CS/M Scholars Program - an NSF S-STEM Project

David Hartenstine, Western Washington University

David Hartenstine is a Professor of Mathematics at Western Washington University. He earned his PhD at Temple University.

Dr. Perry Fizzano, Western Washington University

Perry Fizzano earned his BS degree in Computer Science from Widener University and his MS and PhD in Computer Science from Dartmouth College. He had stints in academia and industry prior to joining WWU in 2005 and becoming chair in 2012. His research interests are in optimization, bioinformatics, information retrieval and computer science education.

Dr. Joseph Arthur Brobst, The Center for Educational Partnerships, Old Dominion University

Joe Brobst holds a BS in Biological Sciences, MA in Curriculum & Instruction, and Ed.D. in Educational Leadership, all from the University of Delaware. Formerly a high school biology teacher, he is now an educational research and program evaluation specialist with experience working on a wide range of projects sponsored by organizations including the National Science Foundation, National Institutes of Health, Office of Naval Research, U.S. Department of Education, and Corporation for National and Community Service. His areas of interest and expertise include broadening participation in STEM higher education, K-12 STEM teacher professional development, and preservice teacher preparation in STEM.

Dr. Elizabeth Litzler, University of Washington

Elizabeth Litzler, Ph.D., is the director of the University of Washington Center for Evaluation & Research for STEM Equity (UW CERSE) and an affiliate assistant professor of sociology. She has been at UW working on STEM Equity issues for more than 15 years. Dr. Litzler is a member of ASEE, incoming chair of the ASEE Committee on Diversity, Equity, and Inclusion, and a former board member of the Women in Engineering ProActive Network (WEPAN). Her research interests include the educational climate for students, faculty, and staff in science and engineering, assets based approaches to STEM equity, and gender and race stratification in education and the workforce.

Regina Barber DeGraaff, Western Washington University

Regina Barber DeGraaff teaches physics, astronomy and science communication at Western Washington University (WWU). Regina completed her PhD in physics from Washington State University with a focus in astrophysics. She also created the position and serves in the role as the STEM Inclusion and Outreach Specialist at WWU. This half-time position is devoted to the retention and support of underrepresented students and faculty in STEM. Lastly, Regina co-created and manages Spark Science a multimedia (podcast, videos and blogs) project that hopes to share science in an engaging, approachable and humorous way while challenging the scientist stereotype.

Preparing Students for Careers in Computer Science and Math - a Report on a Current S-STEM Project

The CS/M Scholars Program, funded by an NSF S-STEM grant, supports students majoring in computer science or mathematics at Western Washington University, a public comprehensive university. The title of the project is "Preparing Students for Careers in Computer Science and Math." Eligible students receive scholarships and are further supported with curricular and co-curricular activities. These include first-quarter seminars in math and computer science, regular program events focusing on professional development, mentoring from recent alumni, and academic advising. Further, "early exposure to computer science" is provided in the seminars and program events.

Research associated with the program focuses on two main questions: 1) How and to what extent do the program features contribute to the development of self-efficacy, CS/M identity, and sense of belonging? and 2) How does early exposure to computer science through coursework and career awareness affect the experience of CS/M Scholars? These questions are investigated through focus group interviews and surveys of the CS/M Scholars and a comparison group.

Introduction

In this paper we discuss the CS/M (Computer Science/Math) Scholars Program at Western Washington University. This program is supported by a $1M National Science Foundation S-STEM Track 2 grant #1742110 entitled "Preparing Students for Careers in Computer Science and Math". S-STEM grants are designed to support low-income high-achieving students working on STEM degrees. For our program, support consists of scholarships and a variety of academic and co-curricular activities. Students receiving scholarships and participating in program activities will be referred to as CS/M Scholars. This current project will run from 2018 to 2023 and builds on the successes and experiences of a previous S-STEM grant at the same institution (#1060473) that was awarded to the PI and one co-PI in 2011, and also focused on students majoring in computer science or math. The previous project was presented at ASEE in 2016 [1].

The project team, all of whom are authors of this paper, includes a math professor (Hartenstine), a computer science professor (Fizzano), the host institution's College of Science and Engineering's STEM Outreach and Inclusion Specialist (Barber DeGraaff), as well as an educational researcher (Brobst) and a project evaluator external to the host institution (Litzler).

