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Positive Impact of an S-STEM Scholarship Program on Computer Science Students' Academic Performance and Retention Rate

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Positive Impact of a S-STEM Scholarship Program on Computer Science Students' Academic Performance and Retention Rate

Abstract:

In this paper, we present a progress report from the first three years of a five-year project supported by NSF Scholarships in Science, Technology, Engineering, and Mathematics Program (S-STEM). The number of graduates with computing-related degrees from colleges and universities, especially female and underrepresented minorities, is too small to keep up with the fast-growing demand for IT professionals across the nation and Tennessee specifically. To reduce the gap in Tennessee, Middle Tennessee State University launched a 5-year S-STEM Scholarship program in 2018 to recruit and graduate more computer science students, especially students who are underrepresented in computing. The scholarship program supports about 20 qualified students eligible for Pell grants every year. Each scholarship recipient receives an annual stipend of up to $6000 for no more than three years. In order to increase their interest in computer science and to improve retention of CS majors, a pipeline of well-proven activities was integrated into the program to inspire exploration of the CS discipline and computing careers at an early stage and help students gain work experience before graduation. These activities include, but are not limited to: a summer research program that provides opportunities for students to conduct research in different computer science areas, a peer-mentoring program that promotes career preparation, and professional conference attendance program that sends students to professional conferences to explore computer science careers and build their own networks. The preliminary data suggest that these activities had a positive effect on our students. We find that the financial support allows students to focus on both academics and searching for computing-related employment. Early analysis of institutional data shows that scholars take more CS credit hours and achieve a higher GPA than other Pell-eligible and non-Pell eligible students, thus making faster progress toward their degree. The support to attend in-person conferences and summer research opportunities had a transformative impact on many participating scholars. The original mentoring program was less effective and has been redesigned to include higher expectations for mentors and mentees and increased faculty involvement. This paper will describe the program elements and explain the effects of these activities on our students with preliminary outcome data and formative evaluation results about the program.

1 Introduction

According to the 2020 report "STEM and the American Workforce" [1], STEM supports 67% of U.S. jobs and 69% of the Nation's GDP. Computer occupations play a critical role in STEM. The U.S. Bureau of Labor Statistics projected that about 600,000 or 67% of all new jobs in STEM between 2018 and 2028 would be in computing. Average annual openings in computer occupations during the decade were projected to be about 450,000 [2]. Although the number of students who graduated with a bachelor's degree in computer and information sciences in 2016 was more than 70,000 (almost double that of 2008 [3]), that number is still far too small to satisfy the projected need.

The state of Tennessee experiences the same shortage of computing professionals as the nation. The Tennessee Department of Labor and Workforce Development studied real-time job listings and active candidates for STEM occupations for the first quarter of 2019. This study resulted in a list of the top 20 STEM occupations with the greatest shortages of candidates, and almost half of them are in computer occupations [4]. The average projected annual openings in IT-related fields between 2016 and 2026 is about 1185 in the Middle Tennessee area alone [5]. However, the number of students graduating from area colleges and universities with a bachelor's degree in computer and information science in 2017 was only 235 [3].

The shortage of IT professionals is at a crisis stage. In order to graduate more qualified IT professionals, in January 2018 we launched a National Science Foundation S-STEM Scholarship program. The overarching objective of this program is to graduate more computer science (CS) majors by recruiting low-income, academically talented CS students, especially from underrepresented groups, and providing academic and non-academic support to help them succeed in our CS program. A pipeline of activities is designed to inspire exploration of the CS discipline and computing careers at an early stage and provide help to gain research or professional experience before graduation. This paper describes the program elements and reports our preliminary evaluation results and outcome data about the program.

In this paper, the term "underrepresented students" (URS) is defined as students who are either female or males who come from the following underrepresented populations in CS: Hispanic/Latinos, African Americans, Native Americans, or Native Hawaiian/Pacific Islanders.

2 Program Design

The program is designed to support MTSU CS majors whether they entered directly from high school, transferred from another institution, or switched from another major later in their academic careers. Our department requires successful completion of 44 CS credit hours. As we were designing the program, we divided the CS majors into 5 levels based on the number of earned CS credits:

- CS level 0 – Students at this level begin the academic year with 0 CS credit hours. They are typically incoming first-year or current students who need to take prerequisite math courses first.
- CS level 1– Students at this level begin the academic year with fewer than 8 CS credit hours. They are typically students who have not yet completed both CS 1 and CS 2, which have the highest failure rate among all computer science courses. Students at this level have a varied background, ranging from incoming first-year and transfer students to seniors who have just declared computer science as their major.
- CS level 2 – ($8 \leq$ CS credit hours < 22). Students at this level have completed CS1 and CS 2 successfully and are taking other required core courses, including CS 3.

