? • Do you connect this change in how you see yourself with this group in any way? • If yes, how so? • If no, then to what do you attribute this change in view?
If you were to describe the group to someone who had never been here but wanted to understand it, what would be important for you to include that has not yet been sufficiently covered during this interview?

the depth and richness of participant perspectives obtained from individual interviews, gathering data in the context of the peer group dynamics provided insight about the most important aspects of the peer group through the group consensus offered by a focus group. Consistent monitoring from other researchers ensured that ethical precautions were met and bias was minimized as much as possible. The focus group protocol was framed with a similar "supports and challenges" framework as with the intake interviews (Table 2). The focus group protocol centered entirely on experiences within the group and impacts felt both within and outside of the group as a result of participating. The semi-structured focus group interview guide was reviewed by multiple independent researchers for clarity and validity.

Data Analysis

Interviews and the focus group were transcribed semi-verbatim. Participants were assigned pseudonyms, and identifying details (e.g., major and hometown) were removed prior to analysis. The transcripts were broken into units of analysis manually before inputting the data into a coding program. Units of analysis were determined by identifying blocks of text based on a single idea being conveyed by the participant. Multiple rounds of descriptive coding (Saldaña, 2016) were carried out for all data, and dual coding was performed on the focus group interview and a subset of the intake interviews to ensure reliability of the coding manual.

For this study, the inter-rater process was used mainly to refine and improve the robustness of the coding manual, more precisely defining the scope of each code. Interviews were first coded to identify main categories of "supports" and "challenges" derived from the PVEST model (Spencer, 1995; Swanson et al., 2002). The coding scheme was further refined to categorize supports and challenges into those relating to academics, relationships, and self-regulation. Coding was performed in three rounds for the intake interviews. First, a quarter of the interviews ($n=3$) were coded independently by LaDue and Zocher. Codes were compared to determine inter-coder agreement, which was calculated as the percentage of total agreed-upon selected codes compared with the total selected codes. This process was repeated until greater than eighty percent agreement was reached (McHugh, 2012). Zocher then coded the remaining interviews independently. A spot check—an additional process of independent coding—was performed on one final interview that had not been previously coded by either researcher to test the reliability of the final coding scheme, and 90% agreement was achieved.

The group leader reflections were also first coded with the "supports" and "challenges" structure by Zocher independently. After compiling a list of all emergent themes generated from the first round, they were consolidated into similar codes to those used for the intake interviews and focus group in order to highlight parallels from different data sources. Each reflection was then re-coded using the refined coding manual.

The focus group coding manual was generated based upon the intake interview code manual and adding or removing codes depending on their alignment with the goals of the focus group. This maintained the "supports" and "challenges" framing of the study and allowed the main takeaways from the participants' experiences in the group to emerge. The focus group transcript was co-coded (side-by-side) by LaDue and Zocher in its entirety, and changes to the coding manual were discussed and made in real time.

Trustworthiness

Trustworthiness was established mainly through triangulation of data sources in order to bring multiple viewpoints to light (Merriam & Tisdell, 2015). First, we collected individual interviews, focus group interviews, and peer group leader memos to draw conclusions about the participants' experiences. Second, the inter-rater process was used to support trustworthiness of the data by ensuring reliability of the coding scheme and the coders themselves. Additionally, although the peer group leader's position in the group presented a power differential that could have influenced results from the focus group, open-ended survey responses from the participants provided by the grant's external evaluator confirmed that the participants' only concerns with the group centered on time management and not with pressure to perform for their peer group leader.

Researchers' Positionalities

It is a common practice in qualitative research for the researcher to have an immersive role in the group of individuals being studied and to be considered an "instrument" in the research (Given, 2008; Xu & Storr, 2012). We as researchers hold experiences and perspectives that influence the study and interpretation of the data (Creswell, 2015). All three of the authors have undergraduate degrees in STEM and identify as White. Authors 1 and 3 were faculty members from middle-class up-bringings and Zocher was a graduate student from a first-generation and low-income background. Additionally, we all had a vested interest in the group "working." Despite our efforts, it was not possible to eliminate power imbalances between the participants and the rest of us. With Zocher having also served as the peer group leader, it was especially important to be explicit with the participants about the boundaries of the peer mentor position and the research. To this end, Zocher clearly demarcated the focus group session from regular group meetings for participants and communicated that while their responses during the focus group could be used for analysis and publications, their contributions to regular group sessions would remain confidential.

