BOARD # 287: NSF S-STEM: Advancing STEM Undergraduate Success and Persistence through Scholarship, Mentorship, and Increased Sense of Belonging

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Abstract

This paper examines the impact of a National Science Foundation Scholarships in Science, Technology, Engineering, and Mathematics (NSF S-STEM) Program at a large, Minority-Serving institution in the western U.S. Despite growing efforts to diversify STEM fields, underrepresented minority (URM) students continue to face significant challenges in persistence and success. This scholarship program addresses these challenges by providing financial support, faculty and peer mentorship, and skills development opportunities to academically talented and low-income URM STEM students. This study evaluates how participation in the program enhances key noncognitive skills, such as students' sense of belonging, leadership and collaboration skills, and science identity, which are critical to STEM persistence. Using both survey and university-based data among the 47 participating scholars, results reveal that program participants report strong levels of sense of belonging, high efficacy in leadership and collaboration skills, and strong science/math identities. Additionally, compared to university rates, scholarship students showed above-average retention and graduation rates, with the majority pursuing graduate studies or careers in STEM. These findings highlight the importance of comprehensive support programs that integrate financial aid, mentorship, and professional development to promote persistence and success among URM students in STEM fields.

Introduction

Many students leave Science, Technology, Engineering, and Mathematics (STEM) after taking introductory science and/or mathematics courses [1]. This not only impacts the development of a STEM workforce; it also negatively impacts humanity's chances of addressing the complex issues our societies are currently facing. Issues such as climate change and environmental degradation need brilliant and diverse teams to tackle them. Diverse teams have been found across industries and disciplines to answer questions better, produce products that make more money, and work together better [2].

Despite efforts to broaden participation and persistence among low-income and underrepresented minority undergraduates in the STEM fields, data indicates that 48% to 65% of students who initially intend to pursue science switch to a non-STEM major or drop out [3]. National U.S. data consistently show that the disparity in STEM degree attainment for underrepresented minority (URM; i.e., African American, Hispanic or Latino/Latina, American Indian, and Alaska Natives) students worsens at each successive degree level when compared to their white and Asian peers [4]. This underrepresentation highlights the critical need for targeted interventions and support programs to bridge the gap and promote persistence in STEM higher education and careers.

We contend that a critical factor in promoting persistence in STEM fields is how students perceive their ability to approach academic and career challenges, such as their self-efficacy [5], as well as their level of engagement—behaviorally, cognitively, emotionally, and socially—within relevant learning communities [6]. Although researchers have proposed different strategies to improve student retention (e.g., learning communities, supplemental instruction), for

URM students, two key factors stand out: financial assistance for college expenses [7] and fostering a sense of belonging [5, 8]. Students who feel both academically and socially integrated into their college and broader community are more likely to persist and graduate [9, 10].

Integrating these strategies into its development, our scholarship program was specifically designed to support underrepresented and academically talented students by offering financial scholarships, faculty mentorship, peer mentorship, and training in both transferrable and technical skills to help them become leaders in STEM fields. This paper aims to discuss how participation in the scholarship program impacts the development of noncognitive skills (e.g., sense of belonging, leadership and collaboration efficacy, and science identity) as well as student retention and persistence [11-13].

Program Description

Our program was carried out at a large, Minority-Serving institution in the western U.S. with a diverse student body of approximately 32,000 undergraduates. Among approximately 2,700 students in the STEM fields, 42.7% were identified as Hispanic or Latino, 27.0% Asian, 16.4% White, 5.0% identifying as two or more races, 2.6% Black or African American, 0.2% Native Hawaiian, and 0.2% American Indian or Alaska Native students. More than a quarter of the students are first generation (28.5%), 62.9% female, and over half are Pell Eligible (56.5%).

Recognizing that financial aid alone is not enough to significantly improve retention and graduation rates in STEM, the National Science Foundation S-STEM Program funded this project not only to provide scholarships but also implement evidence-based curricular and co-curricular activities to foster students' growth in academic and non-cognitive areas such as social-emotional stability and self-efficacy. These activities include faculty and peer mentorship, belonging building and social events, workforce training and skills development, networking with industry professionals, academic coaching, company tours, community engagement, etc., which have been shown to effectively support recruitment, retention, student success, academic and career pathways, and graduation in STEM fields [14].

Over the five years of the program (2019-2024), 47 unique students pursuing bachelor's degrees in mathematics/statistics, chemistry, geology, and physics received at least one semester of funding and support - with a maximum award of $7400 per academic year covering tuition and fees. On average, scholars received 3 to 4 semesters of scholarship support ($M = 3.64$, $SD = 1.67$) with a minimum of 1 semester and highest at 7. These scholarships support students' unmet financial needs, reduce or eliminate off-campus work, and allow them to focus on academic coursework and participate in programmatic activities. Furthermore, the program provides funding to support traveling to conferences and GRE and graduate school application fees, further improving students' chances of pursuing a STEM-related career.

This paper will present results to answer two key objectives: 1) Assessing how effective the scholarship program is in enhancing participants' non-cognitive skills such as sense of belonging, efficacy in leadership and collaboration abilities, and science identity; and 2) Evaluating the overall impact of the scholarship program on participants' success, including academic performance (e.g., grades), retention, and graduation rates.

