S-STEM Lessons Learned: Supporting Community College Transfer Pathways and Access to High Impact Practices during Transfer Transition

Dr. Rebekah Dupont, Augsburg University

Dr. Rebekah Dupont is Director of STEM Programs at Augsburg University in Minneapolis, Minnesota. Dr. Dupont's disciplinary background is in applied mathematics. She is committed to helping STEM students attain academic confidence and financial security by connecting them with resources and helping to remove barriers. Recent projects have focused on broadening participation in STEM through scholarships, professional development, mentoring, as well as connecting students to high impact practices such as undergraduate research and internships. She is particularly interested in the evolving patterns of STEM student pathways including community college transfers and exploring institutional partnership initiatives that provide innovative approaches responsive to student needs.

Dr. Nancy A Rodenborg, Augsburg University

Dr. Nancy Rodenborg is a Professor of Social Work at Augsburg University in Minneapolis. Dr. Rodenborg's primary research and teaching focus is on institutional diversity and inequality in a global context. She is interested in developing inclusive pedagogy and higher education administrative practices that equitably serve students of all social identities. Her perspective is informed by over ten years of social work experience in child protection service (CPS) and research on disparate outcomes in CPS by race. Recent scholarship has explored prejudice-reduction through intergroup dialogue. In June 2019 Dr. Rodenborg received the Lifetime Achievement Award from the National Association of Social Workers Minnesota. Her latest article is: Nancy Rodenborg & Adrienne Dessel (2019) Teaching Note—Learning About Segregation and Cultural Competence, Journal of Social Work Education, 55:4, 809-817, DOI: 10.1080/10437797.2019.1619643

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Abstract

While scholarships help reduce the financial burden of higher education, scholarships alone do not increase STEM bachelor degree completion by low-income academically talented students. Developing strategies to support STEM transfer students is key [1], [2], [3] as is engaging students in high-impact practices such as internships and undergraduate research [4]. We share approaches developed in our National Science Foundation Scholarships for Science, Technology, Engineering and Mathematics (NSF S-STEM) program to support student success and to increase access to research and internship opportunities, particularly during the transition between institutions for the transfer student, which we refer to as transfer transition. We draw implications from student-level qualitative research and make suggestions for changes in institutional structure that better support both student-level and institutional outcomes.

At our small, urban, liberal arts institution, 51% of STEM students are Pell-eligible and 35% are underrepresented. Among juniors and seniors, 42% are transfers. A scholarship program for juniors and seniors funded by two NSF S-STEM grants has supported 111 scholars. Of these scholars, 92 have graduated with STEM degrees and 18 are continuing in STEM. This 99% retention rate compares with a university-wide 6-year graduation rate for first-time full-time students of 63.5% and a 3-year graduation rate for transfer students of 50.0% (2012 and 2015 cohorts, respectively). Five scholars have been awarded NSF Graduate Research Fellowships, of whom two were transfers and two were underrepresented as defined by NSF.

We used qualitative research methods to explore the lived experience of both transfer and non-transfer S-STEM scholars. Using conceptual frameworks from social work, we coded and analyzed individual, semi-structured, recorded and transcribed interviews of scholars, selected support staff, and one faculty focus group. Emerging themes included holistic individual relationships with key faculty and staff; social identity, particularly social class, along with gender, age, race, immigrant status, and religion; and individual traits that helped students succeed despite social identity-related barriers. Faculty also emphasized the importance of establishing a culture of science. While STEM faculty felt supported by the institution, they also questioned whether the administration fully recognized the unique needs of STEM faculty, staff and students.

Introduction

1.1 S-STEM Background

The National Science Foundation (NSF) Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program supports academically talented students who are low-income and have financial need as defined within local institutional contexts [5], [6]. Program funding comes from monies allocated to NSF through the HI-B Visa program [7]. From its inception in

1999 to 2012, S-STEM projects were required to dedicate 85% of budgets to scholarships. Starting in 2012, the NSF solicitation changed to allow increased expenditures for programmatic, evaluation and knowledge generation efforts. S-STEM teams are challenged to implement programs that reflect best practices and generate evidence regarding successful interventions.

1.2 Institutional Context

Augsburg University is a private Lutheran institution with an enrollment of about 3,000 students, approximately two thirds of whom are undergraduates. Founded in 1869, Augsburg has a strong commitment to providing broad access to a quality education and supporting students from diverse backgrounds. As of Fall 2019, 45% of the full-time undergraduates were students of color, and 50% were Pell-eligible.

With a student-faculty ratio of 12:1 and average class size of 17.8, Augsburg offers a relational academic culture with a focus on student learning. In 2018, the Hagfors Center for Science, Business & Religion opened, providing enhanced classrooms to support active learning and expanded laboratory space to support undergraduate research. About 35-40 full-time undergraduate research slots within the STEM disciplines are funded through Augsburg's office of undergraduate research and a TRiO McNair Scholars program each summer. Over the last five years, nine new tenure-track STEM faculty were hired, increasing the capacity to mentor undergraduate researchers.

1.3 The AugSTEM Scholars Program

Augsburg has received two awards under the NSF S-STEM program, Award #1154096 (2012-2016) and Award #1565060 (2016-2020) for the AugSTEM Scholars program. The faculty and staff team that developed the current program chose to focus on students who were within their last five semesters of completing their STEM degrees. They had observed a significant number of students who persisted in STEM majors, while also carrying an extensive non-academic workload in order to shoulder the financial burden of attending college. Their workload not only affected their ability to excel academically but also interfered with their ability to take advantage of high impact practice (HIP) experiences such as undergraduate research. Hence the program was designed to provide financial support combined with support in seeking and obtaining internships and research experiences.

Augsburg serves a significant transfer population. About 40% of STEM students with 60 or more credits (junior or senior class standing) are transfers. Despite this, at the time of the first grant, there were not many institutional supports designed specifically to meet the needs of transfer students. One of the goals of the project was to better understand the experiences and academic pathways of STEM transfers within our institutional context.