Results

In the following section, results from the intake interview are presented to describe the participants' challenges and supports in STEM leading up to the start of the program. Results from the focus group interview and group leader reflections are described separately to highlight the participants' collective lived experiences as a part of the peer group. For the purposes of coding in this study, "support" was defined as a positive impact on the participants' academic or personal development from one of the following three emergent categories: (1) an academic resource or experience, (2) relationship, or (3) internal thoughts or self-driven actions (e.g., self-regulation). Similarly, the same three categories were coded for things having a negative impact on the participants' academic or personal development, which are defined here as "challenges." For example, participants' references to positive experiences conducting research in a lab were coded as an academic support while struggles with the difficulty with a particular course was coded as an academic challenge. Personal interactions or relationships that were reported as being helpful were coded as relationship supports and discouragement from professors were coded as relationship challenges. Positive self-talk or self-regulating behavior was coded as a supportive thought or action while expressed feelings of inadequacy were coded as challenging thoughts or actions. The coding manual is provided in Online Resource 1.

Challenges Prior to the Peer Group

Participants described an array of challenging factors as a result of being in STEM, often speaking to the demanding nature of their chosen fields. Many challenges were described in terms of high workloads and time management. For example, Sonia discussed managing work and school:

> My first semester last year… I was actually working two jobs and taking 18 credit hours. And I don't want to do that again. I learned my lesson. It was really stressful. I was barely sleeping. It was almost discouraging... First semester last year was rough.

Academic challenges in STEM were also explained by the participants in terms of particularly difficult course content. Helen explained, "The subjects… they're very complicated… I just think the material is hard."

Some participants also described challenging relationships as barriers, such as discriminating teachers. Beth described a negative relationship with a teacher: "One of the teachers was very much…a bully and she specifically had a thing against…girls who were smart." Some participants also described struggles with peers. Fiona explained her discomfort among peers as a result of feeling different from them:

> Sometimes I feel uncomfortable just because I was like, "Why aren't [my friends] with me?" It felt different because I just felt…like an outsider... like, "All of these people…their parents help them a lot. They've gone to school." My parents, the highest that they went to was middle school...So that was different.

Helen expressed a similar sentiment, as she noted that she did not have someone in her previous academic settings who could relate to her experiences in STEM:

> I was hoping…to be...with someone who also was [like me]...I can't even put into words how stressful it is. So it'd be nice to feel like I have a shoulder to lean on…it would be nice to have someone who could relate.

While participants frequently described their internal drive to push through such academic hurdles, it was also quite common for participants to discuss their inner dialogues or self-regulation as a challenge. Many of the participants described themselves as harsh critics of themselves. For example, Sonia described her frustration with herself:

> My grades dropped a little bit… I was upset...it feels like, maybe it's you. Maybe you need to start changing some things. ...I got all B's, and I was like, this is not right, because I'm usually the type to get [a] 4.0... I was mad.

Nicholas displayed a similar challenge when he expressed feelings of guilt for not being as prepared as he felt he could have been in a challenging course: "I was kicking myself for not learning it in the first place." It was quite evident that the participants put a lot of pressure on themselves. At times this pressure was described as very extreme and even threatening to their health. Shelby described not taking care of herself: "In November…I was just not sleeping at all…I actually ended up in the emergency room…that was rough."

In summary, the most prevalent challenges included academic challenges associated with difficult course content, unsupportive relationships with teachers and peers, and thoughts or actions where participants put excessive pressure on themselves to meet the demands of being in STEM. Financial pressures of being low-income students (Bettencourt, 2021) and a lack of social capital due to parents' education level (Mishra, 2020) also emerged as challenges prior to the peer group.

