Retention of Academically Talented STEM Scholarship Recipients in Community College

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This qualitative study investigates the experiences of academically talented STEM students with financial need participating in a STEM scholarship program at a community college. These student's lives are characterized by complex logistics and competing priorities that they attempt to balance. Results suggest intentional programmatic support services with attention paid to students' sense of belonging within the scholarship cohort coupled with scholarship monies that allow students to achieve a delicate work-life balance, reduce stress, and be retained in STEM. However, students still contend with uncertainty around transferring to a university. Implications for improving STEM education practice and policy are discussed.

Keywords: S-STEM, community college STEM students, STEM identity development, STEM sense of belonging, scholarships, STEM student supports

INTRODUCTION

Numerous theories regarding student success in science, technology, engineering, and mathematics (STEM) have emerged in academic literature, often overlapping and interrelated. A recent systematic review of literature on Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) programs in community colleges (Espino & Meza, 2024) identified 14 distinct theories related to student success in STEM fields. This literature spanned a wide range of disciplines including psychology, sociology, behavioral economics, social cognition, and student development. While some of these theories have been applied specifically to research that involved STEM students enrolled in community college programs, most were originally developed and tested within the context of four-year universities, often in elite settings (e.g., Madsen et al., 2023; Rodriguez & Blaney, 2021). This research gap presents a challenge to community college STEM practitioners seeking guidance on how best to navigate the complexities of student success specific to their student populations. Instead, community colleges may rely on personal

experiences, student anecdotes, and trial-and-error approaches to develop strategies to support and retain academically talented STEM students, particularly those from low-income backgrounds.

Community colleges present a significant opportunity to broaden access to STEM education for underrepresented groups, including students with limited resources to attend college, first-generation and racially minoritized students and those with limited resources to attend college (Bahr et al., 2023; Van Noy & Zeidenberg, 2014). Despite this potential, low-income students are less likely than their higher-income peers to enroll in STEM programs at community colleges or to successfully transfer into STEM fields (Zhang, 2022). Furthermore, a notable proportion of community college students who complete STEM courses leave without obtaining a postsecondary credential (Bahr et al., 2023), and students from Black, Latiné, and Native American backgrounds remain underrepresented in transfer-level STEM courses (Bahr et al., 2017). Compounding these challenges, students who begin their education at community colleges often encounter financial and structural barriers that hinder their ability to complete STEM programs and achieve their academic and career goals (Bahr et al., 2017; Wang et al., 2020).

THE S-STEM SCHOLARSHIP PROGRAM

The National Science Foundation's (NSF) S-STEM program is a federally funded initiative aimed at improving retention rates for low-income students in STEM fields. The program provides scholarships to "academically talented, domestic low-income students with demonstrated financial need" pursuing STEM degrees (National Science Foundation, 2024). According to NSF guidelines, colleges must allocate between 50% and 60% of funds toward student scholarships, depending on the specific award type (National Science Foundation, 2024). Faculty and staff at participating institutions are tasked with developing and implementing student support strategies designed to enhance student success and retention.

The underlying theory of change behind S-STEM is that combining needs-based financial aid with targeted, education-focused support strategies will help students who might otherwise struggle to begin or complete a STEM education (Herbaut & Geven, 2020). This model allows colleges flexibility in designing and deploying various strategies to foster student success. Commonly employed strategies include research opportunities, peer mentoring, intrusive advising, and career development workshops (Espino & Meza, in press; Meza, 2024). In a recent study, Rodriguez and Blaney (2021) find that S-STEM scholarship recipients experienced "financial freedom and an ability to focus on engineering identity" (p. 1) linked to greater student and faculty engagement fostered by the S-STEM program. Their findings offer valuable lessons for community colleges seeking to improve access and success for students in STEM pathways.

This study examines how students and faculty at one community college understand and engage with the supports provided through the S-STEM program. In 2017, Everett Community College (EvCC), located in the Puget Sound region of Washington state, successfully secured an NSF S-STEM grant. Following the completion of their first five-year grant cycle, the college was awarded a new S-STEM grant. From the outset, EvCC viewed the S-STEM program not just as a scholarship opportunity, but as a comprehensive initiative aimed at enhancing the financial, academic, and co-curricular aspects of the STEM pathway (Washburn & Bragg, 2022).

The EvCC STEM Scholar program specifically targets low-income, domestic, academically talented students, with a particular emphasis on women and racially minoritized groups who may otherwise face barriers to persisting in college and pursuing a STEM major without financial assistance. By implementing curricular and co-curricular changes designed to strengthen the STEM pathway, EvCC aimed to improve equitable access to higher education for a diverse array of students, ultimately preparing them for high-wage employment opportunities in the local STEM workforce. All students in the EvCC STEM Scholar program participated in services tailored to overcoming barriers to college access and success, helping them prepare for and enter STEM careers (James & Singer, 2016).

