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ADVANCING STUDENT FUTURES IN STEM

INTRODUCTION

This is an evidence-based practice paper. The New York City College of Technology (City Tech) STEM program "*Advancing Student Futures in Science, Technology, Engineering, and Mathematics*" was designed as a multifaceted, evidence-based set of strategies deployed to provide both academic and financial support to undergraduate STEM students. This set of strategies involved need-based financial assistance and a matrix of support that encompasses our students' academic life, including close curricular advisement, one-on-one mentoring, tutoring, leadership opportunities, research opportunities, periodic curriculum-related and social activities that fostered a sense of community, career counseling, and, in some cases, guidance towards baccalaureate or graduate and professional studies. The program also examined the outcomes of the described interventions, which were used in the context of our urban, public institutional setting.

This paper concludes the work-in-progress presented in a paper published in the ASEE proceedings in 2018 [1] and the epiSTEMe8 conference proceedings [2]. This project contributes to the national effort in recruiting, supporting, and educating future STEM professionals for the national workforce by providing scholarships and curricular support to academically promising STEM students with financial need in associate degree programs in Computer Science and Chemical Technology and baccalaureate degree programs in Applied Chemistry, Applied Mathematics, and Biomedical Informatics. Based on 2015-16 data, nationally a higher percentage of bachelor's degrees awarded to females than to males is observed (58% vs. 42%). In STEM related fields, however, female participation is disproportionately lower than their male peers: the ratio of bachelor's degrees awarded in STEM fields to males is to females is 64% to 36%. Similarly, the trend of higher percentage of all bachelor's degrees awarded to females than to the males in all fields is similar across different racial and ethnic groups. However, a different pattern emerges when the study domain is restricted to bachelor's degrees awarded only in STEM fields. This disparity is observed widest among Black students (11% women), followed by students of two or more races (21%), Asian students (21%), American Indian/Alaska Native (23%), Hispanic (25%), Pacific Islander (28%), and even in Caucasian populations (33%). Based on 2014 data, the proportion of females awarded bachelor's degrees nationally in Computer Science in particular is about 18.1% [3]. The average proportion in Mathematics and the Statistics is 41.7% [4]. Additionally, Pew research cites significant underrepresentation of Black and Hispanic population in the STEM related jobs including computing fields despite significant recent growth. Blacks and Hispanics held 9% and 8% of all STEM jobs respectively, whereas Whites represent 67% of all STEM jobs. The same research also finds underrepresentation of women in physical sciences, computing, and engineering fields although women are well-represented in the health-related workforce. While women represent 74% in health-related jobs, this representation is a quarter or lower in computing and engineering fields [5]. Because of the significant underrepresentation of women and minorities in Computer Science and in STEM fields overall, the program described here placed a heavy emphasis on recruiting and enrolling greater numbers of female students and in providing evidence-validated interventions to support their retention, graduation, and workforce entry.

Current research identifies two levels of contributions: individual (personal level) and contextual (institutional or environmental) that results in short-and longer-term positive outcomes for URM students. Program interventions based on science, identity, motivations, and values are proven to

improve students' retention. University of Maryland-Baltimore County Meyerhoff Scholars Program suggested a 14-component model that improves success rates of high achieving URM students in STEM fields. Elements such as summer bridge program, tutoring, peer support network, and personal advising were found to be beneficial to improve low motivation and isolation of URM students that might be caused by unsupported learning environments. The lack of financial stability hinders their ability to be fully committed to their studies and involved in undergraduate research as well as engaged in other professional activities that are required for success [6]. Undergraduate minority students are also known to have benefitted significantly from having role models and mentors belonging to the same group/race [7]. The analyses done by The Science Study that followed 1400 URM science students for the past 8 years reported that participation in co-curricular activities have shown to increase the chances of choosing sustaining careers in the science field [8].