Supports Prior to the Peer Group

During individual intake interviews, all of the participants reported that internal drive was an essential component of their successes in STEM up to that point. For instance, Dan described persevering through a difficult science course during his first year of college. After having failed the first exam, Dan stated, "I just tried new options…instead of just doing the homework, I would review the notes and look up more practice problems and more examples… I went in for more help." Here, Dan demonstrated a clear internal drive to succeed despite the initial struggles of failure and feeling unprepared. He made the decision for himself to seek out new resources and means of learning course material. This type of internal drive was common among participants, as echoed by Harold: "I think it was 50 h or 60 h we had to do in order to pass the class. I did 80. I wanted to do more. Give me as many as you can." This theme emerged when Nicholas described his struggles with calculus: "Passing calc two…that was…the hardest thing… in my life… tutors and YouTube every day. I would devote…two to three hours a day of just studying…like mental jumping jacks. It was insane." These examples demonstrate that the participants were highly driven to succeed prior to the BELONG in STEM program.

In addition to intrapersonal support, participants cited relationships with family, peers, and educators as sources of support prior to beginning the peer group. Christina discussed the support she receives from her friends:

> Being able to talk to family and friends has been helping. Especially my friends, because some of them are also in hard classes as well. So it's nice to relate to them even if they're not the same school I go to now. My best friend, she's pre-med so she's got a lot going on, too. So it's nice to be able to relate that way.

Nicholas described how his family, "were always supportive [of] what I've really wanted to do, but having them approve of it definitely impacted it and cemented the fact that what I've thought I wanted to do was good and would be good for me." Andre described an ongoing relationship with a former high school teacher who provided him with both academic and nonacademic guidance:

> There is that one person [who] always... stays in touch with me a lot, and that would be my high school teacher…I sent her a message, like, "this happened and I'm really bummed out" ...I always look forward to her response...And that's definitely that one person I would completely trust a lot. After all, she did guide me on a good path.

In summary, prior to beginning the peer group, participants identified internal drive or positive self-talk and relationships with family, peers, and teachers as sources of support. The participants' stories of supportive relationships suggest many of them had social support (Mishra, 2020) prior to the peer groups.

Peer Group Supports

The focus group interview and weekly reflections revealed how participants viewed their experiences in the peer group during the Fall 2019 semester. During the focus group, the participants described how, at the outset of the peer group, they either did not know what to expect or assumed that it would be similar to other academic STEM settings. For example, Helen shared, "When you see 'STEM' attached to anything, you're always like, 'Okay, so I guess I have to go buy a lab coat.'" Participants expressed surprise and appreciation for the more casual, nonacademic nature of the group—contrasting with the high-pressure academic environment of their STEM courses. For example, Shelby stated:

> I would really emphasize that this isn't a burden of any sort. This isn't like a mountain to climb... I feel like some majors are always out there looking for some challenge and whatnot and this really is just a chill place to get help and to talk and to figure stuff out.
>
> Helen agreed with Shelby and added:
>
> Yeah. I agree with that. I'm joking, no offense you guys, I call it my nerd group [laughter]… it's not a burden and it's not... typical STEM, like, "You

> have to be so smart," or like science oozing out of you [laughter]. No, it's just chill.

These quotes illustrate an appreciation for the non-academic nature of the group as providing a low stress environment (Spencer, 1995; Swanson et al., 2002). Furthermore, they show a link to the concept of science identity (Potvin & Hazari, 2013) in that they came to recognize one does not have to have science "oozing" out of them or "always out there looking for some challenge" in order to belong in their field.

During the focus group, participants also frequently referenced deep, personal stories that group members had shared, as well as the positive impacts these stories had had on their perceptions of themselves and each other. One particularly strong example of this was the "Strange Trails" activity. Participants explained various perspectives and positive outcomes that resulted from the conversations that ensued. Andre discussed connecting with his peers: "I feel like a common thing that happened during those conversations was that we found relatability between…each other…It's the journey that we need to be focusing on." Dan echoed this feeling that the activity helped the group connect:

> The "Strange Trails" conversation…kind of just helped see where people are coming from... It's interesting. Everyone has a story... it kind of helps you learn a little bit more about the people in the group, more about them personally, and maybe explains why they are who they are, why they like what they like.