The program supported approximately 20 scholars each year who met the AugSTEM eligibility requirements (below). Scholars received funding for up to five semesters. Each year, new scholars were selected to fill slots created by graduating scholars. In order to achieve the goal of approximately 40-50% transfers, recruitment efforts targeted community college transfers.

AugSTEM Eligibility Requirements

To be eligible, students must

- Meet NSF's citizenship and financial need requirements:
  - Be US citizens, nationals, or permanent residents.
  - Demonstrate financial need, defined for undergraduate students by the US Department of Education rules for need-based Federal financial aid (FAFSA filing).
- Be within five semesters of graduating from Augsburg with a STEM degree.
- Be enrolled full-time at Augsburg and declared a biology, biopsychology, biochemistry, chemistry, computer science, mathematics, or physics major.
- Demonstrate progress in the major by enrolling in required courses.
- Have at least a 3.0 GPA in their major field (all STEM courses required for major).

All S-STEM programs, as directed by the solicitation, should provide an ecosystem of support that includes faculty mentoring and a scholar cohort. The AugSTEM Scholars Program also uses an Individual Development Plan (IDP) framework to scaffold student contact and programming. IDPs can take different forms and appear in many workplace and educational settings. A scholar alumnus in graduate school suggested incorporating IDPs into the program. This led us to the AAAS *MyIDP* (an IDP platform for faculty, post-doctoral researchers and graduate students) [8], materials on undergraduate IDPs [9] and materials from the Center for the Improvement of Mentored Experiences in Research.

New scholars take the CliftonStrengths assessment and attend an orientation workshop to learn about the program opportunities and expectations, set goals, and schedule one-to-one meetings with mentors. During the semester they attend workshops, connect with recent alumni about navigating the transition to post-bachelor's opportunities, and obtain individualized advice about how to connect with both on-campus and off-campus resources to work toward their goals. An important component is building relationships and creating a trusting environment in which students can seek assistance with any obstacles or barriers they may be experiencing.

An explicit focus of the grant is on connecting students to high-impact practices such as undergraduate research experiences or internships that achieve the following:

- Achieve student-identified goals;
- Improve immediate and future financial stability, e.g. paid internships with additional scholarships, summer research experiences that provide academic year funding, higher hourly rate, STEM work experience;
- Include mentoring or professional development components;
- Inform self-knowledge about possible career choices; and
- Increase marketability for future competitive opportunities.

The program reflects a personalized approach to supporting students and invites active scholar involvement in recruiting and supporting other scholars and adapting the program design.

1.4 Outcomes

Over the period 2012-2019, the two S-STEM grants #1154096 and #1565060 supported 111 scholars of whom 92 graduated in STEM and 18 are continuing in STEM (99% retention). Of these scholars, 41% were transfers.

Several scholars achieved national recognition for their academic accomplishment. Five scholars received NSF Graduate Fellowships. Of these, two began at community colleges, and two were NSF-identified underrepresented minorities. Other honors included a GEM Fellow, two Goldwater Scholars (one a transfer), and four Goldwater Honorable Mentions (two transfers).

A major emphasis of the program was to support scholars in connecting to undergraduate research opportunities. Of the scholars, 61 participated in undergraduate research both on-campus and through external REUs, including at Harvard, Loyola, National Institute of Standards and Technology (NIST) and the American Museum of Natural History. Of these researchers, 25 did two summers of full-time undergraduate research and 21 were admitted to the TRiO McNair Scholars program.

To date, one alumnus has completed a Ph.D. from the University of Minnesota in chemistry; seven have completed Master's Degrees including from UW Madison (engineering), University of California San Diego (engineering), and University of Minnesota (computer science). Twenty-two have entered graduate programs including programs at California Institute of Technology (chemistry), University of San Diego (engineering), Mayo Clinic (virology), and UCLA (physics). Alumni have gone on to work at companies such as 3M, Medtronic, Unisys, Epic Software, UnitedHealth Group, Boeing, Target, and Fluorescence Innovations.

Augsburg received its first four-year Track 1 S-STEM grant in 2012, and a second Track 2 S-STEM grant in 2016. **Table 1** shows a comparison of the number of STEM graduates overall and the number who started as transfers from prior to getting the first grant in 2012 to 2018. Three-year averages were used to compare the growth over this time period of all graduates (11%), STEM graduates overall (56%) and STEM graduates who began as transfers (115%).

Table 1. Three-year averages of Bachelor's Graduates by STEM and Transfer Status since AugSTEM Scholars began in 2012								**% Change 3-Yr Ave**
Year	**2009**	**2010**	**2011**		**2016**	**2017**	**2018**	
All Grads	356	382	426		456	385	448	
		388				**430**		**11% Increase**
All STEM Grads	64	43	76		107	87	91	
3-Yr Ave		**61**				**95**		**56% Increase**
Transfer STEM Grads	18	15	16		36	35	34	
3-Yr Ave		**16**				**35**		**115% Increase**
Source: Augsburg Office of Planning and Effectiveness (Day program students only)								

1.5 Evaluation

Program evaluation was informed by several mechanisms including both formative and summative elements. Internal formative approaches included informal feedback from students and team members gathered in an ongoing manner through dated memoranda, surveys of scholars implemented each semester, and an annual debrief report by the selection committee. For program events such as transfer visits or the annual REU workshop for community college students, short evaluation summaries were written including attendance, event planning considerations and descriptions of what worked well and what needed improvement. At least once every year, faculty and staff from Augsburg and community college partners got together to discuss supporting STEM students through transfer transition. Ideas and feedback discussed during these meetings were summarized and sent to all participants.

Dr. Xueli Wang, Professor of Education and Leadership Policy Analysis at the University of Wisconsin - Madison, was the AugSTEM external evaluator. In this role, Dr. Wang did an on-campus external evaluation visit once each year. Prior to each visit, she reviewed grant materials, internal reports, and knowledge generation progress. She then spent one day at Augsburg meeting with scholars, alumni, team members, STEM faculty, as well as staff liaisons to important offices such as sponsored programs, financial aid, transfer advising, transfer admissions, and key administrators. This was followed by a half day at a partner community college to engage with faculty, staff and administrators in conjunction with AugSTEM team members. Bringing various stakeholders together and convening at the two-year campus was particularly valuable for program evaluation.