Another dramatic change was observed in Harvey Mudd College (Claremont, California). The number of women in computer science increased from 10 to 40% over a 5-year period due to implementation of some intervention techniques, namely, restructured introductory computer science courses, early exposure to research, and introducing women computer science professionals as role models [6]. According to Monica Jenkins, the Program Director of DTech program at Duke University, engaging women early in their careers and involving them in experimental settings helped them get integrated in technology tracks. The DTech program was initiated in 2016 to combat low female participation in technical fields, and provided female undergraduates hands-on experience in solving practical problems creatively while working as interns in technology companies [9].

Context of the Program "Advancing Student Futures in STEM"

The program was designed and implemented at City Tech, the designated college of technology in the City University of New York (CUNY) system, which ranks 21st in top public schools and 24th in top performers in social mobility, according to US News and World Report [10]. It is known that economically disadvantaged students are less likely to finish college. However, by enrolling and graduating a large number of disadvantaged students awarded federal grants, institutions like City Tech are more successful than others in advancing social mobility [10]. More than 60% of City Tech students reported household income less than $30,000, while 80% of incoming first year students and 67% of continuing students receive need-based aid [11]. City Tech, a Hispanic Serving Institution, also ranks 7th in the nation in the number of associate-level STEM degrees awarded to Black students, 8th in degrees awarded to male students, 9th in degrees awarded to Asian students [12]. 48.8% of these degrees are awarded to women [13]. Improving retention and graduation in order to increase the participation of underrepresented minority (URM) students in STEM undergraduate and graduate programs and the New York City workforce was an essential programmatic goal which was promising to have wide social and economic implications for individual students, equity implications for the institution, and lowering the opportunity gaps in the wider community.

Through well-crafted interventions this project accomplished the following: (1) recruited and increased participation in five targeted science, technology, engineering, and mathematics (STEM) majors, focusing on women, underrepresented student population, and undeclared and liberal arts students with strong math preparation; (2) retained and graduated academically talented, low

income students in STEM programs by strongly encouraging students to register for 15+ credits per semester to promote timely progress to graduation; (3) provided comprehensive support structures at critical junctures that include financial support, academic advisement, academic support, and career counseling, using a natural cohort approach to developing a professional STEM identity; (4) increased internal transfer of students from associate degree to baccalaureate degree programs and STEM graduate study or workforce placement through advisement; and (5) evaluated and assessed the program, employing a cycle of continuous improvement and well-defined metrics of project success.

PROGRAM DESCRIPTION

In this section, we provide details about each of the program dimensions: recruitment; retention; financial and academic support of STEM scholars; bringing STEM professional identity and a sense of belonging; and encouraging student advancement in degree attainment and career placement. See the flow chart of program activities at the end of the Program Description section.

1. Recruitment

Recruitment was primarily conducted by reaching out to the student population in associate degree programs such as Liberal Arts and Sciences, Chemical Technology, Computer Science, as well as first-year students in non-STEM majors. Recruitment flyers and application information were distributed, and information sessions were organized. Efforts to recruit at local high schools via fliers and information sessions for the students did not yield many inquiries, so the emphasis was placed on recruiting S-STEM scholars from currently enrolled students due to the strong interest already residing within the college community. (We note that, for the renewed NSF grant that continues this program, new strategies are being devised to reach out to local high schools and improve recruitment at that level.)

Table 1. Number of Program Participants by major, gender, and URM designation

Degree Programs	No. of Women (URM/non-URM)	No. of Men (URM/non-URM)	Total (URM/non-URM)
Applied Chemistry (CHB-BS*)	7 (4/3)	5 (3/2)	12 (7/5)
Applied Mathematics (APM-BS*)	11 (4/7)	20 (7/13)	31 (11/20)
Biomedical Informatics (BIB-BS*)	20 (11/9)	11 (5/6)	31 (16/11)
Computer Science (CSC-AS)**	6 (1/5)	10 (4/6)	16 (5/11)
Chemical Technology (CHS-AS)**	2 (1/1)	2 (0/2)	4 (1/3)
Total	46 (21/25)	48 (19/29)	94 (40/54)

*Bachelor of Science **Associate of Science

The program supported a total of 94 unique students, of which 46 are women and 48 are men. Students come from diverse ethnic backgrounds; in particular, 40 students were identified as underrepresented minorities; 24 were Asian; 30 were non-URM or non-Asian, or did not report

their ethnicity. Twenty-one (21) students were underrepresented minority women. **Table 1** provides detailed information regarding participation within the different targeted degree programs. It should be noted that the percentage of recruited STEM scholars who were women or underrepresented minorities increased over the duration of the STEM program, as a result of recruitment efforts targeting precisely STEM women and underrepresented minority students (**Table 2)**.