- CS level 3 – (22 ≤ CS credit hours < 32) and CS level 4 (≥ 32 CS credit hours). Students at these two levels have completed CS 3 and other low level required core courses successfully and are able to take elective courses based on their own interests.

The S-STEM program primarily targets recruitment and retention efforts to CS level 0, 1, and 2 students because university data showed that most attrition from our majors was happening at these levels.

Each year, the program expects to award scholarships to 20 low-income, academically talented US citizens or nationals who are computer science majors at our university. Each scholarship recipient who meets academic standards and remains a CS major will be continually supported until they reach CS level 3, but for no more than 3 years. Over the lifetime of the project, we expect to award scholarships to at least 60 distinct students. Each scholarship recipient may receive up to $6000 per year for their first two years and $3000 for their third year, but no more than their actual financial need. Scholars in 3rd year receive a lower stipend because we want to encourage them and provide assistance to them to apply for internships or part-time jobs in a computing-related field. Additionally, scholars can participate in our summer research program or peer-mentoring program to receive extra compensation.

To be eligible for a scholarship, a student must (1) be a US citizen or national, (2) be a full-time student, (3) be eligible to receive a Pell Grant[1], (4) be a CS major with no more than 32 CS credit hours, (5) have a GPA of 2.50 out of 4 or higher in CS courses taken at MTSU, or have a math ACT subscore ≥ 22 if no CS courses have been taken at MTSU. Meeting the first three requirements is a condition of NSF funding for the program. Continuing students who maintain their eligibility are funded in succeeding years and all new eligible applicants have an equal chance to receive the scholarship for the remaining positions.

To recruit students, especially URSs, we reached out to local community colleges, high schools with the largest population of underrepresented students, our home college, and our department's academic advisors. Program flyers were sent to academic advisors at each institution, and the department academic advisors also took flyers on university recruiting trips. Additionally, to attempt to reach as many of the target population as possible, project team members recruited from lower division courses in the department.

The program integrates three well-proven participant support components to inspire the exploration of the CS discipline and computing careers at early stage. These components also help participants build a support network, gain research or professional experience before graduation, and help the department improve retention rates.

[1] Federal Pell Grants, the largest source of federally funded grants reserved for undergraduate students, are awarded solely based on financial need without considering academic grades and extra-curricular activities. The money received from Federal Pell Grants does not need to be paid back.

The first component is peer mentoring, which has been reported to be an effective approach to recruit and retain students [6], [7], [8] as well as improve academic performance [9], [10]. Our peer-mentoring program focuses on providing assistance and guidance to help students better prepare for computing careers. The peer-mentoring program leverages experience and expertise of the group of CS majors who work in the computing field by assigning them as mentors for scholarship recipients.

The second component is to involve students in undergraduate research, which is one of five high-impact practices found by Brownell and Lynn to improve engagement and retention in college students [10]. We support 10 students to participate in summer research each year and encourage our Scholars to seek summer research opportunities in other schools.

The third component provides funding for up to 10 students each year to attend professional conferences such as The Richard Tapia Celebration of Diversity in Computing, The Grace Hopper Celebration of Women in Computing, and other conferences that students have expressed interest in. Attending a professional conference is an effective approach to recruit and retain students, particularly URSs in computing majors [11], [12].

In the rest of the paper, we share how the three components of the scholarship program work and how students have responded to them. We also discuss the retention and academic outcomes observed from the program.

3 Recruitment

One goal of our project is to increase the number of underrepresented students in our computer science program and improve their retention with the support of the S-STEM scholarship program. We focus our recruiting in three primary areas: current lower level students who have a potential to be successful in our program, transfer students from area community colleges, and high school seniors.

To reach out to our lower level students, we gave the scholarship flyers to students in our CS 1 courses as well as students in pre-calculus and calculus I courses. We built connections with faculty of computer science programs in area community colleges so that scholarship information could be offered to their students. To recruit high school seniors, especially URSs, we took several steps: First, our department academic advisors frequently participated in university recruiting events and gave the information about the scholarship program to students who expressed interest in computer science. Second, we identified a group of major feeder high schools to MTSU that have a large population of URSs, and established connections with their counselors. Third, every year the MTSU College of Basic and Applied Sciences sends to the CS department lists of high school students who have expressed interest in computer science. We piggybacked on the department welcome package to these students and notified them about the scholarship program.