1. Knowledge Generation Methods

In addition to ongoing formative and summative evaluation described above, our project

included a research component to generate knowledge about the lived experience of STEM students, influences related to social identity and institutional characteristics that contribute to persistence in an urban liberal arts college.

2.1 Conceptual Frameworks

Our qualitative research was guided by two overall conceptual frameworks, one from higher education and one from social work. First, we drew on Nora's student integration model [10], which views students as moving through stages in their college career with support from significant others in the institution surrounding them. From this framework, we sought to understand S-STEM students' experiences at two points in their college career—upon initial receipt of their S-STEM scholarship and as they exited college and were transitioning to a new stage of educational and life experience.

Second, we drew from social work's primary practice model, Person-In-Environment (PIE), which views human behavior within contexts of relevant social environments [11]. Thus, we included questions about students' family, high school, community college, and other prior social environments, as well as about their current experiences within the context of the

university. To be eligible for the S-STEM scholarship all students were lower income; thus one line of questioning pertained to finances and how students experienced financing for college. As a part of our look at the current institutional environment, questions also inquired about how students were affected by high-impact educational practices, including social and academic support programs, undergraduate research and internships.

Finally, we were informed by life course theory [11] which is a central component of PIE. Life course theory conceptualizes human experience as occurring through different and distinct life stages, from prenatal to death. Per this conceptual frame, each life stage is accompanied by different physical, developmental, social, and psychological challenges, personal strengths and social barriers. We wanted to understand if nontraditional-age students, who disproportionately are transfer students, may have a qualitatively different college experience from traditional-age (18-22 years old) students due to their differing life stage. We expected our college's institutional environment might be better designed for traditional-age students.

2.2 Research Design

We utilized a mixed-method research design that included both qualitative and institutional quantitative data. The results reported here are based primarily on qualitative data. Quantitative data was used selectively to provide context and support for these qualitative findings. Guided by a participant action framework [12], both the PI and Co-PI took extensive notes during a wide range of meetings and interactions that occurred as a routine part of programming and in the wider context of the university. Used to supplement and contextualize individual student interviewing, these included: a) meetings with STEM faculty and staff; b) university-wide faculty and staff meetings; c) Co-PI observations of the S-STEM staff during their routine program administrative and student service work; d) meetings with community colleges and local research partners; and e) emails, reports and memos from the university administration and governance committees about a number of university-wide issues and topics. Our mixed-method approach included the potential for triangulation and greater validity of results [13].

2.3 Participants

A total of 18 separate student interviews were conducted, recorded, transcribed and analyzed, including 12 with students beginning the scholarship program and six with students at the time of graduating and completing their bachelor's degree. Two students were interviewed both when entering and exiting the program. Student majors included mathematics, computer science, physics, biology, biopsychology, and chemistry. We also conducted five individual interviews with student support staff, as well as one STEM faculty focus group. Additionally, we recorded, transcribed, and analyzed a conversation between the program director and an external researcher who had participated in coding the interviews.

3. Knowledge Generation Findings

Qualitative interviews with individual students suggested three key themes related to the student experience: 1) holistic individual relationships with key faculty and staff were important to student learning; 2) social identity, particularly gender, age, race, immigrant status, religion and social class presented barriers to student success in the context of our university; and 3) students'

individual traits/characteristics and their relationship strength with faculty and staff helped students succeed despite social identity-related barriers.

Findings from the faculty focus group (FFG) complemented student interview data and documented faculty members' awareness of and sensitivity toward the transfer and low income students served by the S-STEM grant. Five themes were apparent from focus group data. First, holistic relationship-based learning was just as important to faculty as it was to students. However, faculty perspectives on student-faculty relationships were different than the perspectives of students, and limitations and qualifications to relationship-based learning were noted. Faculty also noted the importance of peer relationships for STEM student success. Second, faculty were aware of and tried to accommodate and intentionally include students of diverse social identities, particularly low income and transfer students. Social identity was not noted as a barrier to students' success; rather as something to be taken into account in terms of teaching and learning. Third, practical money-saving strategies were regularly used by all focus group participants, and faculty considered cost when selecting textbooks, planning curriculum, and advising students. Fourth, all focus group participants worked to establish a "culture of science" that they felt was important for students' development as future scientists. Finally, participants felt that the university institutional context did not always recognize STEM's unique curricular and disciplinary needs, and that the university unintentionally placed barriers to success in front of STEM faculty and departments.

All data cited below are from individual student or staff transcripts, or the FFG transcript unless otherwise noted.

3.1 Relationships

Many of our students described faculty and staff relationships as very important to their success. Similarly, FFG members spoke at length about their efforts to establish and maintain research, mentoring, and teaching relationships with students; project staff illustrated relationship-building skills with students throughout the project.

A total of 10 student interviewees described very positive relationships with faculty or staff, including four men and six women, five transfer, three nontraditional-age, three identified as underrepresented minority, and two of another non-white identity. The characteristics of relationship that they identified were: interactions through shared research with faculty, availability of faculty to talk informally as well as meeting with them for formal advising and mentoring, availability of key program staff for general encouragement and direct support (coffee and food, able to stop in as needed), faculty interest in them "as a person" instead of just as students, help with networking and career leads, and help with and recruitment for scholarship applications. Students commented on how faculty belief in them and their abilities gave them confidence to succeed.

Faculty success at making and maintaining relationships with students appeared to transcend social identity. For example, a woman of color expressed appreciation for three faculty members in particular, two white males and one white female: "My professors...helped so much. These are

people who are experts in their field. If they believe in me and are someday willing to potentially call me a colleague, that's important."

