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Examining Integration and Sense of Belonging Among Undergraduate Students Participating in STEM Support Programs

MacKenzie J. Gray
Portland State University

Examining Integration and Sense of Belonging Among Undergraduate Students Participating in STEM Support Programs

by

MacKenzie J. Gray

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Dr. Erin E. Shortlidge

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INTRODUCTION

Of all students who enter college intending to major in the Science, Technology, Engineering, and Mathematics (STEM) fields, less than 40% finish their STEM degree (Olson & Riordan, 2012). National calls have been made to strengthen our nation's STEM workforce by improving student preparation and increasing retention rates (Olson & Riordan, 2012). Barriers to retention can be more pronounced for students that are underrepresented in the STEM fields, such as community college transfer students (Tammy J. Rhine, 2000). National data has also shown that there are disparities in STEM degree attainment for historically underrepresented students (i.e., African American, Hispanic or Latino/Latina, American Indian, and Alaska Natives), and that these disparities increase with level of degree when compared to white and Asian students (Olson & Riordan, 2012, Estrada et al., 2016, Medicine et al., 2016). Though research has begun to address understanding and mitigating these achievement gaps, the majority of work has focused on identifying which student traits lead to perseverance. Much of the research on the context of these disparities has focused on negative factors such as racism, while little work has been done on the positive factors that may influence persistence within STEM (Estrada et al., 2018).

In response to national calls to strengthen the nation's STEM workforce, many federal and non-governmental agencies have invested in the future STEM workforce by funding 'high-impact' STEM support programs nationwide. Such programs aim to support student persistence by providing academic, social, and financial resources to students. Because these programs are often grant funded, they are only able to offer resources to a select number of students and unless institutionalized, may last only for the period of time that the grant extends. These programs often recruit participants from groups that are historically underrepresented in STEM, including underrepresented minorities, community college transfer students and first-generation college

students. Such programs include the National Science Foundation's Louis Strokes Alliance for Minority Participation (LSAMP) and Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) grants, the National Institutes of Health Building Infrastructure Leading to Diversity (BUILD) programs, and the Department of Education Ronald E. McNair Scholars programs.

STEM support programs can increase student persistence in the STEM fields. Self-efficacy, scientific identity, and scientific values are three factors that may work together or independently to influence persistence in the STEM fields (Estrada et al., 2011). A sense of belonging in STEM fields is also thought to be key for persistence in STEM, but many students face barriers that can impede this sense of belonging (Strayhorn, 2018). These barriers can be more pronounced for groups that are underrepresented in STEM, including the groups targeted by STEM support programs. Aspects of high-impact STEM support programs may influence students' integration into science and sense of belonging in a positive way, helping them persist in their STEM degree program and increase graduation rates (Chemers et al., 2011, Syed et al., 2011, Graham et al., 2013).

Our university's student population includes 60% community college transfer students, 70% qualify for need-based financial aid, approximately 50% are of non-traditional age (over 23), and the large majority live off of campus, therefore commute to the university. Likely due in part to our unique student population, we have been awarded several high-impact STEM support programs on campus involving ~10% of all undergraduate STEM students (Table 1). Many participants in these programs are community college transfer students and/or from underrepresented groups.

Table 1: A summary of high-impact STEM support programs at this university

Funding Agency	Program	Goal
Department of Education	Ronald E. McNair Scholars	Increase access to PhD programs for first-generation and low-income students
National Institutes of Health	Build Programs	Increase diversity in the biomedical workforce
National Science Foundation	Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)	Aimed at reducing transfer shock for community-college transfer students majoring in STEM
National Science Foundation	Louis Strokes Alliance for Minority Participation (LSAMP)	Support the success of underrepresented students in STEM
National Science Foundation	Scholars for Success in STEM (S3)	Support educational success and professional development for underrepresented students

Specific Aims

This work aims to measure how students at our university, who are part of grant-funded STEM support programs, may differ in levels of integration into science and sense of belonging when compared to STEM students who are not part of a support program. We also aim to understand what particular aspects of STEM support programs help students persist in STEM fields such that we may ultimately be able to offer similar support to a greater number of students – whether they are supported by a program, or not.

METHODS

This study was conducted at a large northwestern urban research university. To understand the impact of STEM support programs on our campus we used a mixed methods approach,

incorporating both a quantitative survey tool, and qualitative focus group methodology. This study was approved by the IRB (#174450).

Survey Design and Distribution

The STEM Student Survey (SSS) was developed using established scales and additional items. Already-developed instruments included the Tripartite Integration Model of Social Influence (TIMSI) (Estrada et al., 2011). This instrument includes a 6-item scientific self-efficacy scale, a 5-item scientific identity scale, and a 4-item scientific community objectives value scale (Estrada et al., 2011). The SSS also included the already-developed perceived cohesion scale (PCS), including a 3-item sense of belonging scale and a 3-item feelings of moral scale (Bollen & Hoyle, 1990). In addition to these already-established scales, the SSS included items to measure a participants STEM involvement. This 12-item measurement included questions asking participants to rate how likely they are to participate in STEM related activities, such as attending the office hours of a STEM faculty member or read research articles published by a STEM faculty member (M. McCartney, personal correspondence).

The SSS underwent response process validity prior to dissemination, which is a way by which to assess how study participants interpret and respond to survey items (Rickards et al., 2012). Think-aloud cognitive interviewing was conducted with both experts and novice respondents, where they take the survey and think aloud about the process that they use to arrive at a response to each item, and a researcher notes this process to confirm that the respondents are interpreting the items as intended (Willis, 2004). These interviews were conducted with three experts and six novices representing the intended population.

The SSS was initially deployed during the beginning of Fall 2018 academic term and again at the end of Spring 2019 academic term and was sent to all National Science Foundation approved STEM majors at our university. Participants were invited to participate in the survey via email, with the option to enter in a drawing to win an Amazon.com gift card worth $50. At the end of the Spring 2019 survey, participants were given the option to indicate if they were willing to be contacted for participation in a focus group. Those who indicated that they were willing to be contacted were invited to participate in the focus groups (below).

Focus Group Design and Execution

Spring 2019 SSS participants who indicated that they were willing to be contacted were emailed by a researcher to confirm interest and availability. Students were selected to participate in focus groups from the pool of volunteers based on their community college transfer status, as well as their STEM support program status to better understand the experiences of these student groups. Eight focus groups were conducted in total at the end of Spring 2019. Based on preliminary analysis of survey data, focus groups were divided into students with STEM support and students without STEM support in order to understand differing perceptions between the groups.

The aims of the focus groups included understanding and validating the STEM Survey results, identifying how student perceptions differ based on their STEM support program status, and learning what kinds of support have been the most impactful for their success.

Three researchers iteratively developed questions for the focus groups (Table 2). Each focus group had one primary facilitator and one secondary facilitator, both being researchers involved with the study. Each focus group lasted one hour long, followed a script, and took place

within the same two-week time period on campus at the university. Each participant was compensated with a $25 Amazon.com gift card.

Table 2: Focus group questions

Question Number	Question
1.	What do you think of when you think of a scientist?
2.	Do you think of yourself as a scientist?
3.	How confident are you in your ability to achieve your academic or professional goals?
4.	What tools and support do you think you need to achieve your academic or professional goals?
5.	Do you feel that you currently have those tools and support here?
6.	Do you see yourself as a member of the university's community?
7.	Is it important to you to be a member of the community?
8.	Is there a community or group at this university that you feel particularly connected to?
9.	What was the transition process like from your high school or community college to this university?
10.	What would make the transition process to this university easier?
11.	Is this university a good fit for you overall?