2. Retention

To retain and promptly graduate academically talented, low-income City Tech STEM students, we focused on distributing financial awards according to need, and provided scholars with a matrix of support structures, including mentoring and advisement, tutoring services, counseling services, professional and research opportunities, and community building activities such as on-campus seminars and field trips. We particularly focused on encouraging students to register for 15 or more credits per semester to promote timely progress to graduation.

3. Financial and Academic Support of STEM Scholars

a. Financial support - Research data have shown financial aid and scholarship awards based on financial need improve student's retention [5]. From 2015 to 2020, the program awarded a total of 216 financial awards to 94 participating STEM scholars, totaling $501,990. Students were recruited primarily based on their academic achievements and unmet financial need. STEM students with satisfactory academic performance and identified financial need were awarded up to $3,100 per semester. Table 2 shows that the number of financial awards to women and underrepresented minorities had increased over the duration of the STEM program.

Table 2. Distribution of the financial awards to women and underrepresented minorities.

Semester	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019	Spring 2020
Total no. of students Supported	23	28	23	21	26	30	19	22	23	17
Total amount awarded	$54,800	$69,540	$56,153	$55,320	$55,575	$64,225	$36,350	$51,527	$55,400	$3100*
No. of Women (%)	9 (39%)	12 (43%)	11 (48%)	9 (43%)	13 (50%)	15 (50%)	11 (58%)	15 (68%)	14 (61%)	10 (59%)
No. of URM (%)	10 (43%)	10 (36%)	12 (52%)	9 (43%)	11 (42%)	13 (43%)	7 (37%)	7 (32%)	11 (49%)	8 (47%)
No. of Women and URM combined (%)	15 (65%)	18 (64%)	16 (70%)	13 (62%)	18 (69%)	21 (70%)	14 (74%)	17 (77%)	18 (78%)	13 (76%)

*One student was supported by NSF#1458714, hence $3100. The remaining 16 students were supported by the new grant NSF#1930437.

b. Academic Support - Students' academic progress was closely monitored. Every semester, all STEM scholars were required to undergo mandatory one-on-one academic advisement with an assigned faculty mentor in their department to discuss academic progress and career development

opportunities. Such one-on-one meetings were scheduled right before the beginning of registration period, to maximize the impact of course planning for the following semester, with the overall goal of helping students navigate the shortest path to graduation. In addition, at least once a year, students were also required to attend mandatory one-on-one mentoring with one of the STEM program team members. These types of student-faculty communications allow students to address non academic or personal issues that might affect their studies and such interactions have shown to positively impact student retention [14]. 86% of the participating STEM students reported in a survey (n = 41) that they strongly agreed or agreed that they received useful mentoring from the STEM faculty. In addition, students were provided access to college-wide course-specific tutoring, and all scholars were encouraged to participate in peer-led teaching [15]. Out of the same 41 survey respondents, we learned that 44% either became a peer leader or participated in a peer-led workshop.

4. Building STEM Professional Identity and a Sense of Belonging

a. Professional Opportunities– Numerous professional events were organized to help the STEM scholars develop a professional STEM identity. The program periodically organized formal lectures and seminars by invited speakers such as scientists and industry professionals (women and under-represented minorities URM included) with the goal of exposing the STEM scholars to a variety of cutting-edge research topics and providing them with direct interactions with STEM practitioners. Former STEM scholars and City Tech alumni speakers who currently hold jobs in the industry or pursuing postgraduate studies in a STEM- related field were also invited to offer research and career related talks. Surveys indicated that students found these forms of meetings between students, faculty, and invited scientists to be particularly effective. Of note, the students found the talks by alumni were motivating and inspirational.

