# Board 185: ”Someone has Invested in Me to Do This”: Supporting Low-Income Students to Persist in STEM Through a NSF S-STEM Grant

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# “Someone has invested in me to do this”: Supporting Low-Income Students to Persist in STEM through an NSF S-STEM grant

There have been numerous, widespread national efforts to address the challenge of a growing need for STEM professionals. In a 2012 report, the President’s Council of Advisors on Science and Technology suggested that the United States needed to produce one million additional college graduates in STEM fields by 2022 in order to keep up with the expected growth in STEM positions [1]. Between 1970 and 2018, STEM occupations grew 79% [2] and are expected to continue to grow 10.8% between 2021 and 2031 [3]. Evidence suggests that the number of STEM degrees is increasing, as is the diversity of those obtaining STEM degrees, yet representation in mathematics and computing fields lags behind [4].

There is a particular need for underrepresented populations in the STEM workforce, including low income students, women, first-generation college students, underrepresented minorities (URM), and rural students. Women, for example, comprised 51% of the US population in 2021 but only 35% of the STEM workforce. Similarly, more than 30% of the US population in 2021 was Black, Hispanic, or Native American, yet these groups made up less than 25% of the STEM workforce [4]. In 2021 women earned only 26% of the degrees in mathematics and computer sciences and 24% in engineering [4]. While these figures represent slight increases since 2011 (1% and 5%, respectively), percentages have not been monotonically increasing [5]. Black, Hispanic, and Indigenous individuals continue to be underrepresented in computing occupations [6]. First-generation students also face barriers to success across disciplines: first-generation students graduate within six years at much lower rates and are 71% more likely to leave college in their first year than non-first-generation students [7]; [8]. In STEM specifically, first-generation students drop out of their majors at higher rates than non-first-generation students [9]. According to [10], students from rural areas are less likely to graduate with a degree in STEM than students from non-rural areas.

In response to the need for increasing diversity in STEM, professional societies and institutions of higher education have implemented a number of calls and interventions, particularly in the last decade, to “address prior educational system failures, where failures include excluding underrepresented minorities from STEM environments” [11, p. 11]-[13]. Educational researchers are increasingly calling upon universities to consider how systems can be changed, rather than focusing change efforts on how to fix students [11]; [14]. Students from underrepresented groups are just as likely (in some cases more likely) to pursue STEM degrees as white men; however, they are less likely to persist in obtaining a STEM degree because of systemic barriers [15]-[17]. Challenges students face include a loss of confidence in their ability to succeed in STEM, negative class climates, financial concerns, and poor academic performance. For URM, these challenges are typically more pronounced and compounded by inadequate high school preparation and issues navigating the school system [18].

STEM intervention programs aim to fix barriers to student success by providing academic, financial, and social support through components such as summer bridge transition experiences, academic tutoring, peer or faculty mentoring, and skill building [11]; [14]. These components may support students by building support systems that contribute to students’ sense of belonging at the university and within their major, support their ability to navigate existing institutional

structures, and reinforce students' own determination to persist. All of these components are considered critical to supporting STEM persistence [19], [20].

Another way to support increased diversity through STEM is by increasing the number of successful transfer student pathways [21]. However, transfer students face a number of unique challenges on their paths to earning bachelor's degrees, such as academic credit loss and excess credit accumulation, discordant experiences of institutional culture, and fewer opportunities to receive scholarships, since many scholarships are awarded to first-time freshmen [22]-[ 25].

This research reports on the efforts of the STEM Career Opportunities in Nebraska: Networks, Experiential-learning, and Computational Thinking (STEM CONNECT) project to support low-income, first-generation, women, URM, rural, and transfer students ("Scholars") who are pursuing a career in mathematics and computing-intensive fields in Nebraska. STEM CONNECT is funded by the National Science Foundation's Scholarships in Science, Technology, Engineering, and Mathematics program (S-STEM). The S-STEM program awards institutions funding to "adapt, implement, and study evidence-based curricular and co-curricular activities that have been shown to be effective supporting recruitment, retention, transfer (if appropriate), student success, academic/career pathways, and graduation in STEM" [26]. Consequently, STEM CONNECT engaged Scholars in several activities known to support student success. The purpose of this article is to describe how these project activities and structures supported Scholars in building and leveraging the capital that supports their attainment of STEM degrees and careers, as well as highlight the assets Scholars bring to their experiences which influence their persistence in STEM. To that end, we ask the following research questions:

1. How are project activities and structures supporting Scholars in building financial, academic, social, and cultural capital in STEM?