Data Analysis

For the purpose of this study we analyzed the focus group participants survey results only. This allows us to have a better understanding of these student's experiences and perceptions because we have both quantitative data and qualitative data for each participant.

Survey Data Analysis

Confirmatory factor analysis (CFA) was conducted on all results from the SSS Spring 2019 survey to confirm that the already-established TIMSI and PCS were functioning as intended in our population (Harrington, 2009). The CFA results indicated that the TIMSI was working as intended within our population (CFI = 0.972, TLI = 0.947, RMSEA (95% CI) = 0.057 (0.050-0.064)). The

CFA results also indicated that the PCS was working as intended within our population (CFI = 0.975, TLI = 0.966, RMSEA (95% CI) = 0.091 (0.082-0.101)). Analysis were conducted in R (R Core Team, 2014).

Statistical analyses were performed to analyze the survey data of the focus group participants. T-tests with a Welch's correction for small sample sizes were conducted to compare mean sum scores of students that are part of a STEM support program and those that were not (SAS JMP Pro 2019, SAS Institute, Cary, NC).

Focus Group Analysis

The focus groups were audio and video recorded and transcribed verbatim (Rev.com). Multiple researchers read through four of the eight transcripts to identify overarching themes. Two researchers then iteratively developed a codebook using deductive content analysis to test existing ideas within our context (Patton, 1990) by reviewing transcripts and identify themes and codes related to scientific integration and sense of belonging. The same researchers also used inductive content analysis to derive themes and codes from the focus group participant responses (Patton, 1990). These researchers then used a finalized codebook to code each transcript to consensus.

RESULTS

Demographics

This study reports on the SSS results of the focus group participants. Demographics between survey participants and focus group participants are the same, as it is matched data (Table 3).

Table 3: Demographic data for study participants

Group	Number of participants	Age 23+	Female	Underrepresented Minority (URM)	First generation	Community College Transfer
STEM Support	20	63%	65%	55%	45%	90%
No STEM Support	31	60%	52%	20%	33%	52%

Survey Results

Integration into Science

Based on the SSS data, two of the three scales of the TIMSI instrument differed among student groups. The STEM support participants did not differ significantly from the no STEM support participants in the scientific self-efficacy scale (p=0.5095). The STEM support participants scored significantly higher on the scientific identity (p=0.0128) and scientific values scales (p=0044). (Figure 1).

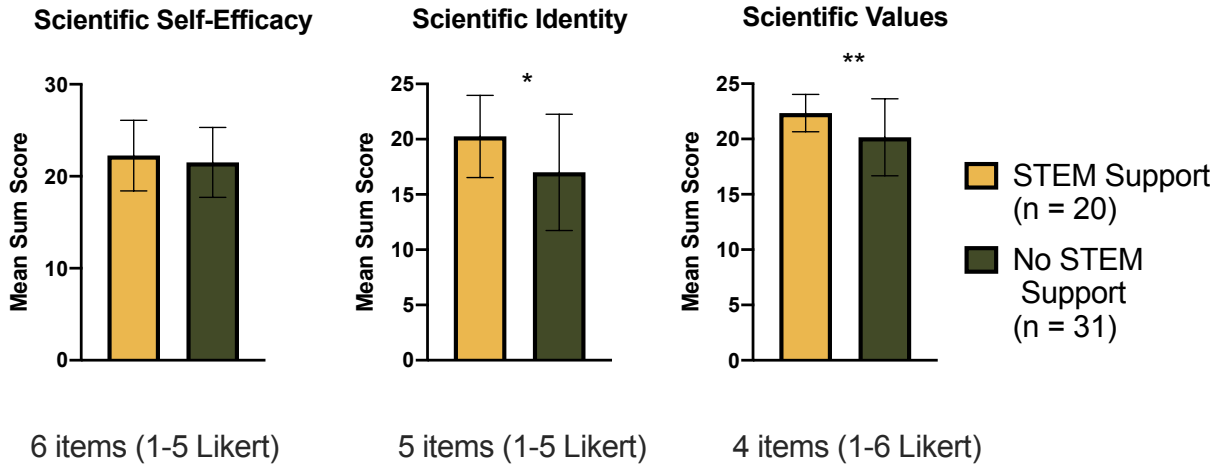

Figure 1: Mean sum scores for the integration into science scales compared by STEM support program status. Bars represent data mean ± SD; Welch's t-tests. Asterisks represent a significant difference between groups.

When we combine all three scales together and look at the overall TIMSI scores we found that the STEM support participants scored higher than no STEM support participants (p=0.0008) (Figure 2).

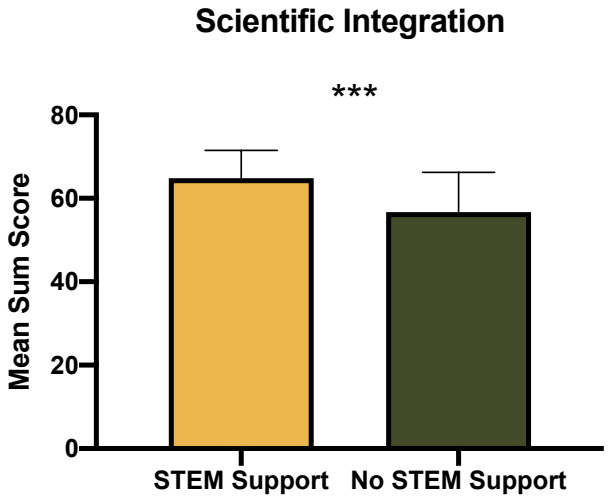

Figure 2: Mean sum scores for the combined scientific integration scales compared by STEM support program status. Bars represent data mean ± SD; Welch's t-tests. Asterisks represent a significant difference between groups.

Sense of Belonging

The SSS survey also measured sense of belonging using the PCS. We measured participants' sense of belonging in two ways: 1) belonging to a group at the university that they self-identified, and 2) to the university overall. Participants self-identified a group based off of a list developed from open-ended responses to the Fall 2018 SSS. We see a significantly higher sense of belonging to a group for the STEM support participants (p=0.0365). We do not see a significant difference in sense of belonging to the university overall (p=0.1566). When we combine

both measurements, we see a significantly higher overall sense of belonging to among the STEM support participants (p=0.0274) (Figure 3).

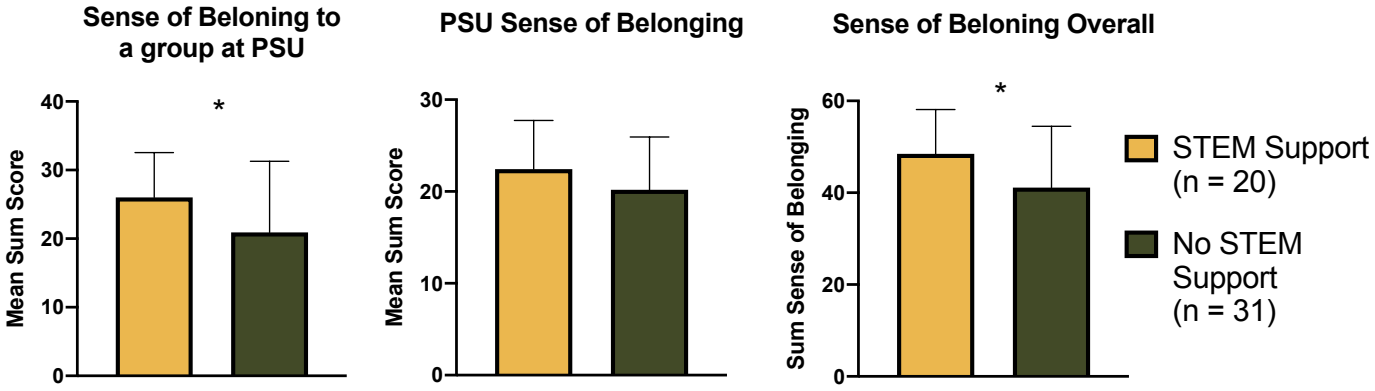

Figure 3: Mean sum scores for the sense of belonging scales compared by STEM support program status. Bars represent data mean ± SD; Welch's t-tests. Asterisks represent a significant difference between groups.