The purpose of this study was to explore two research questions related to how S-STEM programs operate and influence STEM student success in community colleges as part of the NSF-funded (DUE 2224623 and DUE 2224671) Community College S-STEM Network (CCSN). The CCSN connects researchers and practitioners and supports them in conducting and translating research on how students

navigate STEM pathways into evidence-based practices, programs, and policies. In partnership with EvCC, researchers explored the following questions:

- How do community college STEM students perceive and engage with the scholarship and academic and social support services?
- What aspects of the program did participants find most influential in shaping their academic and career decisions?

THEORETICAL FRAMEWORK

Within the broader literature on equity in higher education, sense of belonging has emerged as a critical factor in student success, particularly among students who have been underrepresented in STEM education. Defined by Goodenow (1993) as a student's "sense of being accepted, valued, included, and encouraged by others (teachers and peers)" (p. 25), a sense of belonging plays a significant role in academic success and retention in college (for example, see Freeman et al., 2007; Pittman & Richmond, 2008). The construct of sense of belonging is multifaceted and includes a range of factors such as interpersonal relationships, perceived competence, and personal interest. In the context of STEM, sense of belonging is associated with science identity (Rainey et al., 2018). In STEM fields, a strong sense of belonging has also been shown to correlate with higher retention rates (Freeman et al., 2007; Pittman & Richmond, 2008).

Much of the literature on sense of belonging has focused on four-year institutions, and some studies suggest that the dynamics of belonging are different in community colleges, particularly for STEM students. Gopalan and Brady (2019) note that community college students experience a "greater variability in student backgrounds, goals, and experiences," they theorize that for many community college students, institutional belonging is less significant than belonging within a specific course, major, or professional community. Their findings highlight the need for more nuanced research on sense of belonging in community colleges to better understand the unique processes at play in these settings. This gap is particularly relevant for students in STEM fields, where the challenges of persistence are amplified by a variety of factors, including the demands of the discipline and the historic marginalization of women, racial minorities, and low-income students.

Building on this framework of sense of belonging, science identity theory (Carlone & Johnson, 2007) and its extension into engineering identity (Godwin et al., 2016) provide further insight into how STEM students perceive themselves and their place within their academic and professional communities. Engineering identity is particularly relevant to this study, as it examines how students come to see themselves as the type of person who belongs in an engineering role. According to this framework, engineering identity is composed of three key components:

- Interest (e.g., curiosity, a desire to learn about engineering concepts)
- Competence/performance (e.g., developing skills, engaging in hands-on applications, using engineering tools and language)
- Recognition (e.g., being recognized by oneself and others as an "engineer" or someone capable of performing engineering tasks)

The recognition component is of particular importance to this study, as it speaks directly to how students' sense of belonging in STEM fields is shaped not only by their internal beliefs and abilities, but by the recognition they receive from peers, faculty, and the broader academic community. In the context of the EvCC STEM Scholar program, understanding how students develop a sense of STEM identity and how this identity is reinforced through both formal academic supports and informal peer relationships will be crucial to understanding their persistence in STEM fields.

The theoretical framework presented here, which integrates sense of belonging with science identity, provides a lens through which to examine how the support systems and strategies implemented through the S-STEM program at EvCC influence students' development of identity and sense of belonging within their STEM pathways. It is particularly relevant to community college STEM practitioners wishing to explore how financial, academic, and social supports offered through the S-STEM program may influence students'

engagement with STEM disciplines and their decision-making processes throughout their academic journey.

METHODS

This qualitative research study employed a semi-structured interview approach as part of a larger case study examining the lived experiences of 15 undergraduate, low-income students majoring in STEM disciplines at Everett Community College (EvCC), all of whom were recipients of the NSF S-STEM grant. Additionally, four faculty and staff members responsible for designing and implementing the S-STEM program were interviewed. Qualitative interviews were chosen as the primary method for gathering in-depth insights into participants' experiences through which we could uncover the meanings behind these experiences and construct rich, detailed narratives (Seidman, 2006). Given the research questions, the primary focus was on understanding the "why" and "how" behind students' engagement with the program and their academic journeys in STEM (Seidman, 2006).