Various field trips to science exhibitions and tours at different off-campus locations were organized, including visits to the Museum of Natural History, the National Museum of Mathematics (MoMath), the New York Genome Center, and the Federal Reserve Bank (NYC). In 2020, due to the pandemic, some virtual tours were organized—for example, a SRC Illumination Space trip to the Advanced Science Research Center. Our scholars attended various sessions in STEM-related field**s.** Few such examples are: *Ecology and Mathematics – Interesting Research Questions Solvable by Undergraduates; Multilingual Named Entity Recognition for Text Analytics; Becoming a Data Scientist: Skills, Interviews, and Industries; Porphyrin and Phthalocyanine Dyes for Solar Cell Devices; The Role of Applied Math in Real-time Pandemic Response: How Basic Disease Models Work;* and *Costs and Benefits of Defending Against Viral Infection*.

Scholars were also given the means to actively participate in regional, national, and international conferences. During the pandemic, our scholars attended webinars, and other seminars and/or meetings. Survey data showed overwhelming appreciation of the invited lectures and the field trips. Additionally, existing resources were activated to provide hands-on workshops and seminars throughout the academic year for all STEM scholars to expose them to research topics in various STEM related fields at an accessible level. We also provided career guidance and helped STEM students connect with college faculty in order to work on research projects tailored to their interests. Moreover, in order to sustain interest in STEM, scholars were encouraged to attend

meetings of, for example, Math, Chemistry, and Biology clubs, and the SIAM student chapter. The program particularly emphasized the maintenance of a cohort structure in order to encourage networking and team building. Consistently, whenever possible, we arranged for pairs of participating STEM scholars to collaborate on related research projects supervised by a faculty member.

b. Research Opportunities– Based on a previously developed successful mentoring model [16], all STEM scholars were encouraged to engage in undergraduate research supervised by a faculty mentor. The college already offers a number of such programs, including the Emerging Scholars Program, Honors Scholars Program, CUNY Research Scholars Program (CRSP), which we supplemented by providing the means to participate in other undergraduate research opportunities within the larger City University of New York (CUNY) system or at off-campus facilities. Support for such activities have an added benefit of assisting our students meet major requirements, as many baccalaureate programs at City Tech, including Applied Mathematics, Biomedical Informatics, and Applied Chemistry require completion of an extensive internship as part of their respective curricula. The project team maintained high student participation in various research activities by continuously distributing information about research and internship opportunities, and engaging students in "research mixers" organized by the college's Research Experience for Undergraduates (REU) committee. Few examples of research topics showing a wide range of research projects undertaken by the STEM scholars include: *Characterization of Tetrahymena thermophila; Designing an Alternative 911 Mobile Communication system; Amyloid-β aggregation inhibition effects on Alzheimer's disease*; *Post-Reverse Osmosis; Graphical Approach to Assemble DNA Fragments; 311 as a Proxy for Weather Impacts; Geolocation Correction of Satellite Precipitation Estimates using a Radar-Gauge Product; Kinetic Study of Amine Cured Epoxy Resins; Data Analysis and Visualization of Heart Disease Using Patient Data; Global Lakes Surface Temperature Variability; and Polariton Formation and Propagation in an Optical Microcavity*.

Students were also strongly encouraged and supported to present their research at regional and national conferences. Emphasis was placed on creating opportunities for multidisciplinary and multi-institutional research projects for teams of STEM scholars. A research collaboration between City Tech and the Chemical Engineering Department at Indian Institute of Technology (Kharagpur, India) is one such example.

c. Enabling Social Connection and Networking. Development of social connections was facilitated by organizing informal gatherings such as luncheons at college's dining and social spaces. Most recently, a congratulatory Zoom conference was organized to celebrate the success of upcoming or graduating STEM scholars and former graduates who were either enrolled in graduate school or already involved in the STEM related workforce. During such events, former STEM scholars and City Tech alumni were asked to speak about their individual intellectual and career journeys. Some of these stories involved the journey of a part-time farmer in China to a PhD STEM graduate, and another who started as a part-time cab driver who became a data scientist in the Federal Reserve Bank of New York. The STEM scholars overwhelmingly appreciated these types of gathering and found the meetings motivational. We believe that these types of activities helped the scholars develop a sense of belonging in the STEM universe. Furthermore, to stay connected with the program and with other alumni, all STEM scholars were required to open

LinkedIn accounts. Approximately 88% of the STEM scholars reported that they had opened and had updated their LinkedIn accounts.