STEM Involvement

The survey also measured a participant's involvement in STEM related activities. We see a significantly higher STEM involvement score for participants in a STEM support program (p=0.0047) (Figure 4).

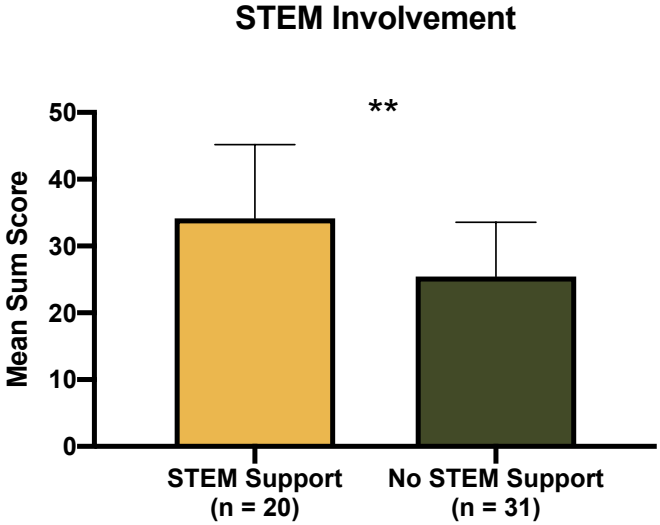

Figure 4: Mean sum scores for the STEM involvement items compared by STEM support program status. Bars represent data mean ± SD; Welch's t-tests. Asterisks represent a significant difference between groups.

Focus Group Results

Eight focus groups were conducted in a two-week time period. The number of participants ranged from two to ten, with a total of 51 participants In order to understand how experiences differed among student groups, the focus groups were comprised of 1) transfer students with STEM support, 2) transfer students with no support, 3) non-transfer students with STEM support, and 4) non-transfer students with no support (Table 4). Several overarching themes arose from the data including: Science Identity, Perceptions of Scientists, Tools and Support, Sense of Belonging, Importance of Community, and Barriers (see Table 5 for quotes).

The focus group results are presented as two categories: STEM Support and No Support. We combined the focus group results in this way to distinguish different perspectives between these two categories. The results are presented as the number of instances a theme was coded within the transcripts for category. Instances are comparable among the STEM Support and No Support focus groups because we conduced four focus groups for each category, and they were uniform in the way that they were conducted.

Table 4: Number of status specific focus groups conducted

STEM Support (SS)	CC Transfer (T)	3
	No Transfer (NT)	1
No Support (NS)	CC Transfer (T)	2
	No Transfer (NT)	2

Three researchers read through four of the transcripts to identify overarching themes. Two researchers used deductive and inductive coding and content analysis to iteratively develop a codebook (Table 5). The same two researchers coded each transcript to consensus.

Table 5: Codebook

Theme	Code	Example
Science Identity	Yes	*Yeah, I would consider myself a scientist at this point. I know how to ... I feel confident in my understandings of the methods that scientists take to do what they need to do.* (STEM Support No Transfer)
	No	*I would not consider myself a scientist, I'm doing the work but I feel like I'm more training to be a scientist or an engineer. And because I can't really work independently yet, or at least not, I wouldn't be able to contribute a lot of knowledge to even a team. I think for that reason I don't consider myself a scientist, because I'm not, I don't have enough to contribute yet, I feel like.* (STEM Support Transfer)
	Emerging scientist	*Sometimes I do, sometimes I don't. I don't know. I guess I just feel I still have a lot to learn and I think that being a scientist isn't about knowing a lot of things necessarily, but I feel I associate it with that.* (STEM Support Transfer)
Perception of Scientists	Scientific practices	*Yeah. I think about hypothesis testing; I'm going to create a hypothesis and then test it. And then re-evaluate it, and test it again. (No Support No Transfer)*
	Discoveries	*Someone who's got a question in mind that they're seeking an answer for, broadly, that contributes to whatever field they're interested in working towards and answer for.* (STEM Support Transfer)

	Desire for change/impact	*I think of people who really want to make a difference in the world, and really care about the planet.* (STEM Support Transfer)
	Highly knowledgeable/trained	*I would consider a scientist to have an advanced degree to know so much more about biology than I would so I wouldn't consider myself to be a scientist.* (No Support No Transfer)
	"Superhero" scientist	*I just think of people in lab coats, for sure, that's mostly it. I just kind of imagine them doing a lot of bench work.* (STEM Support No Transfer)
	Pursuit of knowledge/curiosity	*I feel like someone who has an inclination for curiosity and finding out new things*. (No Support No Transfer)
Tools and support	Academic	*For me a lot of that's been peer mentors and tutors just because sometimes you are more lost than you think you could be and that can be really overwhelming and to see that somebody who's been in the same place as you and that somebody else has gone through it and done it, that is a huge resource.* (STEM Support Transfer)
	Social	*I would agree with the S-STEM group has been awesome. It's really easy to just come in and we all have so much background on each other, which is great. That's just easy to sympathize and connect with.* (STEM Support Transfer)
	Financial	*I think I feel really lucky to be, to have the S-STEM scholarship because that, I mean like Student 3 said the financial help has helped out a lot.* (STEM Support Transfer)
	Professional	*You get to be able to talk to people that may or may not be in your specific field. Just so, that way you have connections out there that can*

		open doors for you. (STEM Support No Transfer)
Sense of belonging	University as a whole	*I feel I am a part of the university community and I live on campus with my husband in the apartment housing, I work here as a lab attendant for the library labs, the OIT labs and I'm just here constantly, I feel very integrated into the community.*
	Smaller community	*Yeah, I feel like it, being in the S-STEM program has definitely opened up a lot of doors for me here. It has also made me feel like a part of [U].* (STEM Support Transfer)
	No community	*I don't really have time to come on campus and explore or get involved with clubs or groups.* (No Support Transfer)
	Lack of community	*It's just really difficult for me to find communities even within the groups that I do interact with.* (No Support No Transfer)
Importance of community	Is important	*A sense of community is really important to me. I don't think I would've stayed or went to PSU if I didn't feel like I kind of belong here or whatnot.* (No Support No Transfer)
	Is not important	*It's something I would like, but at the same time, I don't need it. I feel if I was not a member of any of the groups, I would survive.* (STEM Support Transfer)
Barriers		*This campus kind of feels like an independent campus. It's a commuter campus filled with older students. People come here, go to work, have their own lives in Portland, pay a ton of money for rent.* (No Support Transfer)

Science Identity

We were interested in exploring a student's scientific identity. The survey instrument indicated significant differences among student's science identity, but it was necessary to explore this idea qualitatively to better understand what this means to a student. In the focus groups we asked the following question: Do you think of yourself as a scientist? We asked this question in order to understand the reasons a participant may or may not think of themselves as a scientist. This section presents a summary of the codes that fell under the Science Identity theme, and within this theme, students discussed science identity related to three subthemes: Yes, No, and Emerging Scientist (Figure 5).