Participants were recruited through an email invitation sent by the research team. To facilitate scheduling and maximize participation, interviews were conducted either individually or in small groups of two or three students. Each participant was assigned a pseudonym to ensure confidentiality. A semi-structured interview protocol was used to guide the interviews, allowing for flexibility to explore topics in depth while maintaining consistency across interviews. Audio-recorded interviews were conducted on-site at EvCC by a member of the research team. A second research team member created transcripts of the interviews and then summarized the key findings. Data were analyzed using a thematic analysis approach; NVivo software was used to assist in coding and identifying recurring themes across the interviews. The study design, including the interview protocol, was reviewed and approved by the institutional review board (IRB) for human subjects compliance at a major research university, ensuring adherence to ethical guidelines.

The diverse participant group reflected the varied demographic landscape of community college students (Table 1). Of the fifteen student participants, nine identified as racially minoritized, eight were female, and four were over the age of 30. All students were considered low-income and Pell-eligible. Within this group, eight students were first-year STEM majors, and the remaining seven had completed sufficient coursework to progress beyond the first-year level. These seven students had received the S-STEM scholarship in the prior academic year. This mix of students provided a broad spectrum of experiences, further enriching the insights gathered about the impact of the S-STEM program.

TABLE 1
STUDENT PROFILE

Gender identity	Race/Ethnicity	Major	Age
F	White	Environmental Science	<22
M	2 or more races	Aerospace Engineering	23–29
F	Latina	Computer Science	30–40
F	White	Environmental Science	23–29
M	Latino	Engineering	23–29
F	Latina	Environmental Engineering	
F	Native American	Environmental Science	30
M	Latino	Mechanical Engineering	23–30
F	Latina	Chemistry	40+
F	White	Computer Science	23–29
M	White	Computer Science	<22

Gender identity	Race/Ethnicity	Major	Age
M	Native American/Alaska Native	Electrical Engineering	<22
M	White	Computer Science	<22
M	Black	Computer Science	<22

FINDINGS

When EvCC developed its S-STEM grant, the institution planned a range of activities and supports to enhance the academic success of STEM students. These included career and transfer exploration field trips, social integration activities, targeted academic support, and equity training for faculty. However, due to staffing changes, resource constraints, a new computer system implementation, and the lingering effects of COVID-19, not all planned activities came to fruition as originally envisioned. While some activities, such as field trips to transfer institutions, were readily recognized by students as part of their STEM programs of study, other activities, such as course-specific tutoring, were not as evident in the experiences in STEM that students narrated in interviews. Our research found students interpret and make sense of the S-STEM program's supports (known on campus as E-STEM) and activities in diverse ways. As one faculty member remarked, "There's a difference between what I think is important and what has turned out to be important." Given this context of change, we sought to understand how community college STEM students perceive and engage with their S-STEM experiences, particularly regarding the aspects that they found most influential in shaping their academic and career decisions.

STEM Identity Development and Sense of Belonging

The development of a strong STEM identity and sense of belonging emerged as a central theme in students' experiences. Drawing on concepts from science and engineering identity theory (Carlone & Johnson, 2007; Godwin, 2016), our findings suggest that the E-STEM program played a pivotal role in fostering students' sense of identity within the STEM field. Through the E-STEM scholar designation and structured community-building activities, students reported feeling more connected to the STEM community and more confident in their academic pursuits. As one student noted, "I feel more confident in what I'm learning, and I feel like part of it is because of E-STEM."

The development of a STEM identity was particularly evident in students' increased engagement with professional opportunities. As one student described:

> When I first started coming back [to college], I was all online and didn't really have much of a community. The E-STEM program brought me a lot closer to people who are interested in the same things I'm interested in. They've taken me on field trips where I've gotten to chat with professionals in the industry. And that's really helped me figure out what I do and don't like about certain environments.

The program's emphasis on community integration proved particularly important for students' engagement and aspirations. Students appreciated the program's ability to foster both social and academic connections, which bolstered their confidence in pursuing opportunities outside their comfort zones. One student reflected, "If I didn't have the E-STEM program, I'd probably be a lot more to myself and wouldn't jump at certain opportunities." The community-building activities, including field trips and peer interactions, facilitated students' engagement with professionals in the field, further solidifying their interest in STEM careers.

Building on Strayhorn's (2012) conceptualization of sense of belonging as a basic human need that becomes heightened in certain contexts, we found that the program's community-building activities proved particularly significant for students. Despite faculty perceptions of modest student engagement in some activities, students expressed satisfaction with the level of engagement opportunities. One student described the program's social aspects: "The one thing that was like the most about it is the togetherness ... It's all about like, kind of like a family, right?" This sense of community extended beyond social connections to

academic engagement, with another student noting an improvement in their campus experience: "It helps me enjoy a lot more time [on campus], and I have friends to hang out by and maybe study together."