While one of our goals is to increase the percentage of underrepresented students in our undergraduate program, The National Science Foundation, the agency supporting the S-STEM Scholarship Program, requires that all eligible applicants to the scholarship program have an equal chance to receive the financial support. Our S-STEM Scholarship Program is open to all CS majors who meet eligibility guidelines. Therefore, the only way to meet this goal and NSF requirement is to make sure the percentage of underrepresented applicants is higher than that in our undergraduate program overall. Then, random selection of awardees should yield a higher percentage of URSs than are present in our department overall and ultimately increase the percentage of underrepresented students in our department. In addition to notifying all CS majors about the scholarship program, we identified eligible URSs and invited them to an in-person meeting to encourage them to apply for the scholarship in order to increase the pool of underrepresented applicants to the program.

Each April, all applicants were randomly ranked to meet the NSF requirement that all eligible applicants have an equal opportunity to receive the scholarship. Because financial need for high school applicants was determined in early April, those who were determined to be eligible for a Pell grant and who ranked high enough on the generated list were notified of their awards in order to encourage them to choose to attend MTSU and declare a CS major. Transfer and current student applicants were notified as soon as their actual financial need from our financial aid office became available in early June.

Our recruitment strategy worked very well. Table 1 shows the data for applicants in the first three years of the program. On average, there are 51 applicants each year. Among these 51 students, twenty (about 39%) are underrepresented students, which is much higher than the percentage of underrepresented students in the department – 29% (16% female, 9% African American male and 4% Hispanic male as shown in Table 2). Among the first three years, the second year saw a smaller number of underrepresented applicants and a higher number of incoming first-year students. This was caused by the unexpected and dramatic reduction in financial need of existing scholars and applicants as well as missing financial documents. We expected to have 5 openings in the second year, but eventually had 12 and only 7 out of 30 applicants we had received at that time were eligible to receive the scholarship. We had to recruit more students during July by targeting incoming students at the university's new-student orientation program. After taking steps to handle such changes in the third year, the data came back similar to the first year.

Table 2 shows the demographics of CS majors at fall 2018 and scholars supported by our S-STEM scholarship program in each academic year. As of fall 2018, the department had about 29% underrepresented students who were female, Black, or Hispanic. The percentages of URS scholars in first 3 years are 50%, 40%, and 55%, which, on average, is about 70% higher than the percentage of underrepresented students in the department. Among the 50 unique scholars we supported in the first three years, 11 were first-year students, three were transfer students, and the rest were current CS majors at MTSU.

Table 1: Scholarship Applicants in First Three Years

	2018	2019	2020	3 Year Avg.
Total	56	44	53	51
URSs	26	13	21	20
non-URS male	30	31	32	31
Pell Eligible	45	28	28	39
Non-Pell Eligible	11	8	18	12
Missing documents	0	8	7	5
Incoming First-Year	11	16	8	12
Incoming Transfer Students	0	2	7	3
Non-CS majors	0	2	3	2

Table 2: Demographics of Majors and Scholars

	All Majors		**Scholars**					
	Fall 2018		2018-2019		2019-2020		2020-2021	
	#	%	#	%	#	%	#	%
Female	78	16%	6	30%	4	20%	5	21%
Asian	16	3.2%	0		0		2	8.3%
Black	12	2.4%	1	5%	1	5%	0	
Hispanic	7	1.4%	2	10%	2	10%	1	4.1%
White	42	8.4%	3	15%	1	5%	2	8.3%
Others	1		0		0		0	
Male	421	84%	14	70%	16	80%	19	79%
Asian	49	10%	2	10%	2	10%	3	13%
Black	44	9%	2	10%	1	5%	4	17%
Hispanic	21	4%	2	10%	3	15%	4	17%
White	286	57%	8	40%	10	50%	8	33%
Others	21	4%	0		0		0	
Total	499		20		20		24	

4 Scholarship Program Components

The scholarship program integrates three well proven participant support components to inspire the exploration of the CS discipline and computing careers at early stage – peer mentoring, research participation, and conference attendance. This section will discuss each component in detail. Information and documents about these components are available at our project website: www.cs.mtsu.edu/~s-stem.

4.1 Peer Mentoring

Peer mentoring has been proven to be an effective approach among different disciplines to promote student success. Successful stories of peer mentoring in STEM fields have been

reported across the nation to engage first-year students [13], to improve academic performance on a specific course or topic [9], [10], to involve students in research [14], and to recruit and retain students, especially women and minorities [6], [7], [8].

A peer-to-peer mentoring program is an important part of the scholarship program. Unlike other peer mentoring programs that are structured to aid the transition of new students to university, the goal of our peer mentoring program is to better prepare scholars for future employment by leveraging the experience and expertise of CS majors who work in the computing fields. Mentors were charged with helping their mentees to network, develop career building skills, and find internship or job opportunities. They may also help their mentees navigate CS specific issues like homework and course selection and discuss school-life balance when needed.