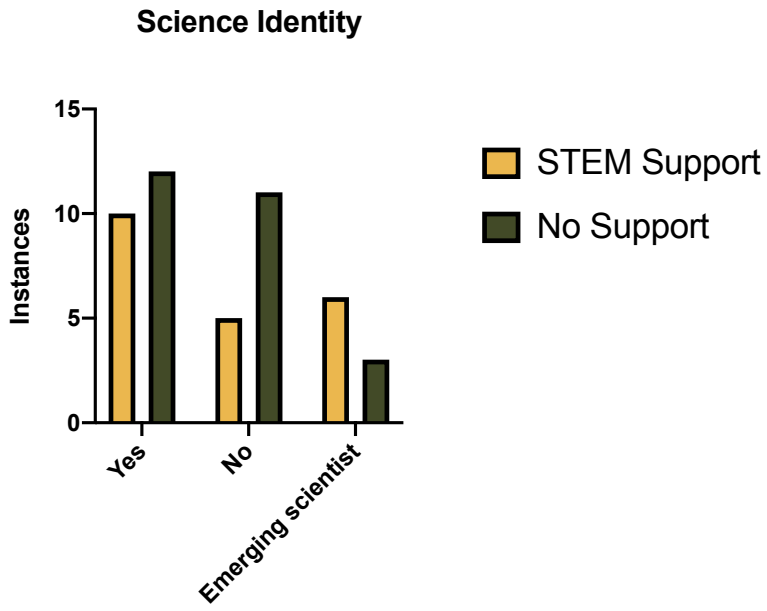

Figure 5: Instances of codes under the "Science Identity" theme, separated out by STEM support program status.

Code: Yes

Yes was coded anytime a participant indicated that they think of themselves as a scientist.

STEM Support Transfer: *When I'm finished with a report and I see what I've written and I see that it's coherent, and it all is tied together, I'm like, "Oh wow, now I really know what I'm talking about." And yeah, that makes me feel like I'm a scientist, even if I wasn't working in a lab.*

This participant discusses feeling like they are a scientist after finishing a report that is coherent. They also discuss how this makes them feel like a scientist outside of their work in a lab.

No Support Transfer: *I guess I think of myself as a scientist because I gravitate towards and enjoy the black and whiteness of the STEM stuff.*

This participant discusses that they think of themselves as a scientist due to their enjoyment of the black and whiteness of STEM. They have connected their enjoyment of aspects of STEM to the feeling of being a scientist.

Code: No

No was coded anytime a participant indicated that they do not think of themselves as a scientist.

STEM Support Transfer: *I don't feel comfortable calling myself a scientist yet.*

This participant discussed that they were uncomfortable with calling themselves a scientist, indicating that they do not think of themselves to be a scientist.

No Support No Transfer: *I feel like I don't feel like a scientist personally because in all of the labs that we do, we're not really finding out new things or testing new things, we're just doing something that people have already done hundreds of times. So that can be a wrong opinion maybe, but I just don't feel like a scientist because I'm not doing anything new, I'm just learning.*

This participant indicates that they do not feel like they are a scientist, and they attribute this to the fact that they do not find new things or test new things within the labs that they take. They do not think of themselves as a scientist because they are only learning, and not doing anything new within science.

Code: Emerging scientist

Emerging scientist was coded anytime a participant indicated that they are learning to be a scientist or have not yet reached the point that they can call themselves a scientist. They did not give a yes or no response but fell in between the two in that they are still in training.

STEM Support Transfer: *For me, I think in a way yes, but sometimes I am just learning how to be a scientist, I wouldn't say I officially am yet. Because I still have a lot of ways to learn and improve to be one going forward. So it is more like a training aspect of becoming something.*

This participant indicates that they are in the training aspect of becoming a scientist rather than being a scientist. They state that they are still learning how to be a scientist.

No Support Transfer: *I feel like a scientist in training or learning to become a scientist or think like a scientist and do things that a scientist would do but not necessarily that I am a scientist right now.*

This participant indicates that they do not think of themselves as a scientist right now, as they are still training or learning to become a scientist.

Overall analysis indicated that there was not a large difference between the STEM support participants and no STEM support participants in whether or not they think of themselves as a scientist, though more no support participants reported that they do not think of themselves as a scientist.

Perceptions of Scientists

Because we saw a significant difference among student's science identity in the STEM survey (in that supported students self-reported a higher scientific identity), we wanted to explore this further through understanding the student's perception of what it means to be a scientist. In the focus groups we asked the following question: What do you think of when you think of a scientist? We asked this question in order to understand the different perceptions that students may have on what qualities a scientist hold. This section presents a summary of the codes that fell under the Perception of Scientists theme: Scientific practices, discoveries, desire for change/impact,

highly knowledgeable/trained, “superhero” scientist, and pursuit of knowledge/curiosity (Figure 6). Within these codes, the largest differences in perception among the groups were amongst the discoveries and pursuit of knowledge/curiosity. These codes are explored further below.

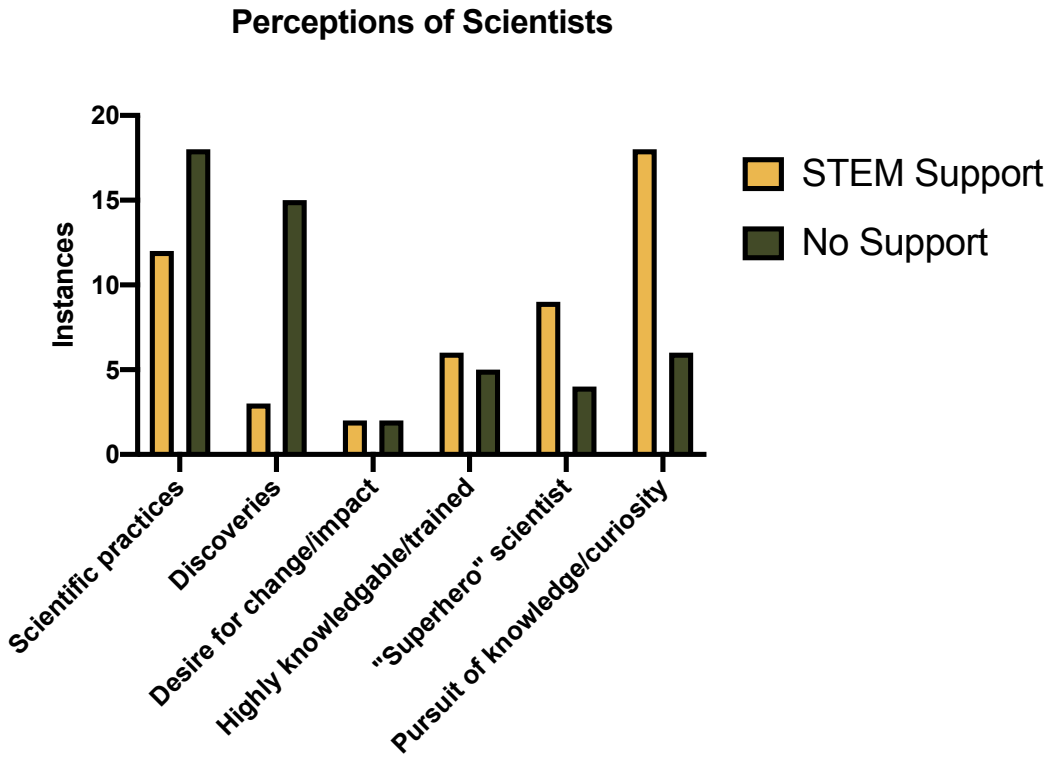

Figure 6: Instances of codes under the “Perceptions of a Scientist” theme, separated out by STEM support program status.

