

Board 306: Improving Retention Rate and Success in Computer Science Scholars

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Improving Retention Rate and Success in Computer Science Scholars

Introduction

In the broader context of Science, Technology, Engineering, and Mathematics (STEM) fields, a study [1] reveals that the likelihood of a Black student switching majors is approximately 19 percentage points higher than that of a White student. Additionally, studies indicate that access to STEM opportunities is restricted for students attending high-poverty schools, where the lack of resources hinders their chances of pursuing STEM careers [2][3]. Thus, while STEM careers can offer a pathway for low-income students to escape poverty, these students often encounter difficulties in pursuing a STEM degree [4].

A growing body of research has concentrated on exploring factors to enhance the retention rate among STEM students. Scholars have shared various intervention strategies, such as implementing peer coaching programs, academic learning communities, professional development workshops, academic counseling, and research seminars [5][6][7].

Study Objectives

To improve retention rates and academic performance among academically talented minority and underrepresented computer science students from low-income families, we have implemented diverse support programs, including co-curricular and outreach activities. These initiatives were made possible through the NSF's S-STEM grant, awarded to us in August 2022. The project aims to prepare talented minority and underrepresented students to successfully enter computing-related workforce or graduate program to meet local and national needs, which would be also helpful for increasing the diversity of computing field. The purpose of this paper is to spotlight our ongoing efforts, provide an overview of the outcomes achieved through these initiatives, and outline our forthcoming plans for continued support and enhancement.

Program Description and Supporting Activities

Our S-STEM program aims to empower academically gifted, low-income Black students to earn CS degrees in four years and pursue careers in the field of CS. In the spring of 2023, we successfully recruited and retained the first cohort of six talented students (i.e., S-STEM scholars). In the fall of 2023, we recruited a second cohort of five students.

Throughout the past year, we provided a series of mentoring and professional development opportunities to the S-STEM scholars, fostering their personal and professional growth. Some of these opportunities were extended to the entire university to maximize the program's impact. Key activities included career mentoring, technical skill development (specifically in Python programming), soft skill development, undergraduate research, and high school outreach. Detailed information for each activity is summarized in Table 1 below.

Table 1: Summary of 2023 S-STEM Activities

Activity	Descriptions
Career Mentoring	S-STEM scholars had the opportunity to meet with senior students who secured positions in major technology companies or government agencies. These mentors shared their life stories and provided tips on college life, job interviews, and career development.
Curriculum Mentoring	Faculty guided the curriculum sequence and appropriate courses to take to complete the degree on time.
Technical Skill Building (Python Seminar)	Our CS program does not offer a Python programming class. This project developed six Python seminars, teaching the fundamentals of Python programming. Two juniors, who have internship experience with high-tech companies, taught these seminars once two weeks.
Soft Skill Building (Begin to Code)	Three first-cohort scholars led an introductory coding seminar series called “Begin to Code” (B2C). The scholars in the second cohort and other students attended the seminars. The primary goal of B2C was to assist first-year CS students in developing logical thinking skills by engaging in block-coding exercises using Apple’s Sphero Bolt and iPad. The scholars took on the responsibility of designing and delivering lessons to participants, contributing to the development of their leadership and communication skills.
Undergraduate Research	All first cohort scholars were engaged in research projects led by faculty in different fields. Two worked on AI research in agriculture, analyzing different types of phenotypes and programming AI robots for farm fields. One scholar collaborated with a math professor on a virtual reality project. Other three scholars joined a research project on quantum computing and AI led by PI. While the freshmen in the second cohort have not been engaged in a research project yet, they have expressed a strong interest in joining a research project in 2024.
Summer Internship	We assisted S-STEM scholars in finding summer internships. In the summer of 2023, two participated in research experiences for undergraduates at the University of Tennessee Chattanooga, one worked as a data analyst/engineer at a medical technology company, and the other one worked with an education faculty member designing a Swift Playgrounds lesson for high school students.

Data Collection

To assess the effectiveness of various initiatives offered, a comprehensive data collection approach was employed throughout the year. The program evaluator participated in career and mentoring meetings with S-STEM scholars, documenting attendance and noting the nature of interactions. Post-surveys were conducted to gauge participants’ overall satisfaction with the Python

programming and Begin to Code seminars. The evaluator also attended these seminars, observing students' interactions and conducting informal interviews with participants.

All S-STEM scholars took part in an initial interview, examining their motivation for pursuing a CS major, previous CS experience, career goals, and overall college life. Follow-up interviews were conducted each semester, where scholars reflected on their engagement in research or academic activities during the semester, shared plans for the upcoming semester, and reported any support needed from the department. Additionally, surveys assessing various factors such as participants' STEM identity, sense of belonging, and intention to complete CS were administered to gather comprehensive insights into the program's impact.