5. Encouraging Student Advancement in Degree Attainment and Career Placement

All STEM scholars were encouraged to pursue continued upward movement in their education and career paths. Typically, scholars completed an associate degree (e.g. in Chemical Technology and Computer Science) and then continued to pursue a baccalaureate degree program in a related discipline such as Applied Chemistry, Biomedical Informatics, or Applied Mathematics. The program allowed for a seamless transition from an associate degree to an undergraduate degree while maintaining the same financial, academic, and cohort support.

The S-STEM program was also concerned with STEM scholars' post-baccalaureate plans. Through advisement, information sessions, seminars, internship, as well as social connections, the program continuously communicated and exposed students to the prospects of advancing their future in graduate schools or career placement. Former scholars and alumni, serving as role models, were invited as guest speakers to share about their graduate school or job experiences.

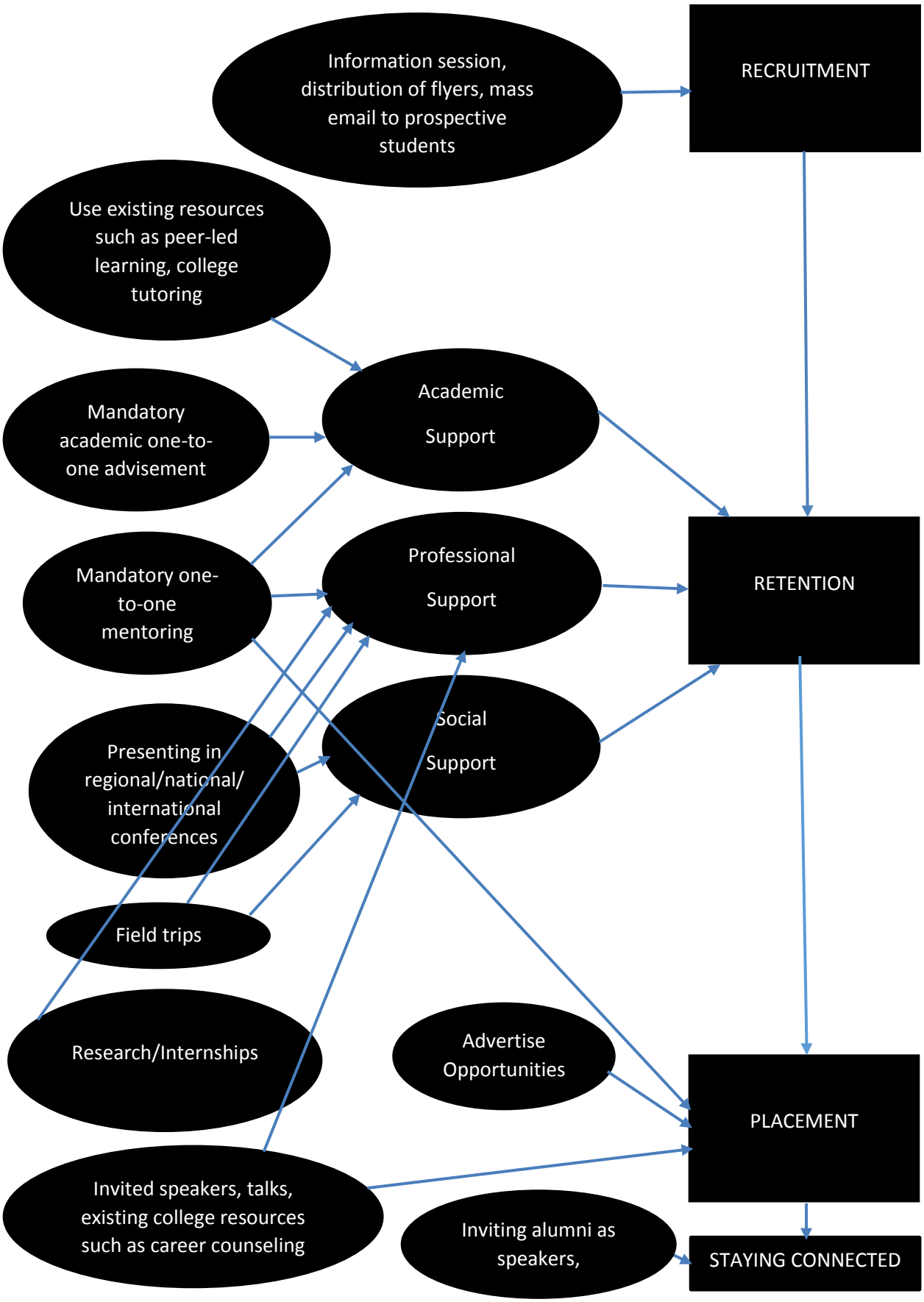
The flow chart in the next page illustrates a multi-tiered model that represents four stages of this program.