2. How are Scholars accessing and leveraging their capital in pursuit of a STEM degree and career?

Often, calls for a more diverse STEM workforce build on competing motivations. [27] outlines three motivations for increasing diversity in STEM: *economic benefit to state*, *diverse perspective as a benefit to STEM enterprise*, and *STEM experience as a direct benefit to students of color*. The argument for increasing diversity in STEM related to economic or national competitiveness is referenced as the interest-convergence argument: an argument that suggests increasing diversity is important to support the needs of the dominant society. Critical scholars reject this as a main motivation for increasing diversity [28]. In this work, we embrace these, at times, conflicting motives and choose to focus on what students, and particularly underrepresented students, stand to directly gain from participation in STEM. STEM careers provide an opportunity for economic advancement for students from underrepresented backgrounds, as those with a STEM career make a higher median wage than those in a non-STEM career. This pattern holds across racial, ethnic, and gender groups [4]. Furthermore, we highlight the assets that students leverage to succeed as a way to highlight ways that such programs might leverage the strengths of students in retention efforts. By highlighting the assets Scholars bring similar to other projects [29], we gain insight into ways these assets can be leveraged for Scholar's persistence and success in a STEM career.

**Theoretical Framing**

This study is framed by theories of capital, including capital students stand to gain to succeed in STEM as well as the capital they leverage in their experiences. Research suggests that student success and persistence in STEM can be influenced by possession of and access to various forms of capital [30]. In general, capital refers to assets and resources (both monetary and non-monetary) that one utilizes to succeed in life [31]. Various frameworks exist in the literature for categorizing types of capital [31]-[33]; one such set of categories is financial, academic, cultural, and social capital [30]. *Financial capital* includes money (such as personal and familial wealth or scholarships and financial aid) and resources that require money to possess (such as personal computers) [30]. *Academic capital* includes skills and knowledge that aids students in their academic trajectories as well as access to academic support, such as tutoring and internship opportunities [30]; [ 34]. *Cultural capital* is capital gained over time through socialization within a particular culture [35] and includes knowledge of norms and understandings of what is valued within that culture [30]; [35]. Finally, *social capital* includes resources that one gains or gains access to by means of a social relationship or membership in a social network [30]; [36].

When discussing social capital, it is important to distinguish between the resource itself and the social relationship through which the resource is gained [37]. As a result, social capital can often be viewed as a means by which other forms of capital are acquired. For example, academic capital includes tutoring [30]; the *access* to this service, on the other hand, is social capital if the access is gained through a social relationship or membership in a social network.

The various types of capital are of particular interest when discussing underrepresented groups in STEM as many underrepresented groups either enter college with less capital than their peers or face greater difficulties accumulating it. For example, first-generation and rural college students often enter college with less financial capital than their peers and are therefore more likely to work while in school [8]; [38]. Students who enter college with high amounts of academic capital (such as having had access to rigorous mathematics and science courses in high school) have been found to be more likely to enroll in STEM courses in college and tend to have better outcomes in STEM at the college level [39]. Entering college with cultural and social capital related to the norms and structures of higher education has positive impacts on academic performance and persistence, but students from underrepresented backgrounds may not begin accumulating these types of capital until after matriculation [30]; [35]; [40]; [41]. Moreover, disadvantaged groups (including women) often have a harder time acquiring social capital, especially if they are trying to do so within a homogenous network [30].

Financial, academic, cultural, and social capital are certainly not the only types of capital that students enter college with. Students (especially those from underrepresented backgrounds) often possess other forms of capital that enable them to succeed. In fact, other frameworks for understanding capital utilize other types of capital that are central to minoritized students' experiences but are not directly valued in the current educational system [33]. The community cultural wealth framework from [33] proposed six sources of capital for this wealth:

(1) aspirational (the hopes and dreams for the future and the drive to make them reality),
(2) linguistic (the intellectual and social skills learned from communication),
(3) familial (the understanding that one comes from a community with history),
(4) social (the peers and social contacts that provide instrumental and emotional support),
(5) navigational (the skills that help with maneuvering through social institutions), and

(6) resistant (the knowledge and skills fostered through challenging inequity).

Transfer students may develop a specific type of navigational capital—transfer capital—as they learn to navigate the transfer process (e.g., by increasing their knowledge about specific transfer-receiving institutions, by seeking out interactions with institutional staff about transfer; [24]). Put together, community cultural wealth provides sources of capital for underrepresented college students to feel empowered in ways that are not necessarily highlighted in comparison to financial and academic forms of capital.