Methodology

A comprehensive online post-survey was administered at the end of the Spring semesters to current students enrolled in the program (via Qualtrics). The survey prompted students to reflect on their overall experiences in the program and self-assess skills and non-cognitive skills (e.g., sense of belonging, self-efficacy, science identity). All items were measured using a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree." In addition to the survey, grade point average (GPA) was also retrieved from university records and both retention and graduation rates were collected by program personnel.

Results

Survey Participants. Among the 47 scholars, 44 completed the surveys (60% female, 40% male). In terms of ethnicity, 34% were self-identified Latino/a, 21.2% White, 8.5% African American, 10.6% Asian, and 25.5% multiracial.

Sense of Belonging. On average (M = 4.07, SD = .92), scholars had a strong sense of belonging to the university and college communities. Specifically, 84.1% agreed that they see themselves as part of the campus and college community, 9.1% (3) were neutral, and 6.8% did not feel this sense of belonging. Findings indicated that most scholars valued getting to know faculty (95.5%), 86.1% valued making friends, 79.5% enjoy getting to know their classmates, and 68.2% want to join campus groups and organizations to make these connections.

Efficacy in Leadership and Collaboration Skills. On average, scholars were generally confident about their collaboration skills (M = 4.56, SD = .56) and leadership skills (M = 4.21, SD = .66). Specifically, most scholars (97.9%) agreed with statements that they know how to work effectively to provide support and be a good team member. Additionally, 93.2% of students believed that they have what it takes to be a good leader – encouraging team members and keeping their teams on task; only 2 scholars reported that they had a negative self-assessment of their leadership skill sets and another scholar felt indifferent (neutral) in their beliefs.

Science Identity. Among science (M = 4.19, SD = .53) and mathematics (M = 4.05, SD = .38) scholars, most identified themselves as scientists or mathematicians/statisticians and enjoyed being part of their community as successful, visible members. Among the 31 physical science students (i.e., Physics, Geology, Chemistry), nearly all had a strong science identity, believed other people see them as scientists, knew their strengths and weaknesses as scientists, and enjoyed learning and solving science problems; only one felt neutral in their science identity. Among the 13 mathematics/statistics students, all students see themselves as a 'math/stats person,' know others see them as a math/stats person, know their strengths and weaknesses in their fields, and enjoy learning and solving science problems; only 2 reported a weak identity.

Retention and persistence. Among the 47 supported scholars, 74% graduated as scholars (32 while in program and 3 left the program) as of Spring 2024. Another 15% of the scholars are expected to graduate by Spring 2025. There are 3 students that left the program but are still attending (6%) and 2 students that have left the university (4%). Among the scholars that started their academic career at the institution as first-year students, the 4-year graduation rate was 71% and the 6-year graduate rate was 100% (compared to the university averages of 39%

and 70%, respectively). For transfer students, the 2-year graduation rate was 36% and the 3-year rate was 88% (compared to the university averages of 44% and 68%, respectively).

Persistence in STEM. Among all scholars, the majority (80.9%) reported interest in pursuing a graduate degree: 34% (16) intend to pursue a Master's (M.S., M.A., professional degree), 40.5% (19) want to pursue a doctoral degree (Ph.D.). Only 19.1% of scholars (9) planned on completing just their bachelor's degree (B.A., B.S.), while 6.4% (3) did not respond to the item. As for actual post-graduate achievements: among those who have graduated as a scholar (35) by Summer 2024, 80% (28) have entered graduate school (17; including 1 post-bac research program), STEM industry work (8), or both (3). These include graduate program at the master's level (15), doctoral level (4), and industry work such as staff geologist, quality control chemist, laboratory technician, and research assistant. Overall, 60% of all scholars enrolled in graduate school and/or secured a position in the STEM industry.

GPA Across Time. To assess scholars' academic success and progress, their cumulative GPA was used. Across the 47 scholars, the average cumulative GPA before they started the program was 3.40 (SD = .44; with a minimum of 2.55 and maximum of 4.29); as a group, they maintained this average GPA each academic year. In contrast, among the eight students that left the program, they experienced an average .72 drop in their GPA (with a minimum of .48 and maximum of .94 drop).

Discussion

Our program, designed to integrate financial, academic, and social support through scholarships, mentorship, and skill-building activities, has proven effective in enhancing retention, academic success, and STEM identity among low-income and academically talented URM students. The program's emphasis on promoting non-cognitive skills such as sense of belonging, self-efficacy in leadership and collaboration, and science identity has been crucial for retention and persistence in STEM disciplines. Scholars, particularly among URM students [15], reported strong levels of belonging to their university and academic community, high perceived connections with faculty, peers, and campus organizations, and confidence in their leadership and collaboration skills, all of which are essential for success in the STEM fields.

The program's success is further demonstrated by the strong science and math identity reported by scholars, which has increased their commitment to STEM disciplines. The academic success of the scholars, reflected in their sustained GPA and high graduation rates, suggests that structured support programs like ours can significantly improve outcomes for URM students in STEM. Additionally, the program has been successful in guiding students toward postgraduate education and careers in STEM-related industries, highlighting the importance of early exposure to research, industry, and leadership opportunities. While financial support from the program has been essential, other key elements such as targeted recruitment, mentoring, research opportunities, and community-building activities can still have a meaningful impact on improving STEM persistence and graduation rates.

Acknowledgements

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