PROJECT RESULTS

As a result of the multifaceted and concerted efforts to support participating STEM students, the program has achieved the following results:

94 S-STEM Scholars were supported by stipends from Fall 2015 to Spring 2020, disbursing a total of $501,990 in the form of stipends. 51% of the stipends were awarded to women, and 43% of the stipends were awarded to URM students. A combined total of 70% of the stipends were awarded to female or URMs students. Although there is not a monotonic increase observed in percentage of women receiving the scholarship during the grant period, from fall 2017 onwards the percentage of women receiving financial awards is observed more than 50% from all supported STEM majors. The data shows that the project has offered robust financial support to female and URM S-STEM scholars.

One of the strengths of the project was the recruitment and retention of STEM female scholars. According to the National Center for Education Statistics, "Overall, a higher percentage of bachelor's degrees were awarded to females than to males in 2015–16 (58 vs. 42 percent). However, in STEM fields, a lower percentage of bachelor's degrees were awarded to females than to males (36 vs. 64 percent). This pattern—in which females received higher percentages of bachelor's degrees overall but lower percentages of bachelor's degrees in STEM fields—was observed across all racial/ethnic groups" [17].


Information session, distribution of flyers, mass email to prospective students
RECRUITMENT
Use existing resources such as peer-led learning, college tutoring
Academic Support
Mandatory academic one-to-one advisement
Professional Support
Mandatory one-to-one mentoring
RETENTION
Social Support
Presenting in regional/national/ international conferences
Field trips
Research/Internships
Advertise Opportunities
PLACEMENT
Invited speakers, talks, existing college resources such as career counseling
Inviting alumni as speakers,
STAYING CONNECTED

Given the low percentage of STEM bachelor's degrees awarded to females nationally, we have made it a priority to recruit and retain females in STEM majors, and can report that a significant number of female STEM scholars–46 out of 96 STEM scholars–were recruited and enrolled in STEM degree programs supported by the project. A notable project achievement is the 89% retention rate of female STEM scholars who are recruited for this program, significantly higher than the college average.

An explicit goal of the program was to target two degree programs for which female participation is particularly low–Applied Math and Computer Science. We report here that we were able to recruit and retain 17 STEM female scholars in these two majors, and that 16 (94%) have graduated to date.

In total, 47% (44 out of 94) of the STEM scholars awarded at least one financial award were underrepresented minority (URM) students, and half of them were URM females.

The STEM scholars earned an average of 29-30 credits annually with a mean GPA around 3.5. This is significantly above the college average (see **Table 3**).

Table 3. Mean number of terms credits and GPA earned by scholars.

Semester	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019	Spring 2020
Mean no. of term credits	15.7	14.4	14.4	15.5	14.4	15.0	15.6	15.2	14.7	15.1
Mean term GPA	3.42	3.50	3.52	3.52	3.52	3.55	3.59	3.63	3.43	3.66

To date, a total of 35 women and 33 men in baccalaureate programs earned a degree in their respective major; 7 women and 5 men in the associate programs earned a degree in their respective major. Of those earned a baccalaureate degree, 34 (17 women and 17 men) also earned an associate degree. Overall, 85% of the scholars have earned either an associate or baccalaureate degree, 72% have earned a baccalaureate degree.