First, we will discuss program activities which include: recruiting, first-year seminars, events aimed at developing professional growth, near-peer mentoring, and advising. Next we detail the research methodology and results which are focused on understanding how the program activities contribute to a student's self-efficacy, identity, and sense of belonging (SEIB) as well as the effect that exposure to CS early in their college career has on a student's academic and career pathway. Preliminary research findings indicate that CS/M Scholars show greater gains than a group of matched comparison students during their first year on several factors related to self-efficacy and sense of belonging in computer science, and that experiences in the seminar courses are tied closely to these gains. The mentoring component of the program, on the other hand, seems to have had an outsized influence on students' developing sense of identity related to computer science and/or mathematics careers.

Many program activities of the current program, including the first-year seminars, advising and regular professional development events, were also part of the previous program. The mentoring aspect was designed for the current project and involves recent alumni, including some people who were supported by the first grant. Furthermore, experience with the first program led directly to the main research questions of the current program.

The previous project was a success in that talented, low-income students were recruited and retained, and most graduates are working in CS/M fields. However, the reasons for that success were not formally investigated. The current project seeks to understand how aspects of the program affect important psychological and emotional factors that contribute to retention and

success in STEM. Specifically, "how, and to what extent, do the program features contribute to the development of self-efficacy, CS/M identity, and sense of belonging?" As discussed below, current research efforts are focusing on the effects of the seminars and the mentoring aspect of the program.

The second main research theme of the project is the effect of early CS exposure (coursework and career awareness in freshman year) on computer science and math majors. For CS/M Scholars, the early exposure to CS consists of the first-quarter CS seminar, a first course in programming the following quarter, and program events where career opportunities in CS are discussed. Because many incoming freshmen have limited knowledge of CS, early CS exposure may attract such students to CS. Evidence from our previous S-STEM project indicates that early CS exposure also positively impacted math majors: many minored in CS or took more CS courses than required; many opted for a BS in Applied Math or chose upper-division electives with a computational or applied focus. Our hypothesis is that early CS exposure improves the experience of math majors by expanding their awareness of career options and by developing skills that enhance their conceptual understanding and problem-solving capabilities.

Recruitment

Our recruitment plan has three stages.

First, we invite students to apply to the CS/M Scholars Program. The invitees have already applied to our university, have demonstrated an interest in majoring in computer science or mathematics and have shown academic potential. We determine a student's academic interest based on their self-identified interest during the college recruiting process. We initially determine a student's academic potential by using a combination of high school GPA and SAT or ACT scores and considering whether they pushed themselves to take advanced classes in high school and/or community college. We use other determinants of academic potential later in the process. We work hard to have our initial invitations be broad so as to create a diverse cohort. Each student who is invited is requested to fill out a short online application. The application questions help us ensure the student is still interested in mathematics or computer science and more importantly the application gives them the opportunity to talk about the qualities they have that are not reflected in quantitative measures like SAT scores or high school GPA.

Next, we review the applications and look for other signs of academic potential and leadership. To us, leadership potential is signaled by significant participation in a student organization or a sports team or a volunteer effort. Admittedly, this is not simple to determine, but generally, we are looking for signs of initiative, growth mindset, and working effectively on a team as we read the applications.

Finally, after the application stage we make a short list and interview those selected applicants. Most of these interviews are done on a campus visit day for prospective students. This interview is not designed to determine if the applicants deeply understand math or computer science topics (we explicitly tell them that coursework in computer science is not required). Instead, we use the interview to follow up on things they talked about in their application (e.g. to determine what they learned from a volunteer effort they mentioned). We also use the interview as an opportunity to "sell" them on the program. The project team does this a bit themselves but perhaps the most effective sales pitch comes from current CS/M Scholars who hold a welcome session that students and their families can drop in on prior to the actual interview. Once all interviews are concluded we consider financial need of the students, our scholarship budget, and our recruitment targets and make formal offers.

While the interview is a crucial part of recruiting, our goal at this stage is not to interview a large pool but to confirm via a personal discussion that those selected are strong candidates and that they understand the program. A very large majority of students interviewed are offered the opportunity to be a part of the program. Not all students who receive offers accept them however; offers are made before some students finalize decisions about where they will attend college. All students who have declined scholarships decided not to attend the institution.