## Methods

### *Context*

STEM CONNECT involves a partnership among three institutions (including one bachelor's-degree-awarding and two associate's-degree-awarding institutions) aimed at supporting cohorts of low-income, high achieving students to succeed in obtaining a STEM degree that emphasizes computer science and mathematics. Scholars in the project receive need-based scholarships worth up to $10,000 per year to obtain degrees at one of the three partner institutions: University of Nebraska-Lincoln (UNL), Southeast Community College (SCC), and Western Nebraska Community College (WNCC). The project used a variety of additional components to support Scholars, including providing academic support through tutoring; connecting Scholars with faculty and peer mentors; developing community-building activities (e.g., puzzle hunts, documentary viewings); and providing career development activities (e.g., tours of local computing, engineering, and technology businesses). Furthermore, the project has supported efforts to improve curriculum. As an example, a group of project leaders across the partner institutions developed two introductory computer science courses and has worked to establish community college pathways into computing at the university partner (one such pathway has been approved).

As of Fall 2023, the project has supported 143 Scholars. Each Scholar was considered low-income by their institution. Approximately 74% of all Scholars were part of the target recruitment population, with 53% first-generation, 28% URM, 39% women or gender minority, and 31% rural. To date, 41 Scholars started the project at the university and 102 entered the project at a community college. Furthermore, 22 Scholars transferred to the university partner (and two of these Scholars have graduated). Thirty-four Scholars have "graduated" from the project by either graduating with an associate's degree, transferring from a community college partner to a bachelor's degree institution outside of the STEM CONNECT partnership, or graduating with a bachelor's degree from [university partner]. Approximately 33% of Scholars have left the project, with an average of two semesters of support before leaving. Scholars have left for a variety of reasons, including changing to a non-eligible major, mental health concerns, and poor academic performance. These results corroborate national findings that attrition in STEM is worse in the first two years of college. Beyond these factors, some Scholars left the project to transfer to a different institution (e.g., an institution closer to home), to pursue a more specific STEM degree program, or because they were no longer financially eligible. Of those that were no longer financially eligible, some chose to continue with the project.

*Data Collection & Analysis*

This study is primarily based on qualitative data collected from focus groups and individual interviews collected periodically over a period of three years. Specifically, the project conducted three focus groups in Spring 2021 (24 students), nine in Spring 2022 (50 students), and eight in Spring 2023 (48 students). Focus groups were recorded and up to an hour long. Focus group questions focused on students' future academic and career plans, experiences and motivations for participating in STEM CONNECT, experiences at their institution (including in their STEM courses), and, when relevant, experiences transferring from a community college to a bachelor's-granting institution. Data were transcribed, then coded using Dedoose qualitative software and a preliminary list of a priori codes based on the structure of the central research questions and the interview protocol. This list was refined over time into a stable codebook used to code all focus group data, including codes for four types of capital: financial, academic, social, and cultural. Each transcript was coded by at least two researchers who met to reconcile differences in the applications of codes. We also read through transcripts for evidence of the capital students brought to their experiences, using the community cultural wealth framework [33]. Additionally, we conducted in-depth individual interviews with five women Scholars at the university who had either persisted in the project or left the project but continued with their degree at the university. The purpose of these interviews was to better understand the experiences of women Scholars who were a part of multiple target groups (e.g., first-generation, transfer, URM, rural). These interviews were transcribed and analyzed in relation to different forms of capital to provide contributing and discriminatory evidence for findings from the focus groups. Beyond these analyses, project documents were reviewed to provide context to the findings regarding the research questions.

**Findings**

Evidence from project documentation suggests Scholars leveraged their experiences in STEM CONNECT and assets to succeed. Thirty-two Scholars have reported either participating in an undergraduate research experience (e.g., an NSF-funded REU) and/or STEM internship (e.g., Bose, Kiewit, Northrop Grumman, Microsoft, Hudl). Furthermore, one Scholar earned an NSF Graduate Research Fellowship. Some of these experiences were directly facilitated by the efforts of STEM CONNECT. For example, one Scholar applied and accepted an internship to Hudl after a local tour, and other Scholars have received extensive feedback on application materials and letters of recommendation from project leaders. A total of twenty university Scholars have graduated in computing and mathematics-related majors, with an average GPA of 3.66. Ten of these Scholars graduated with distinction. Further, 85% were either first-generation, women, and/or URM.

The project consistently positioned Scholars as worth investing in. One community college Scholar reflected on the importance of this positioning:

> I find it very encouraging knowing that someone or the organization has invested in me to pursue my education. Knowing that [makes me feel that I'm not] alone. It's like someone has invested in me to do this.