Fifty-five (55) baccalaureate graduates and 10 associate graduates achieved honor distinctions including 17 *cum laude*, 22 *magna cum laude*, and 16 *summa cum laude.* Two of our scholars were named Valedictorians (both were underrepresented minority women), one named Salutatorian (non-URM woman).

On average, the S-STEM scholars completed the graduation requirement in less time and with higher GPA than other students in the same programs. (see **Table 4**). The S-STEM scholars' mean degree GPA is around 3.5, which positions them well academically to apply to graduate school if they so choose.

Table 4. Graduation Information.

Mean Degree GPA and Number of Semesters to Completion								
	Graduates Fall 2015 – Spring 2021							
	Baccalaureate Degree (APM, BIB, CHB)*				**Associate Degree (CHS, CSC)****			
	Supported Students (N=65)		**Unsupported Students (N=346)**		**Supported Students (N=15)**		**Unsupported Students (N=278)**	
	Women (N=34)	Men (N=31)	Women (N=183)	Men (N=163)	Women (N=8)	Men (N=7)	Women (N=63)	Men (N=215)
Mean Degree GPA	3.57	3.48	3.03	3.06	3.53	3.46	3.09	2.97
Mean no. of Semesters to Graduation	8.6	9.5	11.3	10.4	5.25	5.29	4.19	6.94

*Baccalaureate degree graduates include students with dual baccalaureate and associate degrees.
** Associate degree graduates do not include students with baccalaureate degrees.

About 71% of the STEM scholars reported having research and/or internship experiences during the program duration. Nearly 100% of the participating STEM students attended at least one of the organized program events (e.g. field trips, seminars, workshops) per semester. Approximately 44% of the participating students report being involved in peer-led team learning, either as a peer leader or as a peer-led workshop participant. Additionally, 88% of the STEM participants reported that they have opened and updated a LinkedIn account in order to stay in touch with peers or fellow scholars who had given presentations during the period of the program.

Throughout the program, students were surveyed about their opinions on the various STEM program activities such as seminars and field trips. Several students reported that the program alleviated financial pressures of students, and in many cases, had removed the necessity for them to work in order to support themselves. Many of them have made reports similar to the following personal statements:

- *I have been unemployed for 2 years. . . . I am forever grateful for this grant, and the people who put it all together because it allowed [me] to focus less on my financial needs and more on my classes.*

- *Being a recipient of this scholarship has been a blessing, providing me with the opportunity to pursue my education without any [financial] burden. The financial support has reduced my financial strain tremendously allowing me to focus on my career and future aspirations.*

- *With this support I was able to purchase a new computer. This helped me to complete my assignments without having to go to the library, but work on my own time. It has also given me the chance to work on my programming skills, which is a passion of mine, to one day work as a Data Analyst.*

- *Without the help of this program, I would not have had as much opportunities as I did.*

In addition, the students appreciated that the program provided them with multiple opportunities to attend talks and extend their knowledge about STEM research and its applicability. For example, participating S-STEM scholars have reported:

- *This virtual field trip was very useful because it introduced me to a lot of new forms of science like structural biology, nanoscience, environmental science, etc.I learned about interdisciplinarity. . . .*

- *The virtual field trip also allowed us to see what research is currently being performed at the research center.*

- *I am lucky to participate in this big data program, it is fascinating to see exactly how big data can be used in a hospital setting.*

- *The COVID-19 pandemic is shaping the Earth right now by changing the ways humans move and interact within an ecosystem… This got me thinking we are all closely related in this world from the smallest particle to the most complicated ones – we affect each other in ways we couldn't imagine.*

Many students considered the STEM program as expanding their knowledge of the career opportunities in various STEM fields. For example, several STEM scholars have written:

- *This program has expanded my experience in my field by providing workshops, leadership, and research programs.*