Although current or former scholars are preferred, mentors can be any upper level CS major who either has work experience in the IT field through a part-time job/internship or is actively looking for such employment opportunities. A $200 stipend is provided to mentors at the end of each semester. The peer mentoring program was first launched in the 2019-20 academic year. Five CS majors were hired as peer mentors. Four of them were former or current scholarship recipients, and three of them had strong internship or professional part-time work experience. Each mentor was assigned three mentees. Mentors received brief training from the project PIs and they were provided with a resource handbook and supplemental documents. Mentors were expected to communicate regularly (at least every two weeks) with their mentees and encouraged to meet in person when possible. Mentors and mentees were encouraged to set up a Slack or other group chat. Mentors were required to complete monthly reports on their activities including which mentees they communicated with, the means of communication (e.g., electronic, in-person, group, individual), and the frequency with which they communicated.

Although the peer-mentoring program had positive effects on some scholars, it did not meet our expectations. Based on evaluation feedback from mentors and mentees and our observation, we reorganized the peer-mentoring program for academic year 2020-2021 by focusing on measurable goals. Peer mentors are now required to create a SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goal [15] for each mentee and develop a plan to implement that goal in the academic year. The SMART goal and plan should be completed by the end of October. Project PIs now meet with mentors to discuss the goals for their mentees to make sure it is reasonable. In addition, we survey mentors monthly to document their activities and meet with mentors once a month to gather feedback, identify potential problems, and share successful stories or tips. Based on the monthly report from peer mentors during the 2020-2021 academic year, we have observed positive changes between mentors and mentees.

4.2 Research Experience

Undergraduate research is one of the thirteen key components in the successful Meyerhoff Scholars Program at University of Maryland-Baltimore County [16], and one of five high-impact

practices to improve both engagement and retention in college students [10]. Our S-STEM scholarship program contains a summer research component which encourages lower level students in particular, to conduct summer research to pique their interests in computing and develop a clearer understanding of what studying computer science entails, with the expectation that it will improve scholars' retention in CS.

Each year, our S-STEM scholarship program recruits 10 students for summer research projects on different topics such as bioinformatics, artificial intelligence, cloud computing, and humanoid robots. Based on their preferences, a group of at least two students will be formed for each project. Each student is expected to spend about 150 hours on the project and receives a stipend of $1500. The summer research project is open to all computer science majors. We notify all CS majors about this opportunity in spring and students who are interested need to submit their applications online. The S-STEM scholarship program committee chooses 10 students based on their academic performance and fit to their choice of project. Preference will be given to Scholars, women, and underrepresented students.

Additionally, we compile a pamphlet on NSF REU (Research Experience for Undergraduate) sites in Tennessee and neighboring states. For each REU site, the pamphlet lists a short description of the site as well as benefits, deadlines, and a link to the application page. The pamphlet is updated every January and sent to Scholars and all computer science majors.

Our S-STEM program has conducted summer research projects in summer 2019 and summer 2020. In total, we supported 19 students with only one student participating in both years. Among these 19 students 10 students are URSs, which is 14 percentage points higher than the percentage of URSs in the department. Five were S-STEM Scholars.

Research participants from summer 2019 submitted two full papers and one abstract to professional conferences. One student started his honors thesis work based on his summer project, and another student was awarded a $1000 grant by MTSU URECA (Undergraduate Research Experience and Creative Activity) program to work on an extension to the summer research project during the academic year. Four participants from summer 2020 received a team URECA grant ($4000) to continue working on an extension of their summer project for the 2020-2021 academic year. While these post-summer activities were encouraging, they were performed by non-scholars and therefore may not be reflective of the potential positive impact of the summer research program on S-STEM scholars.

4.3 Conference Attendance

Sending college students, especially underrepresented students, to attend a professional conference like the Grace Hopper Celebration of Women in Computing and the Richard Tapia Celebration of Diversity in Computing has become more and more popular in last decade. Studies [11], [12], have shown that conference participation can be an effective approach to

recruit women into computer science and retain students, particularly underrepresented students in computing majors.