Code: Discoveries

This was coded any time a participant discussed that making discoveries were a part of the qualities that a scientist has.

STEM Support No Transfer: *Someone who's got a question in mind that they're seeking an answer for, broadly, that contributes to whatever field they're interested in working towards and answer for.*

When discussing what they think of when they think of a scientist, this participant talks about a scientist being someone who is seeking an answer to a question, which will contribute to their field. This indicates that the participant thinks that a scientist is someone who is making discoveries.

No Support Transfer: *I think scientist is someone who, finding things that are unanswered and that's what I know since I was a kid, I read a lot on this anyway about different scientists and doing cool experiments and they all do these questions like, "How do we do this?" Or, "I want to make that, how can I make that?"*

This participant states that they think a scientist is someone who finds things that are unanswered. They discuss how this perception comes from what they have known since they were a child. This perception of finding things that are unanswered indicated that they think a scientist is someone who makes discoveries.

No Support Transfer: *I don't think that I'm a scientist. I grew up home-schooled, so the only science I learned was creation science which doesn't have any solid backing to it. So I feel like right now, I'm still learning basics and I'm not at a point where I'm like, "Oh!*

Figuring out new things." It's more so just learning what other people have already figured out.

This participant discusses how they do not think of themselves as a scientist, and attributes this to the fact that they are learning what others have already figured out, rather than figuring new things out themselves. This indicates that they believe a scientist to be someone who figures out new things and make discoveries.

Code: Pursuit of Knowledge/Curiosity

Pursuit of Knowledge/Curiosity was coded anytime a participant indicated that a scientist is someone who is pursing knowledge or have curiosity about a subject.

STEM Support Transfer: *I think a scientist is just anybody who applies any of their time or the majority of their time to the pursuit of scientific knowledge. I don't know like whether ... like citizen scientists, they're still considered scientists, even though they don't follow any specific discipline, I guess, or have formal training. I don't know, I think it's a little gray.*

This participant says that they believe a scientist is someone who pursues scientific knowledge. They point out that this can be anyone, including a citizen scientist, because they are pursuing knowledge.

STEM Support Transfer: *I guess when I think of a scientist, I think of someone who is curious, wants to pursue knowledge, and open-minded and willing to use different methods to find their answer.*

This participant describes their view of a scientist as someone who is curious and wants to pursue knowledge. They also describe a scientist as someone who is open-minded and willing to use different methods.

STEM Support Transfer: *The key thing is the curiosity, it is looking into it and wondering about whatever it is, whatever question piece of the world you're thinking about is. That's what's the defining feature of scientists.*

When describing their view of a scientist, this participant indicates that the defining feature is curiosity, and wondering about whatever question that you may have.

No Support No Transfer: *I feel like someone who has an inclination for curiosity and finding out new things.*

This participant describes a scientist as someone who has an inclination for curiosity as well as finding out new things.

Overall analysis revealed that the perception of a scientist as someone who makes discoveries and contributes to their field was primarily held by the no STEM support participants.

The STEM support participants primarily held the perception that a scientist is someone who is pursuing knowledge or has curiosity about a subject.

Sense of Belonging

We were interested in understanding what factors might lead to students' having a sense of belonging in STEM, a group or the university as a whole. The survey instrument indicated significant differences among STEM support students and no support students sense of belonging, but it was necessary to explore this idea qualitatively to better understand what this means to a student. In the focus groups we asked the following question: Is there a community or group at the university that you feel particularly connected to? This section presents a summary of the codes that fell under the Sense of Belonging theme, and within this theme, students discussed sense of belonging related to four subthemes: university as a whole, smaller community, no community, and lack of community (Figure 7).

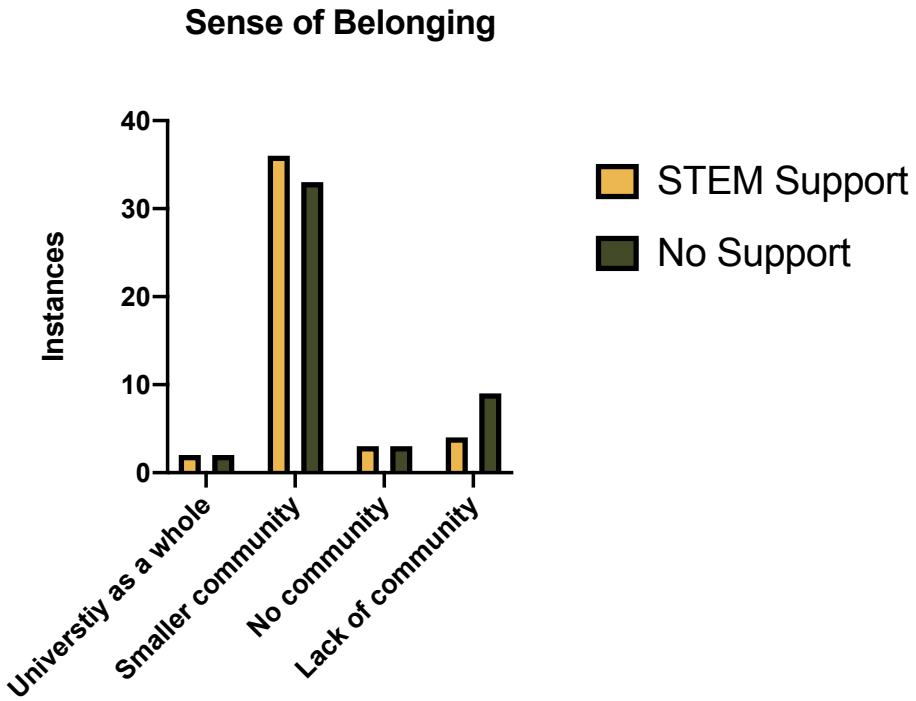

Figure 7: Instances of codes under the "Sense of Belonging" theme, separated out by STEM support program status.

Code: University as a Whole

University as a whole was coded any time a participant indicated feeling like they belonged to the greater university community.

> STEM Support Transfer: *I feel I am a part of the university community and I live on campus with my husband in the apartment housing, I work at the university as a lab attendant for the library labs, the OIT labs and I'm just here constantly, I feel very integrated into the community.*

This participant indicates that they feel very integrated into the greater university community, attributing it to the fact that they live and work on campus, giving them a sense of belonging.

> No Support No Transfer*: I live with my parents, so I commute to campus. I think it places a toll on what clubs I can join or whatnot, but I do feel a part of the university community. I access a lot of the resources. I've had a pleasant experience with my interactions with the Financial Aid or any department like that. I always think of the library as my home away from home because I spend so much time there. But yeah, I do, spending roughly almost four years at the university now, I do feel a part of the community here.*

This participant indicated that they feel that they are part of the university community, despite living off of campus and having to commute. They discuss having positive experiences at the university as well as finding a home within the library.

STEM Support Transfer: *I do think I'm part of the community at the university. I am in all those clubs. I also have been going here for enough years that I know all about it, because I've learned all about it. Ask me three years ago, I would agree with every one of you that have shared about you don't feel part of the community for the university, but more your peer's community, among your classmates.*

This participant indicates that they are involved in multiple clubs and have attended the university for a long time. They discuss being a part of the university community, and how this has evolved over time for them.

Code: Smaller Community

Smaller Community was coded any time a participant indicated that they felt a belonging to a smaller community that provides them with support. This could be a community within the university, or outside of the university, such as family.