In the spring before the program began, current computer science and math majors entering their second or third years were recruited to be CS/M Scholars. This way, the community would not consist solely of first-year students at the beginning. Computer science and math faculty were asked to recommend students for the program. These students were then encouraged to apply and finalists were interviewed by three members of the project team. Students were selected on the basis of their academic promise, their progress toward their degrees, leadership interest and potential, and their likelihood of benefitting from and contributing to the community of CS/M Scholars. Several of the students selected had been supported by the previous S-STEM grant.

Each year, our recruitment numbers have been in line with our goals.

A total of 45 students are now or have been CS/M Scholars in the current program. 33 of them have received scholarships supported by the NSF grant. The remaining students were not eligible to receive scholarships from NSF, but participate in all other program activities. They were supported by smaller scholarships provided by private donors. Expanding the program to students who don't meet the NSF's eligibility criteria allows us to increase the diversity and the overall size of the cohorts, broadening the program's impact.

CS/M Scholars have been retained at a high rate. Out of 45 CS/M Scholars, three have left the university for personal reasons and one changed to a non-STEM major. Thus, there are currently

41 CS/M Scholars. These retention rates exceed our goals for the project. The first CS/M Scholars are on track to graduate this academic year.

Of the 45 current or former CS/M Scholars, 30 are female, and 17 identify as non-white. Of the 33 CS/M Scholars who are now receiving or previously received NSF scholarships, 21 are female and 7 are non-white.

Of the 41 current CS/M Scholars, 15 are majoring or intend to major in math, and 26 are majoring or intend to major in computer science. All CS/M Scholars have a cumulative GPA of at least 3.0 and are making progress toward completing degrees in computer science or math within four years.

Seminars

The two members of the project team who are professors in mathematics and computer science each teach a seminar course to the incoming class of CS/M Scholars in their first term. We arrange the seminars so that the computer science seminar takes place on Monday, Wednesday and Friday at a given time and the math seminar takes place on Tuesday and Thursday at the same time. This makes it easier for the students to schedule other classes since the two seminars can effectively be treated as a single course that meets five days a week.

Several other incoming first-year students who are not CS/M Scholars are also invited to participate in the seminars but we never exceed a class size of twenty. By inviting non-CS/M Scholars to the seminars we broaden the impact of the program. Moreover, these students can serve as excellent replacements if current CS/M Scholars leave the program — their participation in the seminars provides an established connection to several CS/M Scholars and the two members of the project team who taught the seminars, which helps ease their transition into the program.

The big picture objectives of both seminars are to form a learning community and help students improve their problem solving skills and their communication ability. Neither course is a typical introductory course in calculus or computer programming. Instead, their aim is to expose students to big picture topics in the field in a way that is accessible to students without prior experience in those topics. The goal of seminars does not include mastery of the techniques and theory of a particular subject. There are no exams. Instead, students work on projects individually or in small groups, present their work in class regularly, and prepare written reports.

One of the goals of the CS seminar in particular is to demystify technology. Students today are exposed to so much technology and many feel that they should know more than they know to be able to study computer science in college. We address this by explicitly asking the students on

day one of the CS Seminar “What mystifies/excites/concerns you about technology today?” and then we build the syllabus around their replies. This is part of providing an early exposure to computer science and because seminar topics are tailored to the cohort specifically it serves to reassure them that any concerns they have regarding their lack of prior CS knowledge is on par with many others in the class and is perfectly acceptable.

While many CS/M Scholars do not have prior CS experience, they have all taken math courses since elementary school, typically completing at least pre-calculus in high school. All incoming CS/M Scholars take another math class in addition to the seminar during their first term; these range from college algebra or pre-calculus to multivariable calculus or linear algebra. Topics in the seminar course are selected to engage and challenge students at all levels while being accessible to students with less background. The math seminar course provides a mathematical experience that is quite a bit different from their other math classes and aims to show students that math includes much more than the linear progression that leads them to calculus.

The table below shows topics that have been part of past seminars.