Sonia expressed that this activity pushed her to think about her individual journey in ways she had not previously, "When you asked us to write down our strange trails, I was like, 'I don't know.' I've never sat and thought about that before." This particular finding highlighted the power of cultivating a relaxed space where participants have a chance to get to know each other. This resulted in an environment where they felt able to share more of themselves, including their failures and flaws. Some participants explained that this experience carried over into their lives even after the group. For example, Fiona shared, "it just made you reflect on their weird paths [you've] taken. It was definitely something I reflected on after."

The most prevalent theme that emerged from the focus group was the impact of the relationships built over the course of the semester. The feeling of normalizing struggle—group members' realization that others in the group experienced the same challenges as they did—was especially salient. This allowed them to feel less alone. As Dan described, "I struggled with feeling like I'm so alone, struggling in school… Just hearing a bunch of other smart people saying they struggle with school as well, and they're going through hard times. It just makes it feel like you're not alone." Dan's recognition of other group members' difficulties led to his realization that it is normal to struggle in STEM. Similarly, Christina noted that recognizing that other people were struggling like her provided her with motivational support: "You guys are doing so well…even if we're all struggling in some way in what we're trying to accomplish, it's really cool to see everyone trying their hardest in what they want to do. And it's just a very motivating environment to me." While the perspective shared by Christina was in an academic context, the impact was clearly emotional as well. Shelby expressed a similar feeling through her lens as a recent community college transfer:

> When I was back in [university] the first month or so I was like, "Is everyone struggling as much as I am? Am I not able to go to [university]?" And so it was nice knowing that other people were struggling and this is just what school is [laughter].

Results from the focus group showed that the peer group was a successful intervention that provided a unique space for the participants' social/emotional needs to be supported. The relaxed atmosphere was a place where activities such as the Strange Trails conversation elicited meaningful self-reflection and brought the participants closer together as a group. The relationships and relatedness formed during the group was described as helpful and motivating in dealing with the challenges of their academic lives. Participants describe the peer group as a low-stress environment where they received support for their struggles (Spencer, 1995; Swanson et al., 2002).

Challenges from the Peer Group

While the vast majority of the comments from the focus group indicated that the peer group was an exceptionally positive experience, participants were also explicitly asked to describe "low points" and other aspects of the group that they found challenging. Participants described a reluctance to share as the main challenge, ascribing that to their personality, time management, and a sense of awkwardness in the beginning.

Some of the participants were less inclined to speak in front of the group, which in some cases related to participants' personalities and at other times to feeling tired from academic responsibilities during the day. Sonia described being worried about how her lack of engagement was perceived by the group:

> Sometimes I just don't feel like talking. It's not anything against the group or anything, but sometimes I get here and… I just don't feel like sharing in front of everybody. And then I feel bad because I don't want people to think, "Oh, she's...so disengaged."

Harold related a discomfort sharing his feelings and competing pressures on his time:

> Sometimes...I don't really want to show up. I have too much other stuff going on. I want to sleep. So a bunch of stuff just kind of hits you at once, and you gotta go talk about your feelings for a couple of hours. Not my favorite thing to do.

Paradoxically, despite the benefits participants described of hearing others' stories and struggles, the most common challenge participants experienced in the peer group centered around a reluctance to speak in the group.

Participants described time management as another challenge associated with sharing during the peer group. Given the participants' high course loads and the subsequent difficulties associated with scheduling a time for everyone to meet each week, this was not a surprising result. Fiona named her busy schedule as part of the reason why she felt it was sometimes a challenge to share in the group:

> For me, Wednesdays are my longest days of the week for sure. So then after this, I have a study group as well. So… I'm on campus for more than 12 hours… and then I work half of the day… So, I finally get a time to relax here when I get to sit down, so I'm just kind of like, "I need to just listen."