Participants in the FFG spoke about their relationship-building efforts with students as well, and described holistic and flexible relationships with students as a key to student success. Their relationship-building with students seemed to follow a "do what it takes" orientation. For example, in the context of teaching, one faculty member said, "It's who's in front of us, and we're trying to make sure we reach, connect with them. We don't want to lose anybody." Faculty tried to teach each unique person who was "in front of them" regardless of the needs and challenges this person brought. In addition to faculty, project staff supported students with both regular programming and availability for students to drop-in as needed. Several students mentioned their appreciation that project staff allowed them to simply walk in anytime, say hello, pick up snack food or receive a kind word. Staff willingness to meet even unique student needs was impressive to observe. For example, when a student needed professional clothes for an interview staff members located an agency that provided job interview clothing at no cost.

While focus group participants intentionally provided and valued student-faculty relationships, they also noted that relationships alone were not adequate to meet student learning needs and holistic relationships could not be built with all students equally. All FFG participants acknowledged that they could not maintain individualized relationships with all students. "I never know all these students." "I try to invest in all of them the same, but it's like with all relationships. Some of them are different from others." "I mean (I get to know) some more so than others, because some you have a closer relationship with...in your lab, you have a closer relationship with..." These comments suggest limits to individualized mentoring relationships in supporting the broad range of STEM students. What makes some student/faculty relationships work and others not is important for future research.

Time limits made relationship-building difficult as well, and one faculty member questioned whether the time students spent talking to faculty might sometimes be better spent taking care of themselves. "I think that that's actually a tension, that our students have too much (relationship-building with faculty)... I think it sort of tires them out or wears them down or diffuses their focus. On the other hand, I think that that's part of why they are drawn to science and why they are drawn to Augsburg, because...they need some assurance. They need some support...having a faculty member who – they walk into your office and they'll talk to you for half an hour. And it's not clear you need to talk, right? But I think that they want that time. So, there's a tension between those two things. They want that time and a relationship and they don't have it, and they shouldn't take it, and they should be taking care of themselves, sleeping."

Given the busy schedules students maintained, faculty were sensitive about how best to encourage students' time use. One faculty member felt that sometimes students might better choose to study than to talk to faculty: "I don't want relationships for them or for me to replace competence. Right? That they're being relational because maybe they're insecure and they don't have the skills that they want to have... I don't want relationships to replace competence."

Finally, one faculty member alluded to the challenge of developing student relationships repeatedly over many years of service: "Faculty do this all the time." "I'll say that I have learned

that that relationship is very meaningful to the students and I should sort of protect it and value it in that way. But I also have a lot of students. And so, there's an experience that comes with that on my side that is sometimes...for them they'll come back or write at Christmas and those things. ...But, I get to have Groundhog Day and do that over and over and over again. But for them it's the thing, right? That unique thing." For students, the faculty relationship may be unique in their lifetime, but for faculty it is a repetitive challenge.

Many students reported that relationship-building efforts supported their success in STEM. However, along with most other faculty, STEM faculty do not focus on relationship-building as an explicit part of their disciplines, and they may not receive much training in relationship-building. Relationships in a social context form the heart of social work, and social work faculty are trained to be experts in professional relationship-building within the social service and community context. Social work texts center on skills related to work in relationship with others, such as conveying empathy, building trust, behaving with authenticity, understanding nonverbal cues, among many other detailed aspects of relationship-building [14]. Social workers develop relationships with a continuous stream of clients over the course of a long career. This can be a source of burnout for social workers and is frequently addressed in professional literature. In contrast, the personal stress of relationship-building may be unrecognized in higher education literature [15].

3.2 Social Identity

A total of 11 students identified at least one social identity-related barrier that they felt made it harder to succeed in STEM. Since scholarship participation required students to be Pell-eligible, we intentionally explored whether financial pressures were problematic. Students identified the following social identity factors that they felt raised barriers to their STEM success:

- *woman in science,*
- *nontraditional, older age*,
- *person of color*,
- *first-generation,*
- *immigrant, status,* and
- *social class and finances.*

In contrast to the students, faculty did not explicitly identify social identity factors beyond social class and finances and transfer status.

Woman in science. Female respondents frequently commented on their minority status as a woman in science. To one woman it was difficult to overcome stereotypes as a woman: she felt "brushed off" because she "doesn't look the part" when she wears more feminine clothes or is social ("when I would tell people that I wanted to be a...science major...they'd be like 'that's out of character for you. You seem more sociable'…"). She felt she may not appear serious as a scientist because of her feminine clothing and style. Other women felt isolated as the "only" one in a class of male students. ("So, actually, like being a woman in STEM is basically just unheard of"). However, women did not feel female identity held them back since in each case the respondent identified a particular personal strength that helped them overcome, such as being particularly intelligent ("I have always been smart"), being persistent and working harder than

others, or developing a dogged determination to prove the stereotyping wrong ("well, now I'm going to go...like, just watch me!")

One student identified her female status as a benefit as well as a barrier. This student described how a female faculty member referred her to a female scientist career network. Through this network she was able to make advances in her research and her career development.

No faculty in the focus group mentioned gender as an impact on their work with students. This does not mean faculty were unaware of gender and the experiences of women in science, however, in the limited time of the interview, gender did not come up as a topic.

Nontraditional, older age. Almost all students 25 years and older identified age as a factor. It felt "a little isolating" and they were aware of greater maturity ("I think the maturity differences are pretty apparent"). Being married, a parent or with other family demands was a particular challenge. These students reported increased financial strain and worry, greater demands on their time, and more obligations.

Older students identified their age as a positive too. They felt it brought them more maturity, better task management abilities, and that their greater experience allowed them to take leadership roles more easily.

Person of color. People of color reported barriers to learning that were placed in front of them. For example, one student felt that people of color have to "balance" more than white people, were expected to do more, and were judged more severely. Perceived judgement could be subtle, and sometimes related to nonverbal communication. For example, one student felt that professors' attitudes conveyed judgment about their inadequate prior learning in high school: "There are subtle things...I feel like it's been...I don't know if the term is mocking, but it's a, 'You should know this,' or 'You should have learned this in high school.'" Other subtle nonverbal communication from professors felt judgmental: "I feel like maybe just...sighing, body language, eye rolls, things like that."