Additionally, several students exhibited what Deil-Amen and Rosenbaum (2002) describe as "warming up," where community colleges help elevate students' aspirations rather than diminish them. Many students who initially intended to pursue technical careers began to consider transfer STEM pathways, such as engineering degrees and transfer to selective universities, thanks to the guidance and support they received through the E-STEM program. One student shared, "I came here thinking I'd just get my mechanic's certificate, but talking with my advisor made me think I could actually become an engineer." Another student relayed how she had originally interacted with the community college when her son enrolled, but after speaking with advisors, she also decided to pursue a STEM pathway.

Comprehensive Support Systems

Aligned with the expectations of the NSF S-STEM program, a robust network of academic and social support systems emerged as a crucial factor in student success. Students perceived that faculty mentorship, peer academic support, and specialized STEM advising created a comprehensive framework that helped students navigate both immediate academic challenges and longer-term educational goals. Comprehensive support systems emerged as a crucial framework of interconnected academic and social supports that helped students navigate both immediate academic challenges and longer-term educational planning. Faculty mentorship, informal peer academic support, and specialized STEM advising created a network that not only supported students' current academic needs but also helped them understand and prepare for transfer requirements.

This multi-layered support system seemed especially valuable in helping students navigate the complex requirements of STEM transfer pathways. One student highlighted the importance of their faculty mentor: "Having a mentor who actually knows the engineering pathway made all the difference. They don't just advise you; they really guide you through the whole process." Students valued the role of STEM-specific advisors who provided tailored guidance, which contrasted with their previous experiences with general academic advising. One student explained, "Before E-STEM, I was taking classes I didn't even need because my general advisor didn't understand the engineering prerequisites. My faculty mentor helped me get back on track and saved me probably a whole quarter of unnecessary classes." This support system was important for students as they navigated complex STEM pathways, from course selection to transfer planning, ensuring they were better prepared for success both academically and professionally.

Financial Support, Stress Reduction, and Competing Life Demands

Students discussed the scholarship as addressing basic needs security in higher education and its relationship to student retention (Goldrick-Rab et al., 2018). Students reported the scholarship component of the E-STEM program was vital to alleviating their financial burdens, thereby enabling them to focus more on their academic work and less on financial concerns. Many students noted that the scholarship allowed them to reduce their work hours, contributing to a better work-life balance and improved academic performance. One student stated, "Because of the workload of the engineering degree, I've had to cut down my hours of work by half. The scholarship really takes a load off, like the gas money and any extra emergencies." Another student described how the scholarship enabled them to move out of a crowded apartment into a dorm, providing a quieter and more conducive environment for studying. However, a number of students shared that the scholarship monies were not always delivered in a timely fashion or took a lot of faculty intervention to get awarded, sometimes after tuition was due. Faculty then had to manually place holds or ask for holds to be placed on student tuition bills, a process that created stress and uncertainty. Faculty reported that understaffing in the financial aid office, confusion over paperwork requirements, and computer system changes were often to blame.

Despite these challenges, the financial support facilitated fuller engagement with academic opportunities as students no longer had to prioritize work over study. One student shared, "Before the scholarship, I was working 30 hours a week and barely keeping up with homework. Now I can actually go to office hours, join study groups, and really understand the material instead of just rushing through it."

Another student emphasized the scholarship's role in enabling academic focus: "It helps me feel a lot more financially stable and able to like, focus on my schooling and prioritize my schooling." This finding aligns with research by Cabrera et al. (1992) on the relationship between financial aid and college persistence, particularly their assertion that financial aid can influence persistence both directly through the provision of resources and indirectly through enhanced social integration.

Despite these benefits, students faced ongoing challenges related to competing life demands, such as work, family obligations, and the uncertainty of their future educational paths. For example, transfer planning emerged as a significant concern. Students expressed anxiety about the financial and logistical challenges of transferring to a four-year institution. One student reflected, "The scariest part about transferring isn't even the harder classes—it's leaving this support system behind. Here, I know who to go to for help, but at a university, I'll have to start all over." This theme highlighted the tension between the temporary nature of the supports available at the community college level and students' concerns about recreating these support systems at their transfer institutions. While the program successfully created a supportive ecosystem at EvCC, students worried about the transition and the continuity of support during the transfer process. This theme revealed the complex interplay between financial stability, academic persistence, and transfer uncertainty, particularly as students contemplated transitioning to four-year institutions.

DISCUSSION

Our findings underscore the multifaceted nature of community college STEM support programs, demonstrating how these initiatives can create conditions that foster student success through interconnected mechanisms. The experiences of E-STEM scholars at EvCC illustrate the opportunities and challenges inherent in implementing comprehensive support programs for STEM.