Participants also described getting over the hurdle of awkwardness as a challenge of participating in the group. Dan explained, "Initially, it was kind of awkward…No one knows each other so it's just kind of weird at first, but [we] warmed up pretty well." Helen said she struggled with awkward silences and reluctance to share first:

> I guess it's challenging to get over the fear to be the first one talking because either we're all going to sit here in silence for an hour and a half, or I'm going to be the awkward one who talks first, and usually...that was something of a challenge.

An additional minor challenge related to a lack of representation of some majors. Approximately one third of the group did not have a peer in a similar major. While participants were able to relate to one another based on being in STEM in general, there were certain experiences that were unique to individual majors. Pascal explained that he, "hope[d] there would've been one student also from [my major]. Seems like I'm the only one here." Also, although participants described most aspects of the group in a positive light, some of the activities were not enjoyed as much as others. Gia, for example, did not enjoy when poetry was brought into the group experience: "Reading poems and stuff and trying to relate to them…to our lives. I personally hated it. It felt like English class to me…it just felt so forced."

The most prevalent challenge participants experienced in the peer group related to sharing. Numerous participants described the challenge of speaking in groups, which was ultimately overcome throughout the course of the semester. Group members were able to navigate this challenge with the support of other group members. Significantly, overcoming these challenges through the act of sharing and hearing other people share their stories became a central source of support in the group experience.

Discussion

The purpose of this study was to understand the supports and challenges experienced by twelve low-income, high-achieving STEM students engaged in a weekly peer social support group as part of an NSF-funded scholarship program. The supports and challenges framework was derived from *net stress engagement component* of the PVEST model (Spencer, 1995; Swanson et al., 2002), which describes how social supports help individuals in overcoming challenges. We probed participants' supports and challenges prior to the program using semi-structured interviews. The purpose of this was to distinguish between pre-existing challenges and supports versus those that were provided by the peer group. We also probed the impacts of participating in one semester of a peer support group led by a STEM graduate student using a focus group. Despite the abundance of research on social support and persistence in STEM (Ceyhan et al., 2019; Hansen et al., 2023; Mishra, 2020; Pearson et al., 2022), most studies do not describe their intervention in detail. In the present study, we described the social support intervention we designed in detail and the qualitative approach describes the reasons why participants say it was effective.

In the pre-program interviews, participants described prior supports and challenges that contained academic elements, but were primarily social-emotional in nature. In particular, participants reported on relationships they experienced as either nurturing or marginalizing. All participants shared at least a brief mention of being supported by parents and/or siblings, indicating that family was an important support in their pursuit of a STEM degree. This finding is not surprising since several studies have documented the importance of familial connections in student success (Buchmann & Diprete, 2006; Burge, 2013; Dimitra, 2013). In contrast, many participants expressed that they were seeking different support than what they had previously received from teachers and peers. Some explicitly stated that their non-STEM peers were unable to understand the challenges they faced as STEM students, suggesting a lack of a sense of belonging (Rodriquez & Blaney, 2021; Strayhorn, 2018).

After participating in the peer group for one semester, participants highlighted three themes. First, participants felt the relaxed atmosphere gave them spaces to share without the need to conceal their struggles from their peers. This finding aligns with the results of a study of near-peer mentors in which social activities cultivated relationships (Zaniewski & Reinholz, 2016). Second, building relationships with their peers helped them relate to one another. Activities such as discussing participants' "strange trails" proved to be especially instrumental in accomplishing the goals of the group, allowing participants the freedom to share about themselves in an environment devoid of the need to present oneself as a STEM "nerd" or competent academic. These findings connect with previous studies that highlight the significance of small group processes in academics (Dugas et al., 2019) and social support from peers (Zaniewski & Reinholz, 2016). Third, the normalization of struggling in STEM within the group provided support that helped the participants to feel less alone and more connected to their STEM community. This is similar to themes that emerged from Zaniewski and Reinholz's (2016) study of near peer mentoring in physics where participants reported the mentoring helped normalize the academic struggles students faced. The peer group fostered the type of supportive peer-to-peer culture that Williams and Taylor (2022) discuss as an essential component of education practice at HBCUs.