Scholars recognized that having a scholarship freed up time that they would otherwise spend working, allowing them to dedicate more effort to their studies: "the more you work, the less

time you can spend on studying." One Scholar pointed out that "the scholarship allows you to focus on school rather than having to have a job to pay for school as well," setting students up for academic success, and thus the accumulation of academic capital. In addition to scholarships, the project's components supported Scholars in building multiple forms of capital (e.g., academic, social, cultural). Thus, we organize the first part of findings by project components rather than by different types of capital. This is followed by a section that focuses on the capital, or assets, Scholars leveraged to succeed.

*Seminars & Industry Tours*

Across the three institutions, Scholars were encouraged to participate in regular seminars that focused on career preparation, academic success, and community building. Seminars ran roughly twice a month (with one community college holding weekly seminars). Seminar activities evolved over time based on feedback from Scholars to include more emphasis on career preparation and community building. Recent seminars have supported Scholars in developing cultural knowledge of their chosen careers and fields of study by, for example, bringing in industry professionals and organizing local tours. Under this model, Scholars found that "we can get more information than when we go to the UNL career fair." As another example, at the university, project leaders held a career preparation seminar at least once each year to support students in preparing for the university's career fair. Over time, the university modified the seminars to better address the diversity of Scholars' needs:

> I think this past semester especially has done a really good job of diversifying what our seminars look like…the career prep really branched out as more than just resume prep and that sort of stuff. We did whiteboarding for computer science majors and a couple of other mock interviews, those sort of things. And I think having that more diverse nature helps be more inclusive of all of the STEM majors that we have here.

Seminars supported some Scholars in envisioning ways that they could become a STEM person. One community college Scholar found it particularly valuable to hear "how people in other fields got to the field they were [in] and what problems came up for them too, like in their process of becoming what they are now." Similarly, a university Scholar remarked on the value of hearing about a speaker's "life path" to, for example, see the flexible application of a mathematics degree.

In addition, hearing from a variety of professionals in seminars and on tours helped alleviate some of the uncertainty from Scholars at later stages in their major program. As a more advanced Scholar remarked, "even though we do bring in a lot of local business people in our careers, getting to know kind of what they do before actually having to take the full internship or job is nice." Local tours helped Scholars in gaining "some insight on the things they look for in students or interns." Further, these opportunities gave Scholars "a sense of what's going on currently" so they were "up to date with the opportunities that you [can] get."

Some Scholars found value in seminars because of the connections they made with seminar speakers or capitalized on opportunities shared during tours. One Scholar described applying for and receiving an internship with a local company following a tour of the company. Another Scholar shared how they procured a mathematical modeling research position in a lab on campus following a presentation from the lab's principal investigator.

Beyond career building, seminars evolved over time to include more social bonding in response to Scholar feedback. Several Scholars appreciated one seminar in particular: a puzzle hunt that, to solve, required coordination and knowledge of multiple disciplines. One Scholar cited this collaboration as a reason they enjoyed the puzzle hunt:

> There were many different objectives, and each one utilized a different skill that everyone at our table knew. Someone was a math major, someone was computer science or engineering, and everyone being able to work on that and solve it was really awesome.

The consistent scheduling of seminars throughout the school year, where STEM CONNECT Scholars could meet each other and practice team-building, encouraged Scholars to engage with each other and form a community.

*Peer Connections, Tutoring, & Attempts at Cohort-Building*

The project aimed to build cohorts of Scholars that would progress through their academic degree programs together and take common courses. When possible, Scholars were encouraged to take classes together and identify the other STEM CONNECT Scholars in their classes as an additional form of support. Students found these peer interactions useful, especially as a means to support their coursework, with one student describing their "very nice little network" of other students they discuss homework with, and another student explaining the advantage of having social connections both in and out of the classroom: "Being in STEM CONNECT with other people that are taking the same class or that have already taken the class, you can get a nice insight into maybe what you're leading up into or what you're currently taking." In this sense, STEM CONNECT activities that build students' social capital were also helpful to their academic capital formation as they learned to collaboratively navigate within their institutions and chosen career fields. One Scholar shared how valuable it was to be able to interact with peers, even stating that one of their personal goals in STEM CONNECT is "connecting with students who have similar interests, goals, and drives."