Conference participation is incorporated into the scholarship program with the expectation that scholars will take this opportunity to explore computing careers and build their own support networks. Our S-STEM scholarship program funds travel, lodging, and registration for 10 students per year to attend a CS-related conference of their choice. As a result, three scholars attended the 2019 Southern Data Science Conference at Atlanta GA; four scholars attended the 2019 ACM TAPIA conference in San Diego, CA, and one scholar received a travel scholarship from TAPIA conference. During the 2020 calendar year, two students had planned to attend Southern Data Science Conference in April. Because of COVID-19, all in-person conferences were cancelled for all 2020 and spring 2021, but we hope they will resume in the fall of 2021. Initially, we intended to send a faculty representative with the students. But given the number of conferences chosen and the timing these conferences, this did not work out. The lack of faculty attendance did not seem to affect the student experience – they gave very positive feedback in our evaluation as shown in section 5.

5 Evaluation of Program Elements

A multi-method evaluation plan has been created to assess the effectiveness of the program. In the spring of 2020, interviews were conducted via Zoom with 11 current and former scholars. These interviews were the primary information source about recruiting, the value of the various program elements described above, and recommendations for change. Among the 11 interviewees were three mentors and four of their mentees. Each interview lasted from 30-50 minutes and Scholars received a $25 gift card for their time. Interview transcripts were analyzed thematically around the program elements described above. In addition, recruiting was also assessed through a survey of the 2018-19 Scholars in April 2019. Of the 20 active scholars at that time, 13 responded. The mentoring program was also assessed by monthly surveys of the mentors that are administered at the end of each month asking the mentor to reflect on the activities they engaged in with their mentees during the month.

Due to the timing of the award funding, 17 of the 20 students recruited in the first year were already enrolled at MTSU. The most effective recruiting channel was through faculty who were teaching entry level courses. In the second year, seven of the 12 new scholars were first-year students. First-year students interviewed indicated that they heard about the scholarship from their guidance counselors at nearby schools, as well as through the university website and at orientation.

Monthly activity logs completed by mentors indicated a wide range of communication types and frequency. One mentor was particularly strong at communicating with mentees (e.g., group lunches (pre-COVID), regular electronic contact) while other mentors had very minimal contact with their mentees. Interviews indicated the communication, or lack thereof, was two-sided with some mentors only reaching out once a month and lacking much substance to their messages.

Similarly, mentors reported that some mentees did not show up for scheduled meetings or, in some cases, never responded to any correspondence.

Interviews also indicated that mentors did not feel they had clear guidance on how to be effective mentors or had circumstances that made it difficult to provide mentorship, such as working away from campus during the semester or not having an internship where a mentee could job-shadow them. Mentors also reported that they did not share their tools with each other and that there was a lack of collaboration among mentors.

Among the mentees, first year students found the mentorship program most useful. Some older mentees felt they did not benefit because they were too far along in their academic program for the goals of mentorship to be useful to them. For example, one mentee already had an internship and therefore, was not in need of help finding an internship or job shadowing.

Changes were made to the mentoring program in 2020-21 to reflect some of the shortcomings identified through the student interviews and monthly mentor reports. Mentors now receive more training and have more specific expectations (e.g., SMART goals described above). In addition to submitting their monthly activities, mentors are required to meet with one of the project PIs once a month to discuss obstacles they have experienced in the mentoring process and share any successful strategies and tips. Monthly reports indicate that mentors are indeed putting in more effort in communicating with their mentees, but that some mentees continue to be unresponsive. Future evaluation activities will address the mentee perspective of the program.

The summer research component served to both allow quality one-on-one interaction with project faculty as well as to introduce students to research in the computing field. As would be expected, some students became more interested in research while others became less so after the experience.

The conference component of the program was overwhelmingly positive for those who participated. They particularly appreciated the resume workshops, interview practice, and the opportunity to network at those conferences. One student decided to attend graduate school because of his experience at the Southern Data Science conference.

6 Academic Outcomes and Retention

Non-Pell eligible students are expected to have better retention and graduation rates and academic performance than Pell eligible students. Several factors may contribute to this belief. First, non-Pell eligible students face less financial pressure, which allows them to take more courses and devote more time to course work; while Pell eligible students are constantly struggling with finances, which would be expected to affect their academic performance negatively. Second, more than 50% of Pell eligible students in MTSU are first generation

students, who in general lack of knowledge about the college experience and have less support from their family.

To evaluate the effect of the scholarship on our scholars who are Pell eligible and conduct a quantitative comparison of academic performance between Pell eligible and non-Pell eligible students, we compare the academic performance and retention rate among three distinct groups of CS majors who started their first semester at MTSU after summer 2016: Scholars (i.e. S-STEM scholarship recipients), Pell eligible group (excluding scholars) and Non-Pell eligible group. To study the effect of S-STEM Scholarship program, all Scholars are grouped together separate from other Pell eligible students who present the best comparison group to measure the effects of the program.