The challenges participants identified were not surprising but confirm findings in other studies involving low-income students (Bettancourt, 2021). In addition to early experiences of awkwardness as the group became more familiar with one another, participants discussed challenges with time management and making time for the peer group. Bettancourt (2021) explained that low-income students were less likely to have a sense of belonging because they must prioritize financial obligations over socializing. The peer group participants in this study acknowledged this time pressure and were grateful that the group was a non-academic space where they could "chill." While participants expressed this is a positive aspect of the group, this points to the challenge of working with low-income, high-achieving STEM students—they are busy and making time for social support, however helpful, is a challenge.

As the peer group developed, participants became more comfortable and engaged in self-disclosure. An emergent theme from the focus group related to science identity (Potvin & Hazari, 2013; Rainey et al., 2018). Science identity is described as a combination of a student's personal identity (recognition of oneself as a "science person") and social identity (recognition by others, particularly by those in STEM fields, as a "science person") (Potvin & Hazari, 2013). Having a strong science identity plays an important role in student involvement, persistence, and career selection (Carlone & Johnson, 2007; Chang et al., 2011; Williams & George-Jackson, 2014). Potvin and Hazari (2013) studied science identity in physics undergraduates and found that academic performance and competence beliefs are not sufficient for developing a physics identity. Rather, they found that recognition and interest are also necessary for supporting identity development (Potvin & Hazari, 2013). In other words, an individual must be intrinsically excited about the content and have their abilities recognized by others (e.g., mentors, peers, and family) in order to develop a strong physics identity. In our study, participants noted that they were not all "nerds" but shared similar struggles. The peer group created a social setting where participants could talk about things that they otherwise might not have a space for in their STEM education. Sharing their "strange trails" increased their sense of belonging with other group members and provided a launching point for reflection on their beliefs about what makes someone a legitimate "science person," thus providing support for the development of both their personal and science identities (Potvin & Hazari, 2013).

In the supportive space that was created, participants were able to acknowledge that they shared the experience of struggling in STEM and that was part of what defined them (rather than disqualifying them) as a STEM student. In a qualitative study contrasting students that persisted with those who left STEM, Rainey et al. (2018) found that while all students expressed the importance of sense of belonging, those that left their STEM major were lacking science identity. Our findings suggest that the sense of belonging created by the peer group supported participants' science identities, which supported them through the challenges of being STEM majors. We propose that this is the mechanism by which the peer groups reduced participants *net stress engagement* (Spencer, 1995; Swanson et al., 2002).

An important component of the intervention in this study was the graduate student STEM mentor. Raman et al. (2015) suggested that graduate students may serve as more effective mentors because they are closer to the experience of undergraduate STEM majors. The mentor in this study was a graduate student who received significant training prior to the peer group starting and following each peer group meeting. With support from a faculty member highly experienced in group dynamics, she planned and adjusted as the group evolved and reported and support students who found themselves in crisis. Therefore, the mentor in this program met the six attributes of successful mentors discussed by Raman et al. (2015): safe, prepared, proactive, patient, present, and positive. In a study of female secondary school physics students, Oliver et al. (2017) found that recognition from role models promoted science identity. Atkins et al. (2020) found that mentors fostered students' science identity by providing role models, cultivating shared values, and providing academic challenges. Similarly, Robnett et al. (2018) found that instrumental (i.e., task-based techniques) and socioemotional (i.e., social and emotional support) mentoring promoted stronger science identity in undergraduate STEM research students. Therefore, in this study, the peer group leader, a STEM graduate student, provided students with a role model to promote their science identity development and sense of belonging (Atkins et al., 2020; Oliver et al., 2017; Raman et al., 2015; Robnett et al., 2018).