Math seminar topics have included:	Computer Science seminar topics have included:
● Graph theory ● Cryptography ● Fair division ● Discrete dynamics ● Game theory	● Data representation, data compression, networking, error correction ● Machine learning ● Security, privacy, surveillance ● Human-computer interfaces, AR/VR ● Ethics

Events

Throughout the academic year we hold regular events (at least 6 per year) focused on fostering professional growth (in a very general sense) of the CS/M Scholars.
The goals of the events are to:

- Assist students with career preparation
- Connect students from different cohorts
- Form deeper connections among student mentees/mentors
- Introduce students to successful alumni and industry partners

Past event topics have included:

- How to give a good presentation
- Implicit bias
- How to combat stereotypes
- How/why to participate in internships, academic competitions, clubs, research
- How to apply for internships, jobs, graduate school, REU programs

- "Jobs of the Future: What do CS and Math Majors Need to Know?", panel discussion moderated by one of the project's industry partners

We have found that many students are intimidated by the prospect of applying for internships, fellowships, scholarships, and research experiences. Thus, we focus on this topic regularly in various forms. Since the events are attended by first-year students to seniors we try to have aspects of each event address different experience levels. Related to internships and jobs, there are many tasks that even first-year students can engage in like creating a LinkedIn profile and applying for scholarships or internships aimed at first-year students (which they may not even be aware exist). We also try to have current students or recent alumni talk about their successes during these events as a way to help provide encouragement to younger students. Encouraging the students early in their academic career prepares them slowly but surely to apply for and participate in more activities as time goes on.

Mentoring

We designed a near-peer mentoring program [2] [3] to foster the professional growth of CS/M Scholars. In our program, a near-peer mentor is one to four years ahead of the mentee on a similar academic/career pathway. In the following paragraphs we discuss the participants, the mentoring teams, and the structure of the actual mentoring conversations that take place.

All current CS/M Scholars participate in the program. We also invite recent alumni from Math and CS who are typically one to three years past graduation to participate as Early Career Professional Mentors (ECPMs). We form teams of three people each. Specifically each team includes: (1) an ECPM (2) a junior or senior CS/M Scholar and (3) a first-year or sophomore CS/M Scholar. This team functions as two pairs - the ECPM is the mentor to the junior/senior student, while that junior/senior student serves as the mentor to the first-year/sophomore student. Note that each junior/senior student is part of two pairings, one as a mentee and one as a mentor. We hope that having a junior/senior student serve as a mentor helps them develop confidence in their ability to be a professional and future leader. Further, we hope that the perspective and experience of the ECPMs is passed along to the first- and second-year students through their student mentors.

We invite ECPMs to participate because we feel they possess qualities for being excellent mentors. Specifically, we believe they are mature, successful, and interested in being a role model. Moreover, we believe they have strong communication skills, self-awareness, and the ability to empathize. Most ECPMs are employed in local industry while a few are in graduate school. We picked people from a variety of career paths (e.g. software engineer, actuary, consultant, data scientist, teacher, research scientist) which helps us demonstrate the vast array of career possibilities. Recruiting ECPMs has been easy; the overwhelming majority of alumni

invited to participate have agreed to contribute to the program in this way. We hope that ECPMs participate in this role for one to three years. After that time, the gap in age and experience may make it harder for the student and ECPM to connect.

We emphasize to the mentors and mentees that there are many forms of support that people will get in their college career (e.g. academic advising, tutoring, counseling) and mentors in this program are not meant to help with everything. Specifically, we tell all participants that we would like mentors in the program to help with goal setting, act as a role model, offer encouragement and emotional support, share career advice, and provide honest feedback. Mentors are encouraged to alert the project leadership team if something comes up which they feel is outside of this scope and deserves attention.

We begin each year with a semi-structured meet-and-greet. We use this meeting to discuss the mentoring program, articulate the goals of the program, address some concerns that arose from the last year, and answer questions. There is also ample time for the mentors and mentees to get to know each other a bit since this will be the first time that many of them have ever met. We created this meet-and-greet event as a response to the feedback we heard in the first year where all mentoring conversations between students and ECPMs occurred virtually. Most mentoring conversations with ECPMs still occur virtually since most are located in Seattle which is 90 minutes away but this meet-and-greet allows them to initiate the relationship face-to-face which they believe will help them form a stronger connection. The effect that this meet-and-greet event has on the strength of the mentor relationships will be addressed in a future focus group by our program evaluator but it seems to have been well-received this year based on informal conversations with students and ECPMs.