Table 3 displays the distribution of students by level in different groups in fall 2018 and 2019. As the table shows, the ratio of Non-Pell eligible students to Pell eligible students is about 1.4 in both years. There was a similar distribution among Pell and Non-Pell eligible students across levels in each year: The largest group is Level 0, about 40% of the population, and the second largest group is Level 2, followed by Level 1, Level 3, and Level 4 in the given order. There were no students at Level 4 in fall 2018 because students who started their first semester in fall 2016 cannot reach Level 4 within 2 years. The level distribution among Scholars is slightly different. The largest group is Level 2 with 15 students, followed by 10 in Level 0, 9 in Level 3, 4 in Level 1, and one in Level 4. This is a result of selecting many Scholars from among students already enrolled at MTSU and majoring in computer science.

Table 3: Student Distribution by Level in Fall 2018 & 2019

Year	Category	Total	Level 0	Level 1	Level 2	Level 3	Level 4
2018-2019	Non-Pell Eligible	202	79 (39%)	42 (21%)	61 (30%)	20 (10%)	0 (0%)
	Pell Eligible*	143	60 (42%)	23 (16%)	50 (35%)	10 (7%)	0 (0%)
	Scholars	19**	3 (16%)	4 (21%)	8 (42%)	4 (21%)	0 (0%)
	Total	364	142 (39%)	69 (19%)	119 (33%)	34 (9%)	0 (0%)
2019-2020	Non-Pell Eligible	259	88 (34%)	54 (21%)	69 (27%)	30 (12%)	18 (7%)
	Pell Eligible*	182	78 (43%)	37 (20%)	37 (20%)	17 (9%)	13 (7%)
	Scholars	20	7 (35%)	0 (0%)	7 (35%)	5 (25%)	1 (5%)
	Total	461	173 (38%)	91 (20%)	113 (25%)	52 (11%)	32 (7%)
Both Years	Non-Pell Eligible	461	167 (36%)	96 (21%)	130 (28%)	50 (11%)	18 (4%)
	Pell Eligible*	325	138 (42%)	60 (18%)	87 (27%)	27 (8%)	13 (4%)
	Scholars	39	10 (26%)	4 (10%)	15 (38%)	9 (23%)	1 (3%)
	Total	825	315 (38%)	160 (19%)	232 (28%)	86 (10%)	32 (4%)

* Doesn't include scholars who are also Pell Eligible.

** One scholar in level 3 participated in a study abroad program during the academic year 2018-2019 and graduated in spring 2019. His data is not included in the analysis.

Figure 1 shows the average earned hours and yearly GPA during the 2018-19 and 2019-20 academic years by level in these three different groups. Hours in major courses and required math courses are considered to be earned if grades are C or above, while hours in other courses are earned if grades are D or above. Non-Pell eligible students tend to have better GPA across all levels than the Pell eligible group. They also tend to earn more credit hours in all levels with the exception of level 1. The largest gap is at level 4: students in the non-Pell eligible group earned about 7 more credit hours on average than in the Pell eligible group. From level 0 through level 3, Scholars earned more hours with better or similar GPAs compared to the other two groups. The gap of earned credit hours in level 1 and 2 is very impressive: in average, Scholars earned about 7 more credit hours than the other two groups. Such gap at level 3 is trivial because almost all scholars starting at level 3 in fall tend to graduate in the following spring. They have taken all the courses they need for graduation. There was only one scholar at level 4 who started in fall and took 3 computer science courses to graduate on December of the same year. Therefore, data about the single scholar at level 4 is not statistically meaningful.