Implications for Future Practice

The fact that participants found the social-emotional aspects of the peer group so supportive carries important implications for future practice. Rather than being developed around a defined curriculum focused on the development of professional skills or content knowledge, the peer groups were designed based on principles of small group dynamics which centered relationships. This is a departure from most of the research literature on supporting persistence of STEM students, where the emphasis tends to be on academic support and research mentorship (Pearson et al., 2022). While those elements were provided elsewhere within the program, the peer groups purposefully avoided focusing on academics, and participants specifically cited as a benefit the "non-academic" feeling of the groups. Instead of a pre-established curriculum, weekly group activities were planned inductively and organically, based on the needs of participants, whether those be relational, emotional, or academic. In this process, the peer group leader was trained in the development of positive group norms and relationships, and it was these norms that created a feeling of safety and trust that allowed participants to share their challenges openly with one another, which in turn led to feelings of being supported. We recommend that future research in this area continue to pursue this approach, responding to the needs of STEM students as whole human beings, and not merely (or even primarily) as STEM students per se. This will require university staff (and even faculty) to be trained in small group processes to help develop supportive norms. This will also require STEM programs to explore ways to support students' needs more holistically, both within and beyond the classroom.

Limitations

The primary goal of this study was to investigate the mechanisms by which social support can improve persistence in STEM. Although the academic check-ins and professional development activities may have impacted participants' perceptions of their peer group experience, we did not investigate those aspects of the BELONG in STEM program for this study. Future work will explore how participants reflect on those components of the program. This study was limited by the scope of one semester of participation in the peer group; however, the focus group provided insight about how the peer group was supportive of participants overcoming barriers and challenges. We did not do member checks on the data, which is a shortcoming, however member checks would have been colored by the participants' ongoing experience in the peer group. For that reason, we consider this data an early snapshot of the first peer group implemented in this five-year program.

The participants in this study were all high-achieving students, as eligibility for the scholarship program required a high level of academic achievement (GPA > 3.0). Therefore, one limitation of this study is that it is not representative of a wide range of academic achievement levels. Many students who struggle to persist fall outside the bounds of the scholarship program's requirements. It is important to recognize that these students have their own stories as well as supports and challenges that are undoubtedly unique. Specifically, STEM students who are women of color report experiencing pressure to overcome stereotypes (Ong et al., 2011). STEM students in this program likely experienced the intersectionality (Crenshaw, 1989) of their various identities as low-income, first-generation, and/or minoritized ethnicity, all of which are underrepresented in STEM (Charleston et al., 2014). Therefore, one limitation of this study is that we did not specifically probe students' multiple identities and therefore cannot account for how those identities intersected with their experience in their major and in this program.

Conclusions

The peer group described in this study was structured to focus on building relationships instead of STEM skills as a means to foster community among undergraduate STEM peers. The peer group was a low stress, non-academic social setting that the participants described as a valuable experience. Given the many high-pressure situations that students encounter in STEM, our findings show that spaces such as the peer group can help students to feel less alone and more connected with individuals in their communities. This is of particular importance for underrepresented groups in STEM who may lack a sense of belonging due to deficiencies in representation. Our results also support previous findings (Atkins et al., 2020; Raman et al., 2015; Robnett et al., 2018 Zaniewski & Reinholz, 2016) that near peer mentors have great potential to relate and foster a sense of belonging among undergraduates.

Paramount to our findings is the power of normalizing the struggles of being in STEM, which was accomplished via conversations such as sharing and finding acceptance in the "strange trails" that shaped both their academic and non-academic journeys. These results demonstrate that social support can expand students' notion of a science identity by demystifying what it means to be a STEM student. Opening up intentional spaces for STEM undergraduates to feel supported is a demonstrated strategy to help students stay in their chosen fields and persist towards the completion of their degrees.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s41979-024-00116-1.

Acknowledgements This project would not be possible without the participation of the twelve scholars in the peer group or the peer group mascot, Chad.

Author Contribution Authors 1, 2, and 3 co-developed the interview protocol and the code book. Author 2 collected the interview data with participants, and wrote the initial analysis of the data and first draft of the manuscript. Authors 1 and 2 conducted inter-rater reliability. Author 1 conducted a literature review and substantially revised the manuscript with input from Author 3 for publication.

Funding This work was supported by the National Science Foundation grant #1834076 and the Northern Illinois University College of Liberal Arts and Sciences.

Data availability The datasets collected and analyzed for this study are currently not publicly available because they contain identifying information about the research participants. They can be made available from the corresponding author on reasonable request.

Declarations

Conflict of Interest The authors declare no competing interests.

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