- *There were several guest speakers and presenters who spoke about their position in the workforce. They also hosted a few field trips, so that we can learn more about certain jobs, and the people who work there. These were all exciting opportunities, and the amount of knowledge that came from each of them was immense.*

- *The seminars, workshops, and trips are very stimulating for the curious and provides plenty of opportunities to network with professionals.*

- *I was also able to get involved with the clubs on campus. Being more involved with the clubs on campus exposed me to various opportunities to help me grow and network with fellow students. Participating in the workshops held for the NSF S-STEM Scholars, helped me learned about other career paths.*

- *I would like to seek research opportunities in the Advance Science Research Center.*

*A*pproximately 88% of the STEM scholars reported that they either strongly agreed or agreed that the organized talks were useful in providing information about STEM careers and internship opportunities. However, one of the most valued benefits seem to have been the opportunity to have

multiple personal discussions with women STEM professionals invited as presenters or the STEM faculty on the project team, as evidenced by the following comments:

- *My favorite part of it all was the one-on-one conversations with ... (one of the project team members). She provided wonderful input towards my career plans, and supported my decisions, no matter what they were. She provided great guidance and gave me ideas for future goals and steps to take.*

- *This semester I attended the NYCWiC conference in Rochester, NY, this trip was very inspiring, especially being a minority woman. I had the opportunity to hear Reshma Saujani, the founder of Girls Who Code, speak about her experience as a politician and how her defeats in politics inspired her to become an advocate to close the gender gap in technology. She inspired me to advise parents in changing our culture and not allowing girls to "dislike" STEM.*

- *I also had the opportunity to attend workshops and meet women who work in fields of technology. These women faced many obstacles that they were able to overcome due to their passion for what they do and to inspire more women. This trip inspired me to become one of those women.*

Many STEM women students reported about recognizing the struggles of other women in STEM to find a career path and to persist in it, and about being inspired by these women's success as STEM professionals. About 90% of the S-STEM scholars reported that the program helped them to increase their overall confidence.

This paper has outlined the details of the multifaceted approach that our STEM program adopted to support scholars in majors where they are traditionally underrepresented. The undeniable success of this approach, based on retention and graduation as enumerated in the results section above, points to an integrative model that can be adapted and applied to STEM programs in other similar institutions. The student surveys provide important insight as to which aspects of the STEM program were particularly crucial to student success. At the baseline, financial support for at-risk students obviously alleviates financial burden and provides the means for them to refocus on their studies. But beyond that, it appears that periodic mandatory advisement with the same faculty member to go over coursework, discuss progress, and solve any particular issues or difficulties throughout the student's time in college has proven once again to be critical to retention and graduation of URM and women students, particularly because all 4 STEM team members are from URM groups in STEM and 3 out of 4 are women. Interventions were devised for students whose GPAs have decreased, beginning with one-on-one meetings and continuing with regular follow-up communications, catching issues before they become serious. Student surveys also highlight the importance of role models such as URM and women scientists and professionals as well as successful STEM program alumni, brought into contact with students during on-campus seminars and field trips. The sum total of these and other activities and support structures provided consistent academic support and pervasive contacts between the student and faculty, which, on aggregate, markedly decreased the likelihood of any student feeling left behind, and seems to have increased their sense of belonging to the local and the larger STEM community.

CONCLUSION

Advancing Student Futures in Science, Technology, Engineering, and Mathematics was completed in May 2020. The project has met its goals of all planned activities – recruitment was successful, selecting students who have demonstrably benefited from the program; engaged faculty provided close advisement and an impressive suite of extracurricular opportunities. Curricular planning was efficient, significantly decreasing non-contributory credits, thereby facilitating timely graduation. STEM scholars' GPA have been particularly impressive. From periodic surveys, students reported that they were satisfied with the program and appreciative of what the program offered.

The program was successful in increasing the number of student participation in STEM programs, especially among women and underrepresented minority students; in increasing the number of STEM students transferring from a two-year program to a four-year degree programs; in providing comprehensive support structures such as financial support, academic advisement, academic support, and career counseling; in retaining and graduating women and underrepresented minority students in STEM; and in decreasing the number of years to graduation of participating STEM students.

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