About once a month during the school year, we provide "prompts" for the mentor conversations which we suggest should last 20-30 minutes. Here are some examples of the prompts we have given:

- Discuss extracurricular activities that have contributed to your professional growth
- Mentors should share a positive mentoring experience they have had
- Talk about a time when you made a connection with someone who was different than you
- What made you a successful student or a successful employee
- Talk about stereotypes of math or CS students and how they have affected you

These prompts are meant to initiate conversation, but not dictate the exact topic. We know that each mentor will have different strengths and each mentee will have unique questions. We feel that these prompts serve as a way to get the conversation started on the topic at hand but not be so restrictive that the conversations can't be tailored.

Once the prompt is announced we ask the mentee in each pairing to reach out and schedule a time for a conversation. This responsibility helps the mentees develop professional skills related to communication and time management. If the conversation is between two students then we ask they do it in person on campus (at a coffee shop or over lunch), whereas we expect the conversations with the ECPMs to happen over a video chat since most of the mentors are over an hour from campus.

After the conversation we ask the mentee in each pairing to write up a short 100 word summary of the conversation and submit it to us. The point of the summary is twofold. First, it allows us to monitor progress - we want to know if the conversations are taking place by the deadline we provide. Second, we want to know what they discussed at a high level which helps us formulate subsequent prompts for mentoring conversations and topics for monthly events.

The evaluation feedback from the first year of the program was overwhelmingly positive. Mentors felt they provided academic and career advice; they felt that they provided emotional support and a positive role model for students; and they felt the time commitment was not a burden (in fact most felt they should have more frequent contact!). Mentees who were first-year students said they appreciated advice on navigating institutional processes and liked practicing professional communication skills. Mentees who were juniors or seniors liked getting reassurance from ECPMs about their goals and career path.

The constructive feedback we got from the first year of the program via our external evaluator could be summed up in a few key points: some felt the prompts were too restrictive; some felt they wanted more regular contact; some felt that the summaries were a burden. This feedback helped us articulate clearer goals at the meet-and-greet this past academic year. We were thrilled that people felt they had the bandwidth for more frequent contact and felt they had topics to discuss beyond the prompts. Thus, we now encourage mentors to reach out from time to time to check in with their mentee and have some unstructured conversations. We also try to clarify the purpose of the summary so that it doesn't feel like an onerous homework assignment.

We plan to focus on continuous improvement of the mentoring aspect of the CS/M Scholars Program. We will continue to solicit feedback and work to make the logistics of the topic announcement, conversation scheduling and summary submission more efficient. We will also recruit more recent alumni as ECPMs to replace those currently serving. We would also like to find ways to continue to involve former ECPMs in the program and in the departments more generally.

Advising

All CS/M Scholars who participate in the first-year seminars receive academic advising from the math and CS professors on the project team starting in the summer before matriculation.

Additional early advising occurs during a CS/M Scholar's first quarter when selecting classes for the rest of the year. This academic advising then continues throughout a CS/M Scholar's time at the university. Many Scholars prepare a four-year graduation plan during their first year. Typically a CS/M Scholar's official academic advisor is the math or CS professor on the project team.

Research Study Design and Findings So Far

The educational research study was designed based on the perspective that broadening participation in STEM higher education requires that students from traditionally underrepresented backgrounds (women, racial/ethnic minorities, students from families of low socioeconomic status) be adequately and appropriately supported throughout their studies, both academically and in terms of affective factors like self-efficacy [4], identity [5] [6], and sense of belonging [7] (Recall we use SEIB as an abbreviation for these three factors). This perspective, and the corresponding measures described below, are grounded in social cognitive career theory [8] [9] and expectancy-value achievement models [10]. Specifically, undergraduate students' decisions to persist in STEM studies (and, ultimately, enter STEM careers) are believed to be influenced by their patterns of career interests and the value that they place upon STEM-specific academic and career outcomes, with SEIB factors playing a key role in moderating these interests and values [11].