Scholars were encouraged to work with course-specific tutors through STEM CONNECT. In early years of the project, several Scholars shared a desire for more community building, particularly with Scholars in their major. Some Scholars acknowledged that community building was a challenge because of COVID, but reiterated its importance. One Scholar shared ways that they usually make social connections within their major:

> I'm one to normally not only get to know the professors, but I get to know some classmates within a class and maybe even start a study group…[in my classes] I've been able to get some snapchats and been able to make a GroupMe and I have the group chats, but no one's really comfortable enough to talk in those chats. So I feel like aside from the classes, getting to know the people inside of STEM CONNECT would be a good way to kind of break the ice and make some new connections.

Indeed, the project enhanced existing efforts to provide academic support by forming tutor-led study groups in common courses. These efforts supported Scholars academically, socially, and culturally. Scholars found this direct academic support helpful in completing their coursework, especially when taking "challenging" classes. Some students identified tutoring as central to their experience in STEM CONNECT, with one student going as far as calling tutors "the most

important aspect" of their STEM courses. One Scholar shared how their STEM CONNECT tutor was a "fantastic role model" who supported their conceptual understanding and overall mindset in their discipline, helping them to shift away from a memorization-based approach to problem-solving to one that emphasized understanding the "why" behind their process. Another Scholar voiced that an additional benefit of tutoring was understanding how to "apply what you've learned the way that professors are looking for." Through tutoring, students were supported not only in gaining content knowledge, but in the entire process of navigating the university classroom.

As Scholars have progressed through their majors, the courses they take have become more diversified. Additionally, the project was designed to allow transfer Scholars to major in any STEM discipline and continue with the project, as long as they take a mathematics or computing course. This led to a wide variety of majors and made cohort-building challenging. The effects of this were seen in feedback from Scholars. In focus groups, some Scholars have suggested more support for upper-division level courses. One Scholar reflected that they understood why this was a challenge to implement, "I would say that I really enjoyed the tutoring when they offered it…And I know it's also difficult, 'cause as we get into more advanced classes, it's harder to find tutors for them." The project has tried to hire graduate students and senior-level students as tutors. Yet, the project has struggled to identify such tutors, particularly as compensation for tutoring is generally lower than what students can make working in industry or research.

While students had access to other tutors outside of STEM CONNECT and acknowledged these other sources of support in acquiring academic capital, they still expressed that the additional support from STEM CONNECT was crucial to their success. This phenomenon was partially dependent on the student's institution; for example, one community college Scholar felt that their school "generally offers everything that you need" in terms of tutoring resources. However, a UNL Scholar found the support systems offered by their department to be insufficient: "when I was struggling, I exhausted all of my resources within my department, like going to office hours." The student then went on to explain how they were instead and in addition able to utilize support from STEM CONNECT to improve their academic standing: "so after exhausting all those resources, I went to [a project leader] and he was able to help me the most and I felt that that was a really good tool for me."

*Professional Opportunities: Positioning of Scholars as Professionals*

Beyond seminars and cohort building, the project has positioned Scholars as professionals in STEM by encouraging them to conduct research, providing support to attend conferences, inviting them to serve on STEM panels, and connecting them with research opportunities. One Scholar shared their appreciation for these opportunities: "[Project staff] puts my word out there for conferences, which I think are really beneficial to me. I don't have any other resource like that anywhere." Another Scholar said that STEM CONNECT was "always like trying to push us to go out and do other new experiences like REUs or research or internships" and that " they bring new experiences to my awareness to look out for and do." Additionally, one of the project leaders was able to reserve REU spots for a small number of Scholars (from each of the partner institutions) in Summer 2021 and Summer 2022. One of these Scholars shared its impact:

> For me, like speaking back on the REU, the thing that helped me the most about that was not only being able to continue my learning throughout the summer without having to feel the stress of a class, but at the same time just getting the connections that I met at [computing lab], whether it was with fellow STEM CONNECT students because I hadn't met them before that because of COVID, and at the same time just meeting the doctorate professors in there, the graduate students, everyone that's doing research, as well as even more expanded to that now…I met [other Scholar]. I met him also through my REU, and I feel like our connection kind of grew more on top of that after the REU, and like we've even now gone to the rock climbing center.

In total, funds from this REU enabled ten Scholars to conduct research. Local funds supported an additional two Scholars to work in the project leader's computing lab.

*Opportunities for Mentorship*

Each Scholar had access to mentorship through an assigned faculty mentor, project leaders and staff, and peer mentors. Mentoring provided through STEM CONNECT directly or through connections made as a student in STEM CONNECT (such as access to mentors who also take on advising roles) supported some Scholars in (a) gaining knowledge of how to apply to industry and academic positions; (b) acquiring academic capital such as content knowledge and eventually certifications like grades, credits, and degrees; (c) navigating institutional structures to succeed in STEM; and (d) providing social and emotional support that motivated Scholars to continue in their degree.