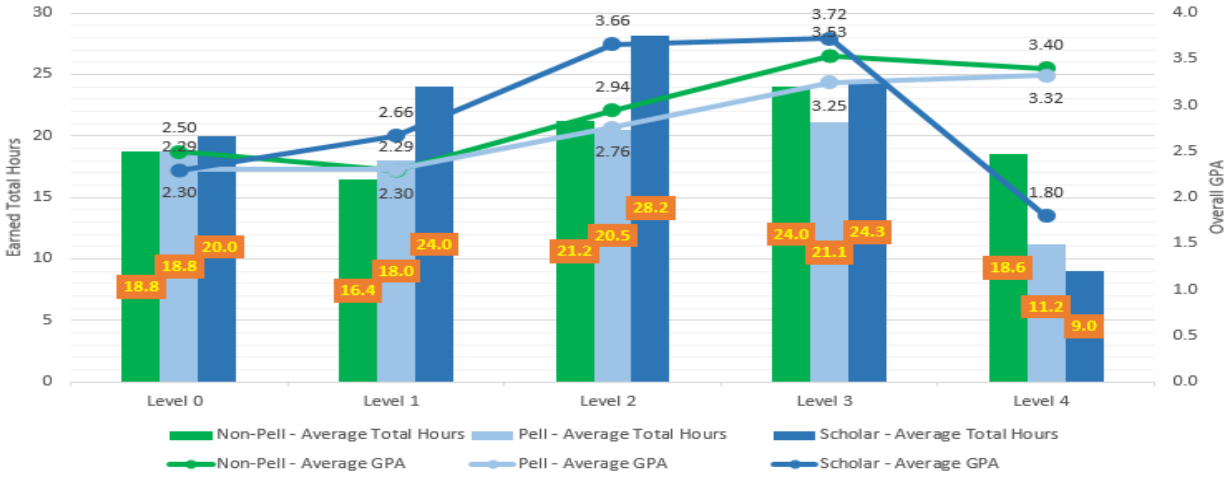

Figure 1: Earned Hours and GPA by Level

Overall, our scholars had far better academic performance than the other two groups-- they earned about 5 more credit hours per year with a higher GPA. We believe our S-STEM scholarship program played an important role in here. Our scholars faced less financial stress by receiving $3000 per semester which our evaluation data shows positively affects scholars through improved mental health, being able to take more courses, and reduced number of work hours leaving more time for academic work.

To take a closer look at the effect of the scholarship program on CS courses, we show the similar data of earned CS hours and CS GPA for the same three groups in Figure 2. Based on this figure, students at all groups tended to earn more CS hours each year as they advanced to level 3. At level 4, they took fewer CS courses because at this level, they need to take no more than 4 courses to meet major requirements. Overall, Scholars had a consistent trend to earn more CS hours at first four levels with better or similar GPAs compared to the other two groups. Non-Pell

eligible students earned more CS hours with a better GPA than the Pell eligible group at all levels with the exception of level 1. With the help of the scholarship program, Scholars tend to earn more hours with better GPA at each level and therefore will graduate and join workforce earlier than their peers.

