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Outcomes of the S-STEM Scholarship Program in Our Institution in the Past Three Years

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Abstract

Our institution was awarded an S-STEM grant in 2018 to continue to provide scholarships and educational opportunities to low-income and talented undergraduate mechanical engineering students. Since then, 44 undergraduate students with diverse backgrounds in Mechanical Engineering department have been awarded the scholarships. In addition to financial support, the S-STEM scholars are connected to individual faculty mentors and provided with opportunities of internships, research-related experiences, and community building activities. The large and diverse applicant pool allowed us to award 22-27 scholarships to students each year, exceeding the targeted annual number of 20 scholarships. Academic records demonstrate that all the proposed benchmarks have been exceeded, especially in the retention rate (91%), diversity of student population, research experience/internship participation (55%), and percentage of our scholars enrolled in graduate school after their graduation (29%). All are higher than that in the regular student population in our department. The results suggested that faculty and peer mentoring, proactive research-related activities, engagement in internship, and interaction with faculty and their peers might contribute positively to the success of the scholars in our program. Some of the cost-effective program activities have been implemented in our undergraduate program, and could be adapted by engineering programs in other institutions. With continuous commitment by faculty members and department/college recognition, the positive impact of the program could be sustained via merging into existing undergraduate program.

Introduction

Recent technological advancements have increased the need for a highly trained workforce that meets the vital technological needs of society. Community colleges and 4-year colleges have been on the forefront in providing students fundamental knowledge of science and technology, as well as developing their technical skills to prepare them for a post-graduate industrial or graduate school environment. However, the retention rate and graduation rate of undergraduate students in STEM fields are typically low and there is room for further improvement. The low retention and graduation rates may be due to not only the rigorous curriculum of the STEM majors, but also economic and academic difficulties those students encounter. Financial support to students alone may not be sufficient to address the problems.

The National Science Foundation (NSF) S-STEM scholarship program was established to encourage higher education institutions to develop academic activities to support undergraduate students in STEM fields to improve their retention and graduation rates, and further increasing their potential of career placement and graduate studies. Our university was one of the institutions awarded the NSF S-STEM grant. Our program uses effective strategies suggested in previous studies to address students' psychosocial needs to enhance retention and graduation in engineering. The targeted psychosocial variables include self-efficacy and outcome expectations, engineering identity, sense of belonging, and academic integration. Addressing these variables is critical for developing effective STEM education programs.

Many previous studies demonstrated benefits of intensive mentoring with at-risk students [1-3]. Mentoring is an essential catalyst for fostering academic success and is especially important for women and students who are traditionally underrepresented in STEM fields. Research experience is another effective strategy for fostering academic success. It is critical for developing and sustaining a student's interests in STEM careers. Engaging undergraduate students in research has been demonstrated to increase students' interest by providing a sense of profession and broadening students' horizons and perspectives [4-7]. In addition, the theory of psychological sense of community stresses the importance of a sense of belonging and integration within a community [8-11]. This would be extremely important to undergraduates who are commuters rather than living on campus. Development of program activities to help students integrate into their academic program and improve their sense of belonging to campus, would be crucial, as those are strong predictors of STEM achievement and persistence. The current S-STEM Scholarship Program in our department actively promotes interaction between students and faculty, undergraduate participation in research projects, and service to the community. In this study, we report the demographic data, academic performance, and satisfaction with program activities of our current S-STEM Scholarship Program supported by NSF, and discuss the best practices and lessons learned.

Methods

Data related to the students' demographics, including race, gender, age, economic status, and whether they transferred from a local community college to our institution, were collected from the original application forms when students applied for our S-STEM scholarship. Data only from students accepted into the program and granted a scholarship were included in this analysis. Academic performance data such as semester and accumulative GPAs were collected through academic advisement accessed by the program director. Attendances to various STEM activities sponsored by our scholarship program were recorded by the program director during

individual events. Students' participation in research experience of undergraduates (REUs) and internships during their duration with our program was indicated in the annual surveys that all scholars are required to complete, and was analyzed by the external evaluator of the scholarship program. The research protocol of conducting surveys was reviewed and approved by the Institutional Review Board (IRB) of our institution.

Results

Our university was awarded an S-STEM grant in 2018 to provide scholarships and educational opportunities to low-income and talented undergraduate students in the Mechanical Engineering Department. Since then, 44 undergraduate students in our department have been selected to receive the S-STEM scholarship. Among them, 63.6% are male and 36.4% are female. Students indicating their race as white have the largest percentage of the scholars (59%), while Asian students have the smallest percentage (18%). Students who identified as an underrepresented minority (URMs) - defined as African American, Hispanic, and/or Native American - made up 34% of the scholars. More than 36% of the scholars originally transferred from a local community college. The demographic data are summarized in Figure 1.

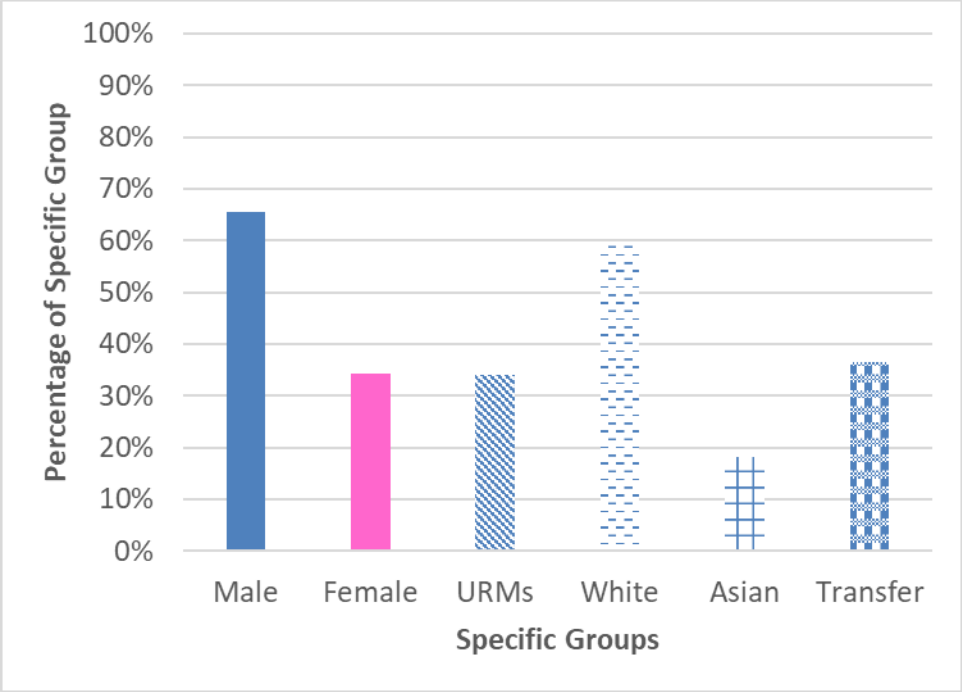

Figure 1. Demographic data of scholars in our S-STEM program.

The main activities sponsored by our program are 1) active recruitment from local community colleges and high schools, 2) faculty and peer mentoring, 3) research related activities such as lab visits, research seminars, and research experience facilitation, 4) professional develop events to help place students in internships and prepare for graduate school, and 5) community building, including annual retreats and lunch with faculty. For most of the activities, attendance was mandatory, however, due to various reasons, the attendance rates varied from 89% to 100%. Shown in Figure 2, the average attendance rates for several key activities (meeting with mentors, attending research seminars, visit research labs, attending retreat, and attending workshops) were higher than 93%.