As the CS/M Scholars program began to unfold, it became increasingly apparent that the mentoring-related co-curricular aspects of the program were influencing students in important ways that likely connect to their developing SEIB related to computer science and mathematics. Thus, the scope of the research study was expanded to examine the nature of the mentoring program in greater depth, with particular attention paid to the types of interactions evident in mentor-mentee conversations. Two frameworks were applied to these analyses: mentoring stances as described in Lipton and Wellman [12] and instrumental vs. socioemotional approaches to mentoring as described in Robnett, Nelson, Zurbriggen, Crosby, and Chemers [13]. Lipton and Wellman's work is primarily grounded in mentoring of beginning teachers and describes three stances commonly observed in mentoring conversations: consulting, collaborating, and coaching. Consulting includes mentors sharing information, advice, resources, and standards for professional practice; collaborating includes mentor and mentee co-development of information, ideas, and approaches to problems; coaching includes mentors supporting mentees' idea production, ability to reflect, and ability to self-coach and become a self-directed learner [12]. Robnett et al. [13] describe how, in research mentoring relationships, undergraduates' developing identity as scientists can be positively influenced by both instrumental (task, skill, and/or resource-focused) and socioemotional mentoring.

With these theoretical perspectives as a background, the two research questions that drove the research study were as follows:

1) How and to what extent do the program features contribute to the development of self-efficacy, CS/M identity, and sense of belonging?
2) How does early exposure to computer science through coursework and career awareness affect the experience of CS/M Scholars?

The main program features of interest were the early exposure to computer science (consisting of the CS seminar course and a subsequent traditional Programming I course), math seminar course, and the mentoring program. Findings explore the connections evident among the seminars, Programming I course, mentoring program, and Scholars' SEIB, with consideration of the roles played by particular mentoring stances as well as instrumental and socioemotional mentoring approaches.

Data Sources and Sample

The initial design of the educational research study included two data sources: an online survey completed by the CS/M Scholars and a group of Comparison students, and focus group interviews conducted with CS/M Scholars only. The sample for the survey data analyzed up to this point has consisted of Scholars and a matched comparison group who began their undergraduate studies in the fall of 2018. We created a pool of potential Comparison students using admissions data, including individuals who had either applied to be Scholars and were not selected or who could have qualified to be selected as Scholars but did not apply to the program. Pre-surveys were administered early in the fall academic quarter of 2018, and post-surveys toward the end of the spring academic quarter of 2019. Scholars were encouraged to participate in the research study but not required to do so as part of the program. Scholars and Comparison students were offered a small incentive (entry into a gift card raffle) to elicit participation. Institutional Review Boards at both the primary institution and the educational researcher's institution approved the educational research study and gave it an exempt determination.

Survey items were adapted from the following previously validated instruments: the STEM Career Interest Survey [14], and the Engineering Student Identity Scale [15]. Adapted items were designed to assess students' self-efficacy, identity, and sense of belonging specific to computer science and mathematics respectively. Additional variables including outcome expectations for computer science and mathematics careers were calculated using sub scales from the adapted instruments, according to the factor structures described in the corresponding validation studies cited above. All items were rated on a 5-point Likert-style scale.

The focus group interview protocol was co-developed by the researcher and evaluator and reviewed by program faculty. It included prompts related to student satisfaction with program components as well as items probing students' perceptions of ways that program activities had

influenced their developing SEIB. The project evaluator conducted four focus groups with a total of 21 participants: 9 first-year Scholars and 12 upper-division Scholars.

Analyses

Mean scores were calculated for each of the SEIB-related composite variables, for Scholars (n = 10) and Comparison students (n = 6), on both the pre- and post-surveys. Due to the small sample that have completed surveys up to this point, the range of quantitative analyses that could be conducted was fairly limited. We opted to perform a simple difference-in-difference (DID) calculation to examine how the mean scores of Scholars changed versus how mean scores of Comparison students changed over a single academic year.

Table 1. Coding Matrix for CS/M Scholars Year 1 Focus Groups. Each cell contains the number of words coded for that topic. Colors represent frequency (darker red means more frequent).

Coding Overlaps	Belonging	Identity	Self-efficacy
Seminar Course	**1974**	**1712**	**1983**
Programming I Course	**188**	**154**	**130**
Mentoring - Total	**1300**	**2575**	**1257**
Coaching Stance	**834**	**1285**	**1083**
Collaborating Stance	**18**	**18**	**0**
Consulting Stance	**457**	**790**	**354**

Focus group data were audio recorded, transcribed verbatim, and imported into QSR NVivo 12 software. The educational researcher coded transcripts first by program activity (i.e. seminar courses, mentoring interactions), then by SEIB constructs. Codes were not mutually exclusive, allowing for overlap and interplay among SEIB factors. Of primary interest were the intersections between program activity codes and codes for different aspects of students' SEIB. An additional round of coding explored how SEIB factors intersected with the apparent mentoring stances present in mentoring conversations based on the Scholars' descriptions of the conversations. Ultimately, a matrix coding query was applied in NVivo to quantify the amount of focus group discussion (number of words coded) that took place at each of these intersections of interest. See full results in Table 1 above.