STEM Support Transfer: *LSAMP's like family to me. That's a much as a community as you possibly could want.*

This participant indicates that LSAMP, a STEM support program, feels like family to them. They describe it as being as much of a community as you could possibly want, indicating that they feel a sense of belonging to this group.

STEM Support Transfer: *I feel part of the S-STEM community. I don't know about the university as a whole. I think for the most part I feel like, I commute here, I attend classes and then I have S-STEM.*

This participant discusses feeling a part of S-STEM, a STEM support program, but not the university as a whole. They indicate that they only participate in their classes and the program.

STEM Support Transfer: *Yeah, I feel like it, being in the S-STEM program has definitely opened up a lot of doors for me here at the university. It has also made me feel like a part of the university.*

This participant shares that participating in the S-STEM program, a STEM Support program, has both opened doors for them and made them feel like they are a part of the university, indicating a sense of belonging.

STEM Support No Transfer: *I think of my friends and my friend group. I feel like I'm part of a community ... I think of Build EXITO and my cohort. That's my community and that's my university community, to me. This university is a commuter school and I knew that when I chose to go here. I tried to build a community and being part of student groups my first*

couple of years of school. Even that, I really didn't build the connections I was looking for or needed. When I was accepted to Build EXITO and started really getting more vested in the scholars and the relationships with my cohort.

This participant discusses thinking of their friends and friend group when asked about a community that they are a part of. They explain that Build EXITO, a STEM support program, is their community, and that it also represents their university community, indicating a sense of belonging. They express that they tried to find community before participating in this program but were not successful.

Code: No Community

No Community was coded any time a participant indicated that they are not a part of a community. Under this code, they suggested that there is a community for them to be a part of, but they are not able to participate in this community. This could be attributed to a lack of time or other barriers, but they know that there are communities available to them. It is important to distinguish between this and a lack of community.

STEM Support Transfer: *I work 40 hours; I take 12 credits. They're all very homework heavy, so I don't really have time to come on campus and explore or get involved with clubs or groups.*

This participant talks about working full time while also attending school full time, and how this impacts their ability to be on campus and find a community. They indicate that their lack of time is why they do not have a sense of belonging to a community.

STEM Support Transfer: *As for me, I have a solid group of friends that I study with, but I don't necessarily think of them as [U] people. I think of them as friends and then we just try and go to the classes that we need. Not necessarily take advantage of resources or being involved in different events. Anything like that. No clubs. It's just take the class that you need and focus on that.*

This participant discusses having a friend group but mention that they do not associate them with the university. They also talk about not taking advantage of the campus resources, and that they only focus on taking classes. This indicates that they do not feel a sense of belonging to the university or a community within the university due to their own lack of participation.

Code: Lack of Community

Lack of Community was coded any time a participant indicated that there is not a community for them to be a part of. This is different from the code No Community because in this code the participants are wanting to be a part of a specific community, but it is not available to them.

STEM Support No Transfer: *You totally get lost in the crowd, I feel like. There isn't an overarching ... even within my class when I first started at [U], I barely met any of them.*

Totally forgot, I was in the honors college, so I met the honors students, but I've not even connected to them, and that's a whole college. It's weird.

This participant discusses how they feel lost in the crowd at the university, and that there isn't an overall community. They also discuss being in the honors college, but forgetting that they were, due to not being connected to the community.

No Support No Transfer: *It's not really...there's not really any incentive to be part of this community. It's...since it's a commuter school, a lot of people just go in for class and then they go, "I'm gonna go home now, because it takes me two hours to get home." And then they go home. And then there's like no point, you know.*

This participant discusses how there is not an incentive to be a part of the university community, and attribute it to the fact that many students commute to campus. This suggests that they do not have a sense of belonging to the community.

Overall analysis revealed that the majority of participants indicated that they have a smaller community that they identify with and feel a sense of belonging towards. Few participants indicated that they have sense of belonging to the university as a whole or that they do not have a community that they identify with. More participants without STEM support indicated that there was a lack of a community to identify with.

Importance of Community

We were interested in exploring whether or not the participants thought it was important to be a part of a community. In the focus groups we asked the following question: Is it important to you to be a member of a community? This section presents a summary of the codes that fell under the Importance of Community theme, and within this theme, students discussed whether community is important to them, or if it is not important to them (Figure 8).

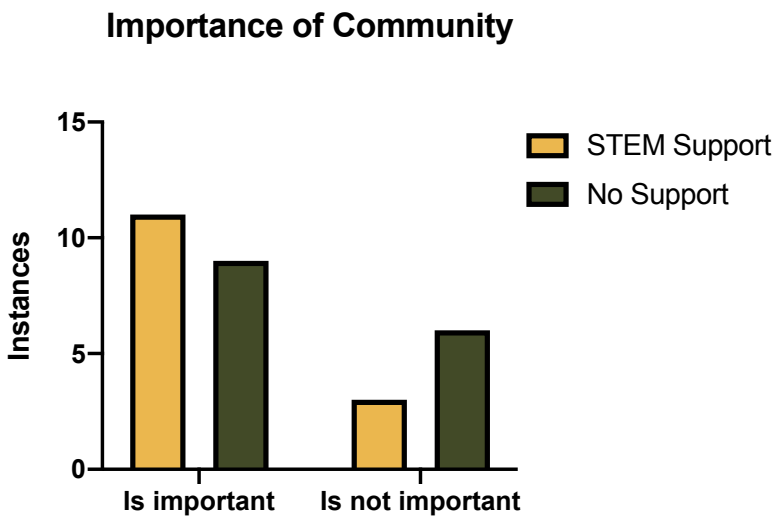

Figure 8: Instances of codes under the "Importance of Community" theme, separated out by STEM support program status.

Code: Is important

The code Is Important was coded anytime a participant indicated that being a member of a community (either the university or a group within the university) is important to them.

STEM Support Transfer: *I think it is important to find, like a pocket or a small sect that you belong. Just finding a group that you belong with, even if it is just a group of friends or a study group or whatever it is. Just having a little family, it is nice to have. Maybe not necessarily feeling like you are part of the whole [U] community as a whole, because it is such a large school, so it is hard to feel, it is hard to go from being a big fish in a small pond to being a small fish in a big pond. I do think it is important to have at least a little tiny circle that you belong in.*

This participant discusses that it is important to them to find a group that they belong in, regardless of what the group is. They mention that it can be friends or a study group, but that having a "little family" is important. They then go on to say that it may not be necessary to be a part of the university community as a whole, but that it is important to at least have a smaller community to belong to.

No Support No Transfer: *Yeah, it's important. I've always really enjoyed community. I grew up moving a lot. Like probably at least twice a year from state to state and at first, it kind of made it difficult to fit into communities. And then as I got older it got easier. You know, I commute here too. I'm only here about three days a week right now. But I still like I fit in, it's still important to me. To be a part of the community.*

This participant states that having a community is important to them and is something that they enjoy. They mention that they have adapted as they have gotten older to fit into communities as they moved around a lot when they were younger. They discuss how they commute to the

university and are only on campus three days a week, but that it is still important to them to be a member of the community despite these things.

> No Support No Transfer: *A sense of community is really important to me. I don't think I would've stayed or went to [U] if I didn't feel like I kind of belong here or whatnot. I get to see other people who are like me, who are in the same kind of boat that I'm in on campus and that really helps show me that they're going through the same things. A sense of community is really important to me.*

This participant states that a sense of community is important to them. They express that they wouldn't have stayed at the university if they did not feel a sense of belonging. They talk about how they have seen other people "like them" on campus, implying that this has resulted in a sense of belonging to them.