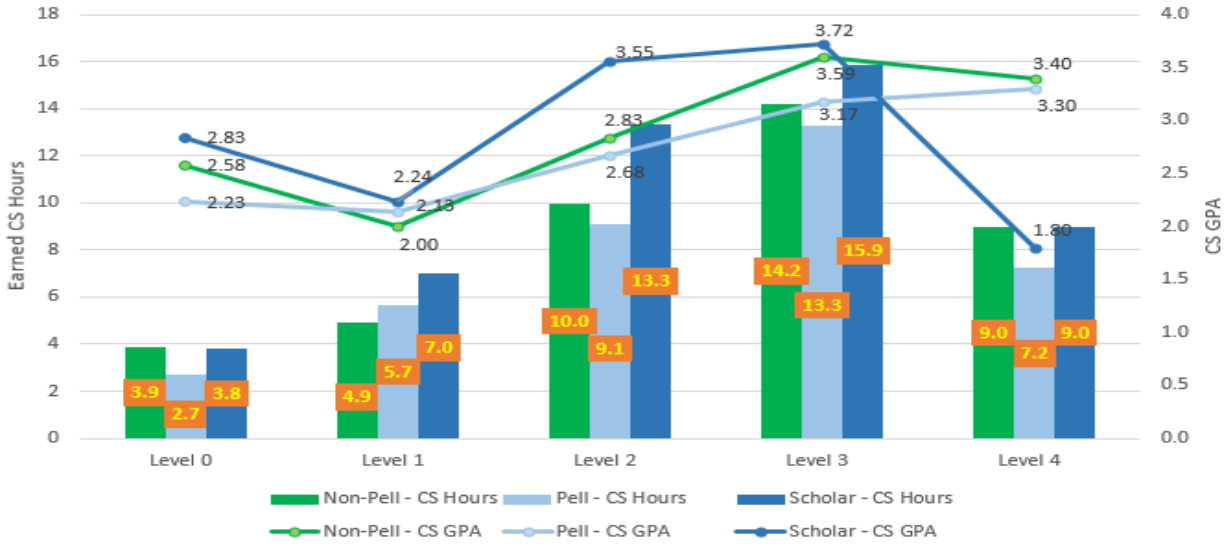

Figure 2: Earned CS Hours and CS GPA by Level

One goal of the scholarship program was to decrease attrition of lower level students, particularly those who are underrepresented, from the CS program. Table 4 displays the number and percentage of underrepresented students and non-underrepresented students at different levels who left computer science after one year of study in fall 2018 and 2019 for three groups: non-Pell eligible, Pell eligible, and Scholars. From the table, we can see there are more URSs in the Pell eligible group than in the non-Pell eligible group, in both absolute numbers and percentage at all levels. The percentage of students who leave CS becomes smaller and smaller as they make progress in major courses. The highest dropout rate occurs at level 0 and level 1, and then decreases significantly after level 2 when students complete both CS 1 and CS 2 successfully. White and Asian men in the Pell eligible group are more likely to leave CS across all levels compared to Non-Pell Eligible peers. Although the same trend occurs in underrepresented students of both groups at level 0, underrepresented students at level 1 and 2 who are Pell eligible have a lower dropout rate than URSs who are non-Pell eligible. No Pell eligible or Non-Pell eligible students above level 2 left CS. The scholars at level 0 had a similar dropout rate to underrepresented students, but with much higher number for non-underrepresented students. No scholars above level 1 left CS during our study. The last row in the table shows the total dropout rate of students at level 0, 1 and 2. Here we can see that underrepresented Scholars had a much better dropout rate (15%) than their peers in other two groups (38% and 36%, respectively). Non-underrepresented Scholars have about the same dropout rate (25%) as their peers in Non-Pell eligible group (27%), but much lower than their peers in the Pell eligible group (37%).

Overall, the data show that the scholarship program had a positive effect on our students – they tended to stay in the major and complete more courses and therefore advance through the levels more quickly. This is confirmed by both figures. As a result, scholars are more likely to remain

in the major and graduate sooner. We will continue to collect data and monitor scholars' academic performance to see if the trend persists during the lifetime of the scholarship program.

Table 4: Fall to Fall Dropout by Level on Fall 2018 & 2019

		Non-Pell Eligible			Pell Eligible			Scholar		
		Total	*Dropout*		Total	*Dropout*		Total	*Dropout*	
			#	%		#	%		#	%
Level 0	*UR*[*]	61	24	39%	68	30	44%	5	2	40%
	Non-UR[**]	106	36	34%	70	32	46%	5	3	60%
Level 1	*UR*	23	11	48%	30	9	30%	2	0	0%
	Non-UR	73	29	40%	30	14	47%	2	1	50%
Level 2	*UR*	23	6	26%	25	5	20%	6	0	0%
	Non-UR	105	12	11%	61	13	21%	9	0	0%
Level 3	*UR*	3	0	0%	8	0	0%	4	0	0%
	Non-UR	46	0	0%	18	0	0%	5	0	0%
Level 4	*UR*	1	0	0%	5	0	0%	1	0	0%
	Non-UR	17	0	0%	8	0	0%	0	0	0%
Total of students at level 0 - 2	*UR*	107	41	38%	123	44	36%	13	2	15%
	Non-UR	284	77	27%	161	59	37%	16	4	25%

[*]: UR for underrepresented students, i.e. female, and male Hispanic/Latinos, African Americans, Native Americans, or Native Hawaiian/Pacific Islanders

[**]: Non-UR for students who are not underrepresented, i.e., White and Asian men

7 Conclusion

We are now in the third year of the scholarship program and this paper summarizes our work in the program so far and presents our preliminary outcomes. The components in the scholarship program were designed to encourage scholars to explore computer science career at an early stage and gain working experience before graduation. The overall impact of the S-STEM scholarship came in three forms – financial, emotional, and opportunity. The financial support allowed students to focus their energy on their classes, which allowed them to take more credit hours and achieve a higher GPA than other Pell-eligible students from which the scholars were drawn. As they progressed in the program, they were also able to focus on finding internships and full-time employment rather than working to afford school. Emotionally, their stress was reduced, because they did not need to take out loans to pay for school or put a burden on their families. The opportunities provided by conferences and research were valuable. The smaller number of students who were engaged in summer research continue their work in various forms leading to undergraduate theses, conference paper submissions, and additional research funding. Sending students to professional conferences can achieve multiple purposes. They are able to explore computing careers and build connections with potential employers while also building community among our scholars who attend the conferences together.

We have learned that the mentoring component of the project requires more structure than we initially designed, with explicit expectations for the mentors and mentees. Future iterations will include additional training for the mentors and greater efforts to facilitate communication, which was significantly impacted by the COVID-19 pandemic and the absence of in-person contact. We have also increased the mentor stipend to reflect the higher expectations. Additionally, if the COVID-19 precautions allow, dedicated housing for the scholars will be utilized to foster relationships.

Overall, the scholarship program had every positive effect on scholars: they tended to earn more credits per semester with higher GPA and therefore graduated earlier than their peers. In addition, scholars, especially women and underrepresented men, had much better overall fall to fall retention. We plan to extend our support program to all computer science majors, especially attending professional conference and the peer-mentoring program, to encourage students to explore computer science careers as early as possible.

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