Results

The results indicate that the scholars benefited from continuous support and a diverse range of learning, teaching, and research opportunities. Activities provided enhanced scholars' overall college experiences, contributing to their pursuit of studying CS. In this section, we demonstrated the program's impact using three key criteria: retention rate, survey findings, and post-evaluation results of Python and Begin to Code seminars.

As of January 2024, all S-STEM scholars remain in the CS program, demonstrating a 100% retention rate. The retention rate of the first cohort is particularly impressive, given that the overall sophomore retention rate is currently about 40% at our institution. However, two S-STEM scholars did not meet the GPA eligibility requirement of 3.0 at the end of fall 2023. PI has talked with these two scholars in person about this issue. The two scholars confirmed that they will continue to pursue a CS degree. They are confident to boost their GPA in the next semester. A specific plan is being developed to support their academic improvement in 2024, which includes peer mentoring.

A survey assessing factors such as scholars' CS identity, sense of belonging, perceived support, and was conducted. The results revealed a high level of CS identity, a strong sense of belonging, perceived CS usefulness, perceived support, and an intention to complete the CS degree. This suggests that scholars are highly satisfied with the CS program. Details are summarized in Table 2.

Table 2: Summary of the Survey Results

Factors		Mean	SD
CS-Identity	Interest	4.67	0.44
	Recognition	4.42	0.46
	Performance	4.23	0.49
Sense of Belonging		4.39	0.74
Perceived CS Usefulness		4.67	0.47

Perceived Support	4.46	0.68
Intention to Complete the Degree	4.67	0.47

Note: The CS-Identity scale ranges from 1 (not at all) to 5 (very much so), while other items use a scale of 1 (strongly disagree) to 5 (strongly agree).

A total of 29 students, representing 7 different programs, registered for the initial session; however, only 12 attended the first seminar. The programs of students who registered included computer science, economics and accounting, electrical engineering, environmental science, supply chain management, mathematics, and information technology. Among the attendees, five were from the first cohort of S-STEM scholars. Following the initial Python seminar, participants were requested to complete a brief program survey. The survey results reflected a high level of satisfaction among participants. They expressed that the session increased their confidence in Python programming and indicated that participation was a valuable learning experience. Figure 1 below summarizes the post-survey results.

The results from interviews conducted with both participants and instructors underscore the perceived value of the seminars. A junior instructor who taught the seminars expressed that the teaching experience helped him review Python programming more in-depth. Feedback from S-STEM scholars who participated in the program also indicated that the lessons not only facilitated a comparison between C++ and Python but also exposed them to another programming language in a relaxed and conducive environment. The absence of test-related stressors, coupled with the opportunity to freely seek guidance from instructors, contributed to an overall enjoyable learning atmosphere.