Code: Is Not Important

The code Is Not Important was coded any time a participant expressed that being a member of a community is not important to them.

> High Support Transfer: *It's something I would like, but at the same time, I don't need it. I feel if I was not a member of any of the groups, I would survive. I wouldn't feel great, it wouldn't be nearly as easy. We've just talked about a few minutes ago, having people to talk to about our struggles is fantastic, but I feel at the end of the day, I am here to get the knowledge and experience to go out into the world and do a science thing, whatever that*

is. I could do it without the community, but I sure would love and be much happier with it. That's how I feel on it.

This participant discusses how they would like to be a part of a community, but it is not imperative for their success. They recognize the benefits that they get from being a part of a community, but still state that they could do without the community if they have to.

Tools and Support

We were interested in exploring the tools and support students believe that they need to be successful with STEM. We asked the following question within the focus groups: What tools and support do you think you need to achieve your academic or professional goals? and Do you feel that you currently have those tools and support here? Here we have only coded the tools and supports that students reported having, so that we can understand how having these specific tools and support may relate to their SSS results. This section presents a summary of the codes that fell under the Tools and Support theme, and within this theme, we were able to code responses based on the four categories of support offered by STEM support programs: academic, social, financial, and professional (Figure 9).

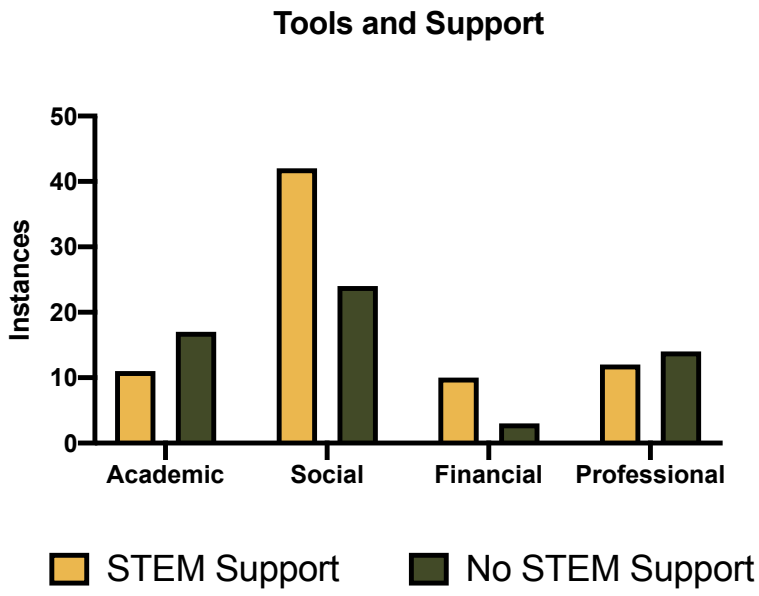

Figure 9: Instances of codes under the "Tools and Support" theme, separated out by STEM support program status.

Code: Academic

> STEM Support Transfer: *And he helps me a lot, especially about homework or when there are things that I don't understand, like concepts that I don't understand. And I don't feel comfortable going to my instructor or my PI or anything like that and he is like, well let's talk about it and figure it out. And it is not only with him but the other grad students who are also in that lab. They provide me that same kind of support.*

This participant talks about receiving academic support from the graduate students in the research lab where they work. They talk about getting help with homework and concepts that they don't understand and getting this help when they don't feel comfortable approaching their instructor or PI. They also talk about getting this support from multiple graduate students in the lab.

No Support No Transfer: *Yeah, it's basically the same exact story with me and the robotics club. Basically, just a pretty small group of friends. And I think an added benefit to basically everything you said about networking and friendship is that we're all engineering majors of some kind so what I alluded to earlier about having...basically a community of other students who want to help you and can help you academically succeed is also in that club. Because it's an engineering club. You're going to have a lot of engineering going on there in addition to team building*

This participant reflects on their experience in the robotics club, where they are all engineering majors. They talk about this group of students being friends, but also helping each other succeed academically.

No Support No Transfer: *For me personally, the resources that helped me a lot is kind of on the second floor in the middle of the library kind of tutoring services and also office hours, I really enjoy going in the office hours to get extra help with the material.*

This participant discusses receiving academic support from tutoring services offered in the library as well as office hours provided by their instructor.

Code: Social

High Support Transfer: *When I was going to transfer from community college, I kind of felt like when I was going from elementary to middle school, in the same sense that going from*

a small school to a bigger school, I felt like I wasn't going to know anybody, and it was intimidating. And I felt the same exact experience here. But once I found BUILD EXITO and they had a summer induction and I got to know some people, that fear dissipated.

This participant discusses receiving social support from their STEM support program during their transition from a community college to the university. They discuss being afraid during the transition, and this fear dissipating after getting to know people within the program.

High Support Transfer: *At the time my child was five months, so I was terrified. I was like, how am I going to do this full time school and full time parenting? And you know, I was just terrified, like ... A lot of times during the BUILD EXITO introduction I was talking with other parents and that was their same fear. And I cried a few times during that time. But then, knowing that I had that resource here really helped, like calmed down my nerves.*

This participant expresses the fear that they had about attending school full time while also being a parent. They discuss receiving social support at the introduction to their STEM support program while talking to other students who are also parent. They state that knowing other parents and knowing about the resources available to them helped to calm their nerves.

STEM Support Transfer: *I think definitely going through S-STEM, at least for me, from my experience, going through having an internship over the summer, and then coming into this program with the bridge week and with S-STEM, it really helped introduce me to all the resources that are available for me, both on campus and even outside of campus with*

having a group of, I call them my tribe, my tribe of people who are like minded that we can talk to outside of class and debrief. And they are just there for moral and emotional support. Which at least for me is the most important part. I get so tied up in my inferiority complex, like I'm not good enough, I don't belong here, I should just quit, and it is just nice to have that base level underneath it of people who are in the same boat as you, who can tell you no, you are doing fine.

This participant discusses how their STEM support program provided them with resources. They refer to the scholars in the program as their "tribe," who are like minded and provide both moral and emotional support. They express that this is the most important aspect of the program to them, because these people reassure them when they are feeling like they are not good enough or don't belong here.

STEM Support No Transfer: *I think also our peer network. You were saying networking, but more like having people who are literally doing the grind with me day in and day out. That I know I can rely on. I have my little group of friends who, if I need someone to time out on school and just spend a day with me to mind relax, I have those people and I know they're there. I owe a lot to them and their ways of mentally supporting me and emotionally supporting me through the entire process.*

This participant discusses a group of friends that they have who spend time with them to help them relax when they need it. They talk about these friends supporting them mentally and emotionally throughout the process of obtaining their degree.

No Support No Transfer: *I'm not in a particular group but I do spend time in the multicultural center, one of the resource centers at [U] and touching on this from earlier, but yeah, just being in a place where other students are just like me complaining about how hard an exam was and just being able to relate to one another and have that kind of empathy with each other is really nice. It's really important to me.*

This participant discusses that having a space to relate to other students where they can express empathy with each other, about things such as hard exams, is important to them even though they are not in a particular group.

Code: Financial

STEM Support Transfer: *I think so, I mean, I think I feel really lucky to be, to have the S-STEM scholarship because that, I mean like [student] said the financial help has helped out a lot. I don't work now. Which is really really nice, because I can just focus on going to school and doing research.*

This participant expresses feeling lucky to have the scholarship from the S-STEM program, and they don't have to work now that they have this scholarship. They discuss how this has allowed them to focus on school and doing research, rather than spending time working.