Findings

Based on the first set of survey data, the Scholars outgained Comparison students on the overall computer science career interest scale (DID = 0.39). These gains were driven primarily by gains on sub-factors related to computer science outcome expectancy (DID = 0.86), contextual support (DID = 0.54), and self- efficacy (DID = 0.38). Additionally, Scholars outgained the comparison group on belonging in computer science (0.73). The measures used a 5 point scale, so the largest DID value possible would be 8, in a case where one group's mean went from 1 to 5 while the other went from 5 to 1. Thus the highest DID reported here (0.86 for CS outcome expectancy) represents 10.75% of the maximum possible DID while the DID of 0.38 for CS self-efficacy represents 4.75% of the maximum.

Coding of focus group transcripts indicated that the seminar courses most influenced Scholars' belonging and self-efficacy, though identity was not far behind. In contrast, the mentoring program clearly had its strongest influence on Scholars' identity, with approximately double the amount of text coded at this intersection versus the intersection of mentoring with either belonging or self-efficacy. Scholars' focus group discussions suggested that coaching was the most common stance employed in conversations, while consulting also played a role. Collaborating was virtually absent from Scholars' descriptions of mentoring conversations. Scholars also devoted little discussion to the influence of the Programming I course on their SEIB.

The prompts provided to mentors appear to have been successful at promoting reflective mentoring conversations, as evidenced by the coaching-heavy descriptions of these conversations that Scholars gave during the focus groups. Additionally, the near-peer dynamic of mentoring pairs likely has much to do with the prevalence of coaching vs. consulting. In mentoring relationships where there is a greater imbalance in experience and/or professional status (e.g. pre-service teacher mentees with practicing teacher mentors; undergraduate research student mentees with faculty mentors), it is more common to see conversations skewed toward a consulting stance, often based on a tacit understanding that the role of the mentor is to impart knowledge and the role of the mentee to absorb it. The lack of collaborating is unsurprising, since this stance focuses largely on joint problem-solving and the CS/M Scholars mentoring program was not explicitly problem-focused.

Based on Scholars' descriptions during the focus groups, conversations with their mentors clearly included both instrumental and socioemotional aspects. This appeared to be mediated to some extent by the type of mentoring pairing (i.e. two undergraduate students vs. one undergraduate student and an ECPM) and the level of alignment between mentor and mentee goals and interests. Specifically, mentoring conversations appeared more likely to take on an

instrumental focus when mentors were ECPMs and/or had career aspirations similar to those of their mentee. The following quotes are representative of these findings:

Mentee, speaking of experience with an ECPM:

> *So, I want to be a data scientist after I graduate, my mentor is currently working as a data scientist…he gave really good career advice, certain coursework, what things to focus on, on my resume…internship advice, a lot of advice for really cool stuff. So, I'm very glad to have a mentor who shares my career…working as my potential career future.*

Undergraduate mentor, speaking of experience with their fellow undergraduate mentee:

> *Like we're both undergraduate students, me and my mentee, it's less about I have all this wisdom to give you, and more about I'm just someone you can talk to and express the challenges you're going through. And have some solidarity.*

Research Next Steps

The first cohort of Scholars and Comparison students will be invited to complete a final (delayed post) survey administration in the Spring of 2020. A second cohort of Scholars and Comparison students already completed a pre-survey in the fall of 2019, with their first post-survey also planned for spring of 2020. These and additional cohorts in the remaining grant years will add to our sample and allow us to see if the trends in student SEIB observed up to this point continue.

Since student focus group data suggested the mentoring experiences had such a strong influence on Scholars' development, particularly related to identity, we have already extended the research study to include additional data: transcripts from ECPM focus groups, and the summaries submitted by Scholars after conversations with their mentors. Moving forward, the research study will examine these data from the first and future cohorts, along with additional Scholar focus group data to more fully explore and triangulate observed connections among mentoring experiences and Scholars' SEIB.

Disclaimer

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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