Another commented that social life on campus was "cliquey" and therefore less welcoming to people of color. Finances were identified as more problematic for people of color, due to having less knowledge of the details about financial aid, and therefore these students felt at greater risk for ending up with greater financial debt than white people. Still, in all cases these students identified a particular personal trait, such as working harder, being persistent in asking questions and just not giving up, that had helped them get through.

First-generation. First-generation status was noted as a factor in many students' experience. For example, one first-generation student commented that they did not come from a "culture of learning," and therefore did not have guidance to take advantage of educational opportunities. Students whose parents had gone to college were assumed, by comparison, to have had such guidance. Another student felt that first-generation students "...don't really know what education brings." All in all, being a first-generation student brought more challenges: "There's significant differences between how I sort of interpret things from school and the choices I make

compared to students that I know are not first generation and have had a lot of support from parental figures...there's definitely a gap...it's definitely more of a challenge."

FFG members were also aware of first generation status and its possible impact on learning. "I'm just thinking that some of them are first-generation students. Their families have no idea what their college experience is like. They want to talk to somebody."

Immigrant status. Immigrant status was mentioned as a barrier for two students. One immigrant was "alone" without a family in the country, which made education harder. Another immigrant student had ongoing problems with English language vocabulary, worrying about forgetting words and having difficulty with memorization.

Social class and finances. For some students, the S-STEM scholarship was pivotal to their ability to pursue a STEM major at all. Upon receipt of the scholarship, one student "...literally sobbed tears of joy…It's like $5,000 can go a really long way." For some it meant the difference between attending this particular university and not: "AugSTEM was the only reason why I came…I would not have come... if I did not get that funding." For others it meant working only two jobs instead of three while attending school: "I just decided to quit one of my jobs because it took so much of my time." For another, the scholarship provided the opportunity for education abroad, which otherwise would not have been possible. For still another student, the scholarship meant a boost in self confidence. "It gave me a lot more confidence in me, saying to myself, that, wow, I got this scholarship. To me it was a big deal."

How students handled their debt emotionally varied. Some expressed high anxiety: "If you're a person who has to take out loans, then I think you probably think about it at least once a day." I worry more "...about how I'm going to pay. I want to pay all the stuff I have off."

Other students chose to not worry about finances during their time in school, even though they had accrued high debt: "I feel pretty good. You know, obviously I have some loans...I have, I want to say over $60,000 that I'll have to pay back." However, this student wasn't worried because they expected these loans to be deferred during grad school. It was not clear to the interviewer that the cumulative impact of higher loans was apparent to the student. Another student expressed mixed feelings about finances: "it's (my educational debt) recurring more and more in my mind...But, I'd say it's still pretty minor. You know…I'll just chip away at it…". Still another student had chosen to attend a cheaper community college and take a year off to save enough money for school. This student's goal was to graduate with no debt at all. The S-STEM scholarship made achieving this goal more likely.

Thus, students described a wide range of attitudes about their debt and about school financing that were not clearly related to their actual debt amount.

Participants in the FFG paid close attention to how the cost of education affected their students, and early in focus group conversation, all participants shared routine ways in which they tried to save students money. These included selecting lower cost textbooks, (i.e., using one text for two courses, choosing lower cost texts, loaning texts to students, including lab manual costs in course registration), always keeping course cost and degree progress in mind when advising students, ensuring that students are paid for STEM projects rather than volunteer ("I try to avoid having

students volunteering. I think it borders on unethical."), occasionally paying students out of their own pockets for lab work or other research tasks ("..out of my own pocket (I've) paid for students to work in my lab occasionally. Just if they've graduated and they have something they need to finish, I have tried to give them some compensation"), and routinely inviting students to their homes or out for lunch, which they frequently paid from their own funds.

Cumulative barriers. Of course, individual students do not just bring one social identity. The intersectionality of race and ethnicity with gender, lower social class, and/or first-generation status impacted some students more than others. For example, one student noted how minority racial status made financial pressures more severe. "...(T)here's not like constant education, there's not thorough education about financial aid...It's highly loan encouraged...not knowing what the financial aid jargon is. So, they get into a lot more debt than they thought they were going to…". Minority race/ethnic status intersected with first generation status and being a woman: "And then it got down to like, one, I'm a minority, two, I'm a female, three, I'm the first person in my family to go to college."

Others noted the intersection of finances with nontraditional age: "And then financially… My husband and I were going from double income...to living off of his salary. I was worried about working during school…". Family obligations and finances can be more burdensome for older students: "If it wasn't for the AugSTEM program, I would literally have probably burnt out by now, honestly. I have such a high financial strain on my shoulders…And, though education is important, I also need to live and survive. And, I pay my bills. I pay both my parents' bills, and...all throughout college, financially supported my family and myself." One student described how cumulative educational debt over prior schooling was "...extremely stressful. It kind of makes you feel a little bit nauseous looking at the numbers."

Still another student pointed out that being female and a person of color was difficult: "I feel lonely as a female and as a minority. There's not that many people in the STEM fields. And the professors don't look like me either. I feel like if I did not have support I would not be successful…"

3.3. Individual Traits

Despite these barriers, all students who identified social identity-related barriers to STEM learning took responsibility for their own success anyway. In particular, they noted two strengths that helped them succeed--their own internal drive and personal characteristics, and their strong positive relationships with particular faculty or staff.

Personal characteristics. Students expressed a variety of individual characteristics that helped them succeed. For example, one student expressed a sense of "destiny" that helped them persist despite discrimination by race, low income and first generation status: "...whether that's something in the universe, whether that's my own internal drive and strength, whatever it is, there's a reason why I'm here...and I'm so successful." Students found various words to describe their determination to keep going: "But knowing me I'm driven. I will have that career. I just might have to go through a few more hoops but I'm used to jumping through hoops." "I am

just determined…" "I've taken more initiative" "...(other people) said that you can't do it. Yes, don't listen to those negative words and then just believe yourself that you can do it."