Some faculty mentors leveraged their own social networks to provide Scholars with opportunities to network with professionals and work in academia and industry. Several Scholars spoke about internship and job offers they had received from their STEM CONNECT networks and attribute those connections to their mentors. One Scholar described how their faculty mentor helped them reach out to local businesses so they were able to "actually get in touch with them and job shadow," also opening the door to future employment. Another Scholar described how their STEM CONNECT faculty mentor helped them identify a research advisor for their thesis, as well as develop a presentation at a regional conference:

> The first thing that comes to mind is my STEM CONNECT mentor. He helped me... like originally when I met him in the program he was my professor and my employer in the math department. So when I got to know him after a little while, he helped me by... he wrote me letters of recommendation, he coached me through different things with my majors and stuff like that. He helped me find research advisors for my thesis. He did a lot for me. He helped me…[to get] my stuff ready to present at a regional conference too. So he's helped me in a lot of different ways.

The above quotation highlights the role social capital can play for students in acquiring other forms of capital as they start their careers.

Some faculty mentors also provided academic support to Scholars, which was particularly important in early stages of Scholars' programs as well as in times of transition. At the community colleges, faculty mentors were often also instructors of introductory courses taken by Scholars. This helped recruitment efforts (as faculty mentors encouraged students in their courses

to apply to the project) as well as perhaps reinforced the Scholar-mentor relationship for some Scholars. For example, one community college Scholar shared that "one of the instructors was informing me about the scholarship saying how it'd be a great idea to meet more like-minded people. And I'd say that's exactly what I found." Another Scholar described how "having my teacher and my mentor [be] the same person was very good" and "the best thing I got out of STEM CONNECT." One Scholar, in agreement, explained why they valued this dual role of their mentor: "I liked it [having my mentor also be my instructor] because it felt like it was easier to talk to him, since I would see him on a regular basis."

Most Scholars who mentioned the mentorship from the project focused on support in navigating college (i.e., cultural and social capital) and motivating them to continue. Scholars especially found support from mentors valuable during times of transition, such as the transition to taking proof-based math courses or transferring between institutions. One Scholar said, succinctly, "without the help of STEM CONNECT and other people, I would fail my proof classes." Another Scholar shared how peers in the project could act as mentors:

> But this semester, one of the other Scholars, he always reaches out and he's like, "yo, is anyone taking 310, 'cause I'll tutor you." So he reached out and I was like, "okay, sure." It's been a pretty good experience going through it with him.

Despite several successful stories of mentorship, the success of faculty mentor-Scholar relationships varied widely across the project. While some Scholars met frequently with their mentors (e.g., one Scholar met with their mentor bi-weekly and reported getting a lot out of interactions), other Scholars rarely if ever met with their mentors. However, one Scholar shared how, even with infrequent meetings, a faculty mentor could be useful: "I've only met with him a couple of times, but …he took what all my interests were and he kind of pointed me towards data science. He's a big football fan too, so we bonded over that."

*STEM CONNECT Project Leaders as Mentors*

Across all institutions, in addition to students' assigned faculty mentors, project leaders and staff acted as mentors in multiple capacities. Sometimes project leaders and staff provided advising support to supplement institutional advising, with one Scholar noting that project staff "always respond fast and try to help" whereas they only meet with their academic advisor once a semester.

Some Scholars also reached out to project leaders and staff for connections to career opportunities:

> I know I've been able to reach out to [project leader and staff] and say, "Hey, do you have any connections that I can maybe reach out to?" then, I mean, they might be able to get you a foot in the door and get those opportunities a little bit more than some other students can.

This "foot in the door" suggests that students are not only leveraging the social networks of project staff, but also the institutional knowledge and confidence project staff draw on to advocate for students in securing career opportunities.

Furthermore, several Scholars identified social and emotional support from project leaders as being vital to their college trajectories, including multiple students who shared that they would not have persisted through college had it not been for the project leaders and staff. One Scholar recalled that the project leader "really helped me keep going, to keep moving, never ever give up on this area, stay in STEM CONNECT... he always tells me that I have to keep pushing and work harder, that I can succeed."

Another Scholar considered STEM CONNECT to be their main community on campus, and said that they felt cared for by the project leaders—namely, the leaders supported their mental health:

> I cried in front of [project leader] and [project staff] got me a tutor but also prioritized my mental health and made sure that I was getting into therapy. And I think all of those things together create a community that I have not had anything else like in my college career.