No Support No Transfer: *I had hit a wall with my finances so I had gone looking for help and someone from the Financial Wellness Center was able to help me out pretty much in*

the nick of time too. I was struggling pretty bad and now I got to go talk to him again to thank him.

This participant discusses hitting a wall with their finances and how they found support within the Financial Wellness Center at the university when they were struggling. They mention going back to thank the person that helped them, showing how much this support meant to them.

Code: Professional

STEM Support No Transfer: *I have research mentors, people who have worked with me on how do develop my skills as a researcher. I have clinicians who, whether I'm shadowing or working with them, I'm getting experience clinically. So, those are more clinical mentors. Then, I have another mentor at OHSU who's an MD PhD, and he works in admissions. He's really helping mentor me and preparing myself as an applicant, and developing the skills I really need to hone in on for becoming and thinking in the ways that I need to flourish, I guess, in what I want.*

This participant mentions that they multiple mentors in their life that has supported their professional development, including their research skills, clinical skills, and application skills.

No Support No Transfer: *I've been able to grow as a leader through that. I think there's a lot of networking that goes on within that club, there's a lot of biochem majors, and psychology majors and pre-health people.*

This participant discusses how there is networking within the club that they are in because there are a lot of different majors within that club, indicating that they are receiving professional support from being within this community.

Overall analysis revealed that social support was discussed the most amongst both groups, but the STEM support participants reflected on social support much more than the no support participants. The STEM support participants also reflected on financial support more than the no support participants. The no support participants discussed academic support and professional support slightly more than the STEM support participants.

Barriers

Barriers was coded when participants discussed anything that obstructed them from feeling connected to the university or a smaller community. This theme was one that arose inductively. This section presents examples of quotes that fell under the Barriers theme (Figure 10).

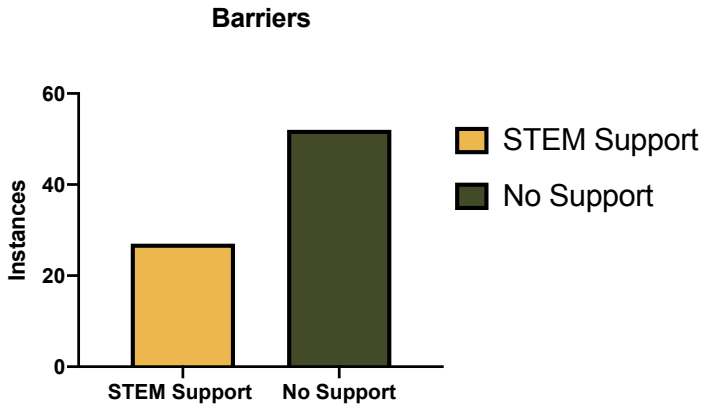

Figure 10: Instances of codes under the "Barriers" theme, separated out by STEM support program status.

No Support No Transfer: *I didn't have enough time to explore it this year, because I paid out of pocket this year so I work always. But there are a lot of clubs and things that I want to interact with.*

This participant talks about how there are a lot of clubs that they would like to interact with, but they were not able to do that during this year. They attribute this to having to pay out of pocket, causing them to always be working, leaving them with no time. This suggests that they have a financial barrier that is keeping them from connecting to a community.

No Support Transfer: *And I work full time and go to school full time, so I don't really have a lot of time to drop in for open hours, or really engage in some other resources that are here. I'm barely keeping up with homework.*

This participant states that they do not have time to go to office hours or engage with other resources at the university because they have to work full time while attending school full time, which does not give them time to connect with resources. This indicates that they have a financial barrier to connection in the community.

No Support Transfer: *I'd love to be more involved and do more campus stuff but realistically that's not doable for my financial situation.*

This participant states that they have a financial barrier to being involved in things on campus. They state that being involved is not doable for their financial situation, keeping them form connecting to a community.

No Support No Transfer: *There's not really any incentive to be part of this community. It's...since it's a commuter school, a lot of people just go in for class and then they go, "I'm gonna go home now, because it takes me two hours to get home." And then they go home. And then there's like no point, you know.*

This participant states that there is no incentive to be part of the university community. They attribute this to the fact that there are a lot of commuters within the student population, so people tend to spend less time on campus and more time commuting. This indicated a barrier to connection that is specific to the environment of the university.

Overall analysis revealed that student reported many barriers to developing a connection or a belonging to the university or a group within the university. Participants not in a STEM support program discussed barrier more often than those that are in a STEM support program.

DISCUSSION

Here we used mixed methods to identify if and how students that are supported by STEM support programs differ from those that are not in a STEM support program. Though mixed methods designs can be challenging in that they require extensive data collection and time, it also allows us to broaden our understanding by utilizing both quantitative and qualitative methods, as

well as develop a better understanding of the results from each method (Creswell & Creswell, 2017). The results from the quantitative data and qualitative data collected in this study are mostly aligned, and the qualitative data helps us better understand the results from the quantitative data and any mismatches observed among the results.

Students in STEM support programs report higher integration into science, sense of belonging, and STEM involvement than those not in support programs in the SSS. These data provide support for the efficacy of STEM support programs. Although these students are still enrolled in our university, we do not yet now about their retention, however, integration into science and sense of belonging have been correlated to persistence (Estrada et al., 2011). Therefore, because integration into science and sense of belonging may be key for retention in the STEM fields, this may indicate that students in these programs may be more likely to obtain their STEM degree.

Students perception of what a scientist is may have an impact on their scientific identity. We saw quantitatively from the survey that participants in STEM support programs have a significantly higher scientific identity compared to those that are not in STEM support programs. When exploring this further qualitatively in the focus groups, we did not see a large difference in whether or not students from each group thought of themselves to be a scientist. When discussing the student's perceptions of a scientist, we saw that STEM support students reported a scientist to be someone who pursues knowledge or has curiosity, while the no STEM support participants described a scientist as someone who has made a discovery and contributed to their field, suggesting that perception of scientists may influence science identity. Previous literature has found that perceptions of gender stereotypes and racial stigmas within the sciences influences student's science identity (Chang et al., 2011, Williams & George-Jackson, 2014, Zhao et al., 2005).

Students in STEM support programs report significantly higher sense of belonging in the SSS, but the majority of participants report that they have a smaller community that they identify with within the focus groups. Variation is seen in the type of support that students discuss receiving from these communities, suggesting that the type of support within the community may influence sense of belonging. Social support from STEM support programs appears to be the most impactful for increasing sense of belonging. While discussing the tools and support necessary for their success, we saw the largest difference in the discussion of social support. The participants in STEM support programs discuss being supported socially more than those not in STEM support programs. The STEM support participants also reported a higher sense of belonging, indicating that the two may be related. Socially supporting students may be a way to support broader participation in the STEM fields and increase persistence (Estrada et al., 2018). Previous research suggests that academic environments with cues affirming social inclusion may result in greater persistence (Estrada et al., 2018).

CONCLUSIONS

We believe that is clear that aspects of the STEM support programs on our campus are working for students involved. We need to think about what we can do institutionally to foster a sense of belonging for all students. Because STEM support programs are typically grant funded, they are limited on the number of students that they can serve due to the limits of funding and time. If we can understand what the most impactful aspects of these programs are, we may be able to implement them institutionally. If we can implement these supports institutionally, we can reach more students and be more likely to increase retention rates, especially for underrepresented students who may be more likely to leave their STEM degree path.

LIMITATIONS

We acknowledge that we used self-reported survey data from students at a university with a unique student population. We also acknowledge that we report a small n for the survey data, as we only reported the focus group participants data.

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