Another noted their own intelligence as important:" I've always been like extremely intelligent and always have kept extremely high grades." Another said their good time management helped them get through.

Others expressed delight over learning that kept them going: "I really enjoy working, doing experiments every day, analyzing your data, and if it doesn't work, finding a way to make things work…" "...just learning all these things is just really exciting…". Another said a particular class was "just mind-blowing. It was really good." Finally, two people expressed determination to succeed just because others felt they couldn't: "...I feel like that's been basically my whole life, and I've done things that people didn't think I was able to do, and so it's been interesting (proving them wrong)." This respondent felt excitement specifically because they were overcoming some of the stereotypical barriers faced by minority race, low income, and first generation students.

Relationships. In addition to their personal traits, the students attributed their success to the strong support they received from their personal relationships. Sometimes these relationships were with people of a similar identity, for example, women students gaining support from female faculty and staff. In these situations, students appreciated having role models. For example, female students were encouraged by help from female staff: ("They're very knowledgeable women and they're women, which is super awesome. They're very knowledgeable on options, which I really appreciate…") Similarly one male student who was also an athlete repeatedly noted how much encouragement and support he received from faculty members who talked about his sport with him, indicating interest in him "as a person" beyond just STEM. In this situation, the faculty member shared a love for the same sport, which formed a bond beyond their STEM discipline.

Importantly, overall relationship strength transcended social identity, since almost all faculty and staff relationships crossed one or more social identity barriers. Women scholars of all racial and ethnic identities noted how important male faculty had been to their development as a scientist. Male students drew encouragement from the holistic relationships offered by S-STEM staff regardless of their gender. Thus, faculty and staff were able to build individual relationships with students who overcame social identity barriers.

Our research also revealed that having a key relationship with a person acting as a mentor, such as faculty, employers, family, peers, etc. was integral for students in even deciding to enroll at Augsburg or to apply to the AugSTEM Scholars program. The majority of students explained that they learned about the scholarship or made the decision to apply based on personal connections. Flyers, e-mails and other passive forms of communication alone may be less influential for recruitment. Students valued personal conversations in which they felt their skills were validated, and they were personally encouraged to participate or shown a pathway into STEM. Relationships also played a role in connecting students to high-impact practices, specifically research and internship opportunities, both at Augsburg and off-campus. One student commented that key S-STEM staff "... kind of have been like guiding me in this crazy thing... I

check in with them – we don't have to check in with them, but I still stop by like once a week just to say hello and thanks, and grab something...granola bars or something."

Faculty attitude toward students and teaching. Faculty members held an attitude of respect for students that pervaded the entire focus group conversation, and professors seemed well aware of the complexity and challenge of their students' lives. One professor commented that faculty were "...sensitive to the fact that the students we're teaching are probably in a very different place than we were as students in...all sorts of different ways…(not)...particular to low income, but in some sense I assume that almost all of my students have some sort of financial challenge. And, if they don't they're likely dealing with significant questions of addiction or mental health…(and) very fragile in their own way." This statement seemed to illustrate faculty awareness of the students' intersectional identities.

Faculty respected student persistence even when facing significant challenges. For example, participants noted that inadequate prior academic preparation was a problem. One professor described it as "jarring" that occurred when these students encountered the difficulty of college-level courses. Another described how some students were "ill prepared" after community college and have "big gaps" in knowledge. To overcome this, the faculty member prepared individualized "remediation work for the student...to help...fill the gap so they can survive the class. It's either that or they'd have to drop and repeat a class...to tutor them along." The student was required to keep up with the remediation assignments as well as the regular course assignments, but "they're tenacious. They dig in…". Another noted that "It's a different landscape with our students (than I myself experienced). We have a lot of students now especially that transferred from community colleges that are working two 12-hour shifts on Saturday and Sunday... and, they're full-time students as well."

This attitude of respect was evidenced in repeated comments about faculty attempts to build a "culture of science." While not directly defined, a "science culture" seemed to include faculty-student collaborative research relationships, referrals of students to internship, graduate school and research opportunities, routine department seminars in which both professional and student researchers shared findings from completed and in-process empirical projects, and explicit attempts to treat students "like graduate students." Treating students "like graduate students" seemed to imply an equity-based collaborative search for scientific findings.

As we shift our focus from research to lessons learned, we observe a similarity between social work and academic supports for students. As faculty and staff strive to help students persist despite the challenges they face in and outside the classroom, their actions are characteristic of basic social work intervention strategies. First, *attention to basic needs* is fundamental to all good social work [11]. The S-STEM program starts with the scholarship money to meet financial necessity. Second, our data suggest that students are better able to succeed when surrounded by academic and personal support systems that *respond holistically to their unique, individual situations*. Faculty commitment to teaching the whole person who was "in front of them" regardless of the needs and challenges this person brought -- particular assistance that is provided for a unique need of a unique person at a unique time and place -- is characteristic of many of the

best social work intervention strategies. Students are able to communicate these unique needs in collaboration with individuals with whom they have built a *trusting relationship*.

4. S-STEM Lessons Learned

4.1 STEM Retention Outcomes

Retention is a critical element of S-STEM goals. Since the AugSTEM Scholars Program was designed to support juniors and seniors as well as to explore the experience of transfer student versus non-transfers, data was requested to compare year to year retention data for transfers versus non-transfers. Table 2 shows these comparisons for all STEM students in the left two columns as well as for juniors and seniors only (as defined by having at least 60 credits) in the right two columns. Table 2 shows that while the retention rate is comparable for the population of all students (73% versus 71%), there is an eight point difference (79% versus 87%) for the populations of only junior and seniors.