Similarly, one Scholar recalled how their project leader met with them late at night to help with deciding between two internship offers and expressed that "[faculty mentor & project leader] has been a major help throughout my time at UNL." These quotations exemplify the importance, for some Scholars, in having project leaders who cared about them as individuals, with project leaders even stepping in for some cases to provide familial-type support that motivated Scholars to improve:

> I feel like he [project leader] really takes on that role of being like, "you need to do better," being that parent role - in a good way. That's not in a bad way at all. It's like I get the support and then I also get the talk that I need."

Other Scholars shared a similar appreciation for mentorship that was honest and assertive, with one Scholar tying this to their status as a non-traditional student:

> I'm like a super non-traditional student. So they're [project leaders] very straightforward with me. Like straight shooters - you can't do that if that's where you wanna go…And I've gotten on a level with them where I can just be super honest with what I can and can't do, which helps because sometimes I think we push ourselves a little too hard and take classes that we probably shouldn't take or need to take the class before that. So I learned that this last semester…as far as mentors and instructors they are very patient.

However, the project's efforts to communicate high expectations and motivate students could sometimes have unintended, negative effects. One Scholar shared that conversations which were meant to be motivational ("I know you can do better") made them feel like they were "never enough" as they minimized the successes the Scholar did achieve (e.g., improving their grades). Different Scholars expressed preferences for different types of mentoring relationships, including differing opinions about both the mechanics and outcomes of mentoring.

Transfer Scholars expressed difficulty transitioning between the two institutions and re-building their academic capital (while also navigating the necessity of acquiring financial, social, and cultural capital). One concern for Scholars was differences in classroom policies and course structures between institutions, yet advising from STEM CONNECT could support the transition: "I was able to take a lot of online classes at SCC and when I transferred to UNL I

wasn't able to do that as much, so that was difficult at the start. But I do feel like STEM CONNECT has definitely helped me in regards to that." Some transfer students reported struggles in trying to align community college credits with their degree plan at the university.

This challenge was not unique to transfer students—a Scholar at the university, who joined later in her degree program, described how in her first year of college advisors dismissed her attempts to get credit from high school that should have counted for her degree. She tied this to her status as a first-generation student: "I had no college experience, I knew nobody, I was just complacent because, I mean, at that time they knew everything and I didn't." In response to these challenges, project leaders at the university are now reviewing degree plans for all incoming Scholars. Furthermore, in prior semesters project leaders have advocated for Scholars by facilitating incomplete grades as necessary (i.e., so Scholars could have additional time to complete coursework beyond the term) and by requesting the substitution of community college credit for general education requirements.

By attending to Scholars' academic support needs in addition to taking on roles of social and emotional support, STEM CONNECT staff provided individualized mentoring opportunities for students (that complemented the mentoring provided by other STEM CONNECT-affiliated faculty). They further built on their knowledge and expertise of their institutions to guide Scholars. STEM CONNECT project staff, through attending to Scholars' academic support needs, facilitated Scholar's accumulation of academic, social, and cultural capital.

*Students' Capital (Assets)*

Some Scholars shared instances of how STEM CONNECT mentors reinforced or supported them in enacting their own capital. For example, one Scholar described how they advocate for change in their degree program:

> There have definitely been a few professors who will [make you] feel like you're on their nerves when you speak to them, whether it's about getting help or anything like that. But I know, for me, I like to speak up and if something's not being necessarily done the way that I think it should be done or not justifiable or anything like that, I can start talking to people whether it's someone in STEM CONNECT, whether it's one of my classmates, whether it's [project leader]. And then once I talk about that, get my feelings heard and see if my thought process is reasonable or not, I can definitely move up the chain and try to maybe reach out for change. I know I have done that in the past and ironically enough am currently doing that in this semester.

This Scholar drew from their resistance capital to question disciplinary and institutional practices. They described how an STEM CONNECT project leader was a resource in helping them enact this capital and feel justified in doing so.

Another Scholar described how their STEM CONNECT faculty mentor supported their aspirations to succeed in STEM:

> The most influential mentor figure was [community college STEM CONNECT faculty mentor]. He took a personal interest in my success as both a student and as a lifetime learner, encouraging me to push myself intellectually and reach for even greater goals

> than I had originally set. His passion for exploration and growth is infectious, and is truthfully one of the wisest and most intelligent people I've ever met.