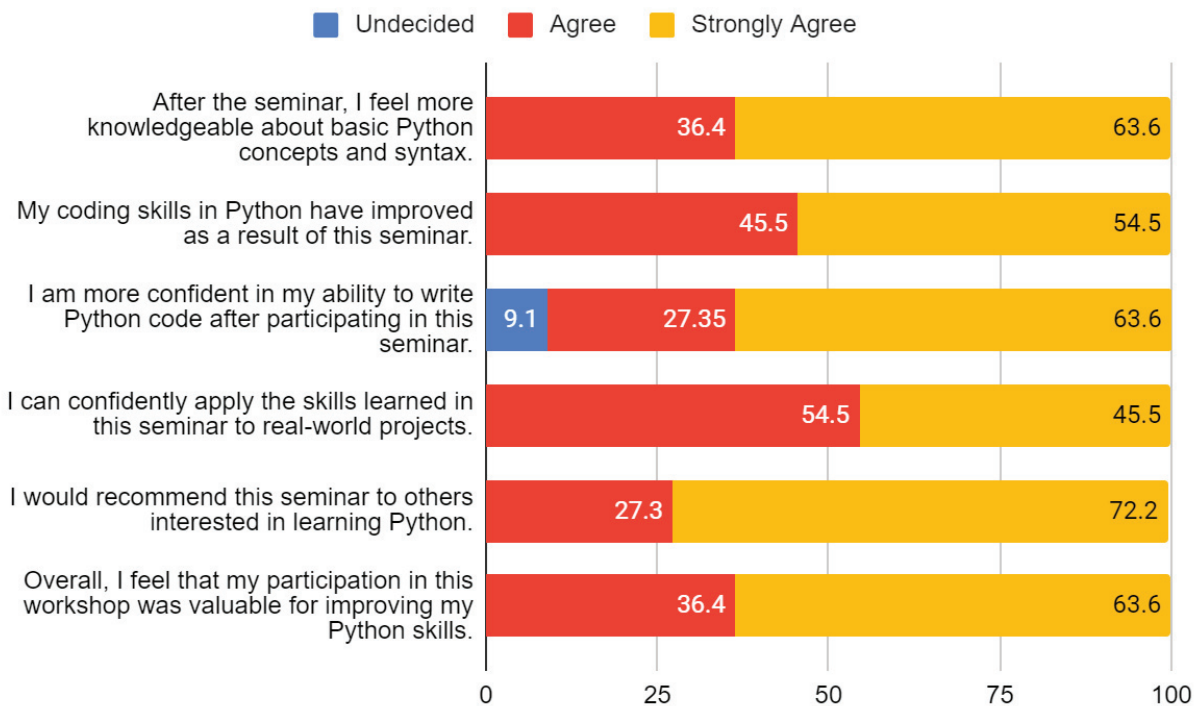


Figure 1. Python Seminar Post-Survey Results

Note: The values within the bar graph represent the percentage of the responses.

Initially, 21 students, all from the CS department, registered for the seminar, but 13 students attended. The post-survey results indicated a positive outcome, with participants expressing that the seminar boosted their confidence in block programming. Additionally, they expressed a willingness to recommend the seminar to others. Figure 2 below provides a summary of the post-survey results.

Three first-cohort STEM scholars who led the seminars described the experience as quite meaningful. They expressed that they felt rewarded when students remembered what they taught last session. Similar to the positive feedback received from the Python seminars, participants in the “Begin to Code” seminars also characterized their experience as “fun and relaxing.” They emphasized that the program was not perceived as an obligatory task; rather, they chose to participate due to the enjoyment and perceived benefits. Participants underscored that witnessing the outcomes of codes (e.g., Sphero moved following the codes) helped them have a sense of achievement but also served as a bridge between their theory-oriented classroom learning and the more application-focused block programming.

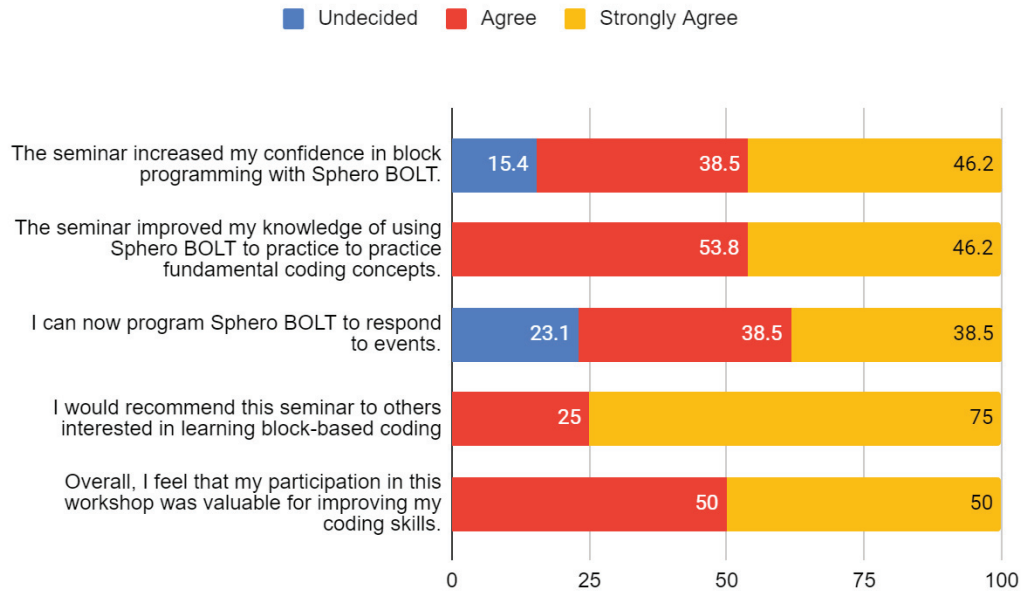


Figure 2. Begin to Code Seminar Post-Survey Results

Note: The values within the bar graph represent the percentage of the responses.

Conclusion and Future Work

The program evaluation of these initiatives demonstrated valuable impact. A total of thirteen first-year students participated in the first B2C seminar and continued to engage in activities every two weeks. Eleven students, including five S-STEM scholars, attended the first Python seminar. Three first cohort scholars who attended the Python seminars have been involved in quantum computing and AI research and using Python in daily basis. The majority of scholars maintained good academic performance demonstrated by a GPA of 3.0 or higher. Some students whose majors were not CS also benefited from these efforts.

We will keep conducting the activities to achieve the objectives. We will hold first-year CS seminars and Introduction to Python seminars with S-STEM scholar instructors in the fall semester of this year, advise scholars involved in quantum computing and AI research, make impact to local high school students, support scholars in their personal, leadership and career development.

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