Table 2. Augsburg STEM Year to Year Retention by Transfer Status	**1st-Years through Seniors**				**Juniors and Seniors Only**			
	Transfers		Non-Transfers		Transfers		Non-Transfers	
Headcount STEM majors F17	131		347		103		145	
Retained in STEM F18	64	48%	192	55%	50	49%	73	50%
Grad with STEM major by F18	31	24%	53	15%	31	30%	53	37%
Grad. or retained to STEM	***73%***		***71%***		***79%***		***87%***	
Enrolled, no longer in STEM F18	15	11%	43	12%	7	7%	3	2%
Not currently enrolled F18	21	16%	59	17%	15	15%	16	11%

Source: Augsburg Office of Planning and Effectiveness; some percentage sums impacted by rounding.

We disaggregated rates for Pell, Students of Color (non-white), and NSF-underrepresented (Black, Hispanic, Native American or Pacific Islander). For juniors and seniors, we found minimal differences for Pell vs. non-Pell (84.5% vs. 82.6%) and SOC vs. non-SOC (83.7% vs. 83.3%). However, the retention rate for NSF-underrepresented students (54 out of 248) was ten points below that of non-NSF-underrepresented (75.9% vs. 85.6%). This highlights the importance of tracking outcomes carefully and identifying additional input and program modifications that can lead to equitable outcomes.

To date the AugSTEM retention rate is 99%. All of the scholars are currently enrolled and on track to graduate or have graduated in STEM except for one student who graduated with a non-STEM major and a STEM minor. These students are all junior and seniors, of whom about 40% are transfers. Thus, this 99% retention rate compares to year-to-year retention rates for junior and senior STEM students of 87% (non-transfer STEM students) and 79% (transfers). We would like to better understand some of the factors involved so that retention rates for all students can go up, especially for juniors and seniors who have already invested significant time,

effort and money into pursuing a STEM degree. One possible factor has been labeled by our team as the "What year are you?" question.

4.2 STEM Transfer Retention: What year are you?

As part of the recruitment process, the admissions office sends a summary of incoming STEM transfers, which includes their GPA and total number of credits. Program eligibility requirements are based on STEM GPA and being within five semesters of completing a STEM major. Computing STEM GPAs and measuring progress to degree completion from the endpoint (a feasible completion plan within five semesters) instead of the starting point (60 or more credits taken) requires checking transcripts and credit transfer audits. This process led to increased awareness by the AugSTEM team that many students enter as transfers with junior status but are not close to completing a STEM degree in five or fewer semesters.

"What year are you?" is a common question to ask when meeting a student. More than once, the Project Director observed a student replying to the question by saying, "It's complicated." The labels of first-year (freshman), sophomore, etc., all have connotations that align reasonably well with students following traditional four-year pathways to a degree. For students whose pathways are different, these labels can be ill-fitting and leave out important information. Students may have junior class standing, be taking first-year STEM coursework, and have years of professional work experience, be a parent, own a home, be a veteran, or have taken on more significant life responsibilities than some of their classmates. This mismatch can impact interactions with fellow students, staff and faculty, as well as influence how institutional processes and procedures impact the student's experience.

Student narratives in several student publications illustrate this issue. The Reporter Magazine is a student-run publication of the Rochester Institute of Technology (RIT). A recent blog post by Tyler English titled *Transfer Perspective* described the experiences of Rakshanda Jha, a bioinformatics major [16].

> *"The biggest struggle for us transfer students is to answer one question; what year are you?" said Jha. She then explained how at RIT, students are judged on their year level rather than their level of credits.*
>
> *"It changes how people look at you," Jha said. "If someone hears you say that you are a transfer, you are looked at as if you are different sometimes." As a transfer, you can have the same number of credits, if not more, than your peers. However, due to transferring, saying what year you are can be tricky.*

In the University of California - Davis student publication, The California Aggie, Brody Fernandez writes about the potential different life stages of transfer students [17].

> *"What year are you?" is undeniably a common question asked by students at UC - Davis. But it ignores the diversity of our student population. So let's examine this question a bit further to better understand how the life of a transfer student compares to the life of a student who has not previously attended another university. When we look at the stark differences between the*

two, we can see an ever-growing divide that may reach a point of no return if student demographics do not effectively intermingle.

If you pose the question "What year are you?" to a transfer student, more often than not you will get a bewildered look. Transfer students come from all walks of life: a wide range of ages, ethnicities, classes and backgrounds. In terms of age, the youngest student in the transfer class of 2018 is 14 years old, while the oldest is in their 70s. So these transfer students find themselves unable to answer the question of their "year" without some ambiguity.

Our team has been reflecting on our use of language with students. For instance, "What courses are you taking?" works well as an introductory question and provides meaningful information on a student's current experience. In our mentoring, we are attentive to pressures on transfers to compact their major coursework into shorter time periods, which can result in needing to take three upper level lab courses simultaneously, for example. Sometimes this can't be helped when trying to maintain desired progression to completing a degree. In such cases we provide encouragement and honest acknowledgment that the reason they might sometimes feel they are working harder than other students might be because, in some situations, they are.

4.3 HIPs and Transfer Transition

Augsburg began its first S-STEM implementation for junior and senior STEM majors with the goal of growing to a cohort that included 50% community college transfers. Since all students can apply with equal consideration, this challenged the team to develop strong community college partnerships and develop mechanisms for engaging faculty in recruiting STEM transfers. Building on Augsburg's strength in undergraduate research, the Provost Scholar model was developed, in which well-prepared incoming transfers could enter into the summer undergraduate research program if sponsored by a faculty mentor. Provost scholars, some of whom have gone on to receive NSF graduate fellowships and other honors, have transformed institutional culture regarding STEM transfers.

Student interviews implemented through qualitative research confirmed that the ***HIP during the summer of transition*** provided a bridge between institutions and allowed students to begin their first semester with supportive relationships with faculty and peers in place. Further, multiple HIP experiences were influential in success with fellowships and post-graduate opportunities. Consulting the literature reinforced this conclusion and also supported that participation in multiple HIPs can be particularly beneficial for underrepresented students (Huber, 2010). The PRISM T^2 goal of seeking to connect scholars with ***multiple HIPs*** has grown out of this evolution.