This excerpt highlighted multiple forms of capital held by the Scholar, particularly aspirational capital. Their STEM CONNECT faculty mentor was integral to strengthening and expanding their dreams and aspirations of being a "lifetime learner." Many other Scholars drew upon aspirational capital, as they expressed their hopes of finding a good paying job after graduation or pursuing a graduate degree are what motivates them.

Another Scholar also showcased navigational capital in their ability to code-switch, a process by which individuals put on an "academic mask" to protect themselves—i.e., modifying their behavior in academic settings to dissociate themselves from negative stereotypes associated with their social identities [42]; [43]. This Scholar viewed their ability to change the way they present themselves, to fit in with others in their discipline, as a strength.

Scholars' families also influenced their persistence in STEM. One Scholar in particular drew from their familial capital to continue in their major despite facing challenges such as lack of representation in their courses and microaggressions from peers. They shared that their family emigrated to the US and found success in spite of challenges with the language barrier. This Scholar found their family's story to be a source of inspiration in that they can also accomplish things in spite of challenges like their parents did. They also expressed that getting a bachelor's degree was an important achievement and milestone in their family, and they felt supported rather than pressured to pursue a bachelor's degree.

## Discussion

Overall, Scholars valued the extent to which the project invested in their educational and professional success. These findings highlight the importance of multiple, integrated project components to support the varied interests and needs of Scholars. By having a variety of opportunities for Scholars to engage with industries and in research experiences, Scholars were encouraged and given space to envision various career pathways for themselves. The project also positioned Scholars as professionals in multiple ways (e.g., by inviting Scholars to serve as panelists at local events, giving students funding to attend a STEM conference). Further, Scholars appreciated the project's efforts to connect Scholars with one another. Mentors were shown to play a critical role in supporting times of transition (e.g., from applied to proof-based courses, from small class sizes at a community college to large enrollment courses at a bachelor's-degree-awarding institution). Some mentors also helped Scholars get a "foot in the door" to obtain relevant work experiences, assisted students in navigating academic structures perceived as barriers to their academic pathways, and provided social and emotional support that motivated Scholars to continue in their degrees. Further, project structures and activities were often successful because they built upon or reinforced the assets (e.g., aspirations) that Scholars brought with them to college.

### *Implications for Practice*

In general, Scholars had different perceptions of the utility of various STEM CONNECT activities (e.g., the seminar, learning about REUs, etc.). This difference in perceptions likely connected to Scholars' own goals and achievements thus far. That is, a Scholar who already has

an internship does not necessarily see the value in learning about REUs. In response, the project differentiated support for Scholars, which was received well. The positive response from Scholars corroborates findings from [44] which report that low-income, first generation, and racially minoritized students benefit from programs tailored to their multiple and varied needs and identities.

One important takeaway from the project has been the need to support Scholars early in planning their degrees. The twenty university Scholars who received bachelor's degrees in STEM earned an average of 139 earned credit hours, compared to a minimum of 120 earned credits for a bachelor's degree. While some Scholars had double majors, and thus more credit hours were anticipated, the additional credit hours reflect a concerning pattern in Scholar experiences. STEM CONNECT continued to support students beyond 120 credit hours; nevertheless, more credit hours conferred more of a financial burden on students.

*Implications for Research*

Despite stories of successful mentoring experiences, not all Scholars had strong relationships with their faculty mentors. Mentoring relationships required commitment from both faculty and Scholars to succeed. The project has endeavored to make faculty-Scholar assignments clearer to Scholars (e.g., posting them directly on the Canvas page, in addition to introductory emails) as well as by giving Scholars in later stages of the program more flexibility in selecting their mentors (e.g., offering to set up industry mentor connections) to encourage such commitment from Scholars. Furthermore, research strongly suggests the efficacy of reinforcing high expectations with academic, social, and cultural support [14]. However, such broad statements belie the complexity of mentor-student relationships. Further research should consider how different approaches in mentor-student relationships influence student belonging and persistence. These findings could be used to support further qualitative, quantitative, and mixed-methods studies seeking to establish causations between program supports and outcomes. For example, these findings point to the value of studying mentorship at a variety of points of transition to understand its efficacy, as well as the need to more deeply understand how mentorship approaches affect different students differently.

Pearson and colleagues [14] note that few articles about STEM intervention programs share details about program implementation, yet understanding how program supports are implemented is important in understanding which supports are worth implementing and why. Importantly, successful programs rely on the commitment of multiple stakeholders (administrators, faculty, program staff) to function. This study focused on sharing, from students' perspectives, what assets they gained and/or leveraged to succeed. Further analysis could go into depth into how the project was designed, investigating project leadership decisions and positionalities to better understand project implementation and its outcomes.

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