Theoretical Implications

This study extends and refines existing theoretical frameworks in several ways. First, our findings build on Deil-Amen and Rosenbaum's (2002) concept of "warming up" by demonstrating that these institutional supports reinforce each other and may help elevate student aspirations. Second, our research contributes to a more nuanced understanding of how STEM identity develops in community college contexts. Whereas much of the existing literature on STEM identity development focuses on four-year college students (Carlone & Johnson, 2007; Godwin, 2016), our study demonstrates that community college students may develop STEM identities through distinct, yet equally impactful, pathways. These pathways may be shaped by institutional and peer recognition. In particular, the E-STEM scholar designation itself acted as a powerful form of institutional recognition that catalyzed students' self-identification as legitimate members of the STEM community. This finding suggests that the process of STEM identity development in community colleges can be more closely tied to the support and recognition students receive from both the institution and their peers rather than solely from personal interest or intrinsic motivation.

Practical Implications

Our findings offer several practical implications for community college STEM programs, especially for those aiming to support financially needy, underserved students and foster successful transfers to four-year institutions.

First, while comprehensive support programs like E-STEM require substantial resources and coordination, even partial implementation can yield meaningful benefits. We found that the key elements of the program—faculty mentoring, peer communities, and financial support—worked synergistically to enhance student outcomes. These components can be incorporated, even in resource-limited contexts, to create a holistic support system that addresses both academic and social needs.

Second, the critical role of STEM-specific advising emerged as a key finding. Our research suggests that community colleges must prioritize the development of specialized expertise among advisors working with STEM students, particularly those pursuing transfer pathways. The contrast between students'

experiences with general academic advising versus STEM-specific advising highlights the complexity of STEM transfer requirements and the need for detailed knowledge about specific program prerequisites and transfer institutions. STEM-specific advisors can better guide students in navigating these pathways, ultimately improving their chances of successful transfer and completion.

Third, our findings regarding financial support emphasize the importance of considering not just the amount of aid but also its timing and stability. While the scholarship provided crucial financial relief, late disbursements and uncertainty about the continuation of funding created significant stress for students. This tension between the immediate benefits of financial aid and the uncertainty surrounding its sustainability underscores the importance of ensuring that scholarship programs provide reliable and consistent financial support throughout the student's academic journey. Addressing these concerns could help reduce student anxiety and enable them to focus more fully on their academic and career goals. Fourth, the importance of creating a sense of belonging cannot be overstated, particularly at community colleges where students may experience less general belonging than at a university. Programs like E-STEM that facilitate peer relationships and foster a sense of community play a critical role in student success. Our study underscores the importance of accounting for the social dimension of community college programs in the design of effective support systems, particularly for marginalized and first-generation students. Ensuring that students feel part of a community and recognized as legitimate members of their chosen fields can significantly enhance their persistence and academic success.

Limitations and Future Research

While our study provides valuable insights, several limitations suggest directions for future research. First, these findings are based on the experiences of students who persisted in the program. Future research should consider the experiences of students who left the program or withdrew from the college, as this group may provide crucial insights into potential barriers to program participation and persistence. Understanding why some students disengage from STEM support programs could inform the design of more inclusive and effective interventions.

Second, while we observed evidence of "warming up" in students' aspirations, future studies should explore how these elevated aspirations translate into long-term academic and career outcomes. Longitudinal studies could track students' progression through the transfer process, college completion, and entry into the workforce to determine the lasting impact of programs like E-STEM on student success and career trajectories. Recent research has revealed that only 11% of low-income community college students attain a bachelor's degree within six years of entering a community college (Velasco et.al, 2024). While community colleges might warm up aspirations, structures are still misaligned with student goals.

CONCLUSION

The EvCC E-STEM program exhibits both the potential and challenges of comprehensive STEM support programs at community colleges. Despite implementation challenges, students described how the program created valuable conditions for success through multiple mechanisms: fostering STEM identity development, providing targeted academic support, and reducing financial barriers. However, the persistence of transfer uncertainty even among well-supported students suggests that additional attention to the transfer transition is needed.

These findings contribute to a growing body of literature on supporting community college STEM students and suggest that support programs can yield meaningful benefits for students. Future research should examine how these programs can be sustainably implemented at scale and how their benefits can be extended through the transfer process. As community colleges continue to play a crucial role in broadening participation in STEM fields, understanding how to effectively support students through comprehensive programs becomes increasingly important. The experiences of E-STEM scholars at EvCC provide valuable insights into how students experience such programs and how they understand the influence of these experiences on their success in STEM pathways.

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