4.4 Major Challenges and Responses

Inadequate STEM preparation of transfers. In order to support students and advisors at the 2-year institutions, one of our staff members facilitated communications between department chairs, faculty at Augsburg and area 2-year institutions to develop 32 STEM Transfer Guides at eight community colleges. In addition to making them readily available online, the Guides are presented in person to advisors at our annual Community College Advisor brunch (which is

attended by upwards of 50 area academic advisors), and to students at events targeting STEM transfers.

Continued financial pressure. Even with the AugSTEM scholarships of up to $10,000, many students still experienced financial need. While Pell grants can be utilized for 10 semesters, Minnesota State Grants run out after eight semesters - which we came to call the State Grant "cliff." Mentors support students in seeking additional scholarships, finding employment that pays higher wages per hour. Due to identifying this specific need for high-performing students with financial need, there is a new donor-funded scholarship specifically for 5th year STEM Transfers.

Turnover (co-PI's, key staff). Over the course of the project, two co-PI's left the institution and there was turnover in key roles such as the vice president who oversees transfer admissions and the director of financial aid. Careful documentation of roles and any institutional commitments help minimize disruptions to the program. In addition, for offices that are key collaborative partners, we took a cross-training approach, if possible, and tried to have at least two individuals that are familiar with your program.

Funding qualitative research support. The qualitative research efforts for this project involved setting up multiple interviews and focus groups, taping and transcribing interviews, coding, and analysis. In order to complement the budget that was included in our grant, we sought additional research support by engaging undergraduate researchers and obtaining two internal research grants. The funds from the grants allowed us to purchase qualitative research software and work with a local researcher to assist with coding.

Finding common time for cohort meetings. Since the AugSTEM Scholars are made up of different STEM majors, finding a common meeting time each semester was often impossible. We adapted by offering each workshop twice, for instance once on a Monday and once on a Tuesday (with the same content). Scheduling meeting times far in advance can help students build the meeting times into their busy schedules.

4.5 Theory of Action

In the summer of 2019, the Project Director attended the American Association of College & University (AAC&U) Project Kaleidoscope (PKAL) Knowledge Exchange Institute on Culturally Responsive Evaluation and Education Research. The purpose of the institute was to provide STEM faculty the opportunity to interact with national experts "to understand and gain evaluation and education research expertise that is culturally sensitive and necessary for more accurately pinpointing the areas where institutional interventions, particularly those related to broadening participation, are likely to flourish [18]."

There is no one simple way to increase the number of low-income academically talented STEM-intending community college students who transfer and complete bachelor's degrees. Scholarships, articulation agreements and opportunities alone are not sufficient. From our qualitative research exploring the lived experience of STEM scholars grew a theory of action (TOA) for improving support for low-income STEM students. At the core is the formation of trusting relationships with faculty and staff as a means for academic and professional growth. To

form these relationships, there must be a first step in which students, in one student's words, "cross the threshold." A starting point of this cycle is to provide something of value to the student – scholarships, fellowships, research experiences or internships, embedded in structures that *initiate* trust and relationship. Students then identify *their* goals and barriers. These are a means to engage program support mechanisms – connection to resources, navigation of application processes and troubleshooting to overcome barriers – so they *acquire* success. Once students acquire success, mentors *build* trust and relationship through continued support during participation in order for students to *experience* success. To complete this cycle, mentors *sustain* trust and relationship by supporting students to *narrate* success – including challenges faced and how they dealt with them. These narratives reinforce scholar development through reflection and empower students to invite others at previous stages to "cross the threshold."

This TOA aligns with theoretical models and best practices including appreciative advising [19] and social work theory [14]. Creating a TOA resulted from participating in the PKAL STEM Knowledge Exchange Institute on culturally responsive evaluation in Summer 2019. The TOA is a reciprocal relationship that reveals critical student perspectives and contexts; these are necessary inputs for lasting solutions and will guide our evaluation. This TOA is implemented through the IDP framework to support connecting students to HIPs such as internships and undergraduate research.

Combining this TOA with the analysis of scholar pathways highlights the gap created for transfers during the transition between institutions. While students often form strong relationships with faculty mentors at both 2-year and 4-year institutions, the period of transition between institutions can create a gap in the student's institutional home. Further, when transfer students start at a 4-year institution, they usually lack relationship histories with the 4-year STEM faculty similar to those of students starting in their first year.

To address this, future interventions should build upon successful student-level interventions and add a professional development component for faculty. In particular, it is important to bring faculty from different institutional contexts together to gain perspective in the cross-institutional navigation that is a necessity for our transfer students so that we can improve institutional and cross-institutional structures to support STEM transfer transition.

5. Summary and Conclusions

A core goal of our project is to strengthen institutional infrastructure to increase retention, student success, graduation, and transition to STEM-related graduate education or employment for more of our STEM students. Creating relationships is fundamental to achieving this goal. Overall, qualitative findings suggest that relationships matter to both students and faculty, but that all students do not benefit equally from faculty member mentorship. From a faculty perspective, their ability to form relationships is limited by time and capacity. The individualized and holistic relationship-building that students seek and that appears to help them succeed, is not available to everyone. How to increase opportunities for more students, given the time and resource limitations of faculty, should be pursued in further research. For example, can holistic relationships be built through online and/or hybrid learning models? These and other ideas should be explored. Findings also suggest that a combination of faculty and staff relationships,

coupled with financial and other assistance can together transcend race, ethnic, gender, social class and other social identity differences. Our research also underlines the need to build upon Augsburg's institutional environment and to invest in our partnerships with other educational institutions to streamline initiatives to bolster student support.

A core goal of our project was to strengthen institutional infrastructure to increase retention, student success, graduation, and transition to STEM-related graduate education or employment for more STEM students. Since transfers comprise approximately 40% of our scholar cohort and our STEM graduates overall, this institutional infrastructure includes partnerships with community colleges. In addition to relationships between faculty and students, relationships among faculty and staff between and within these partnerships are important to building institutional infrastructure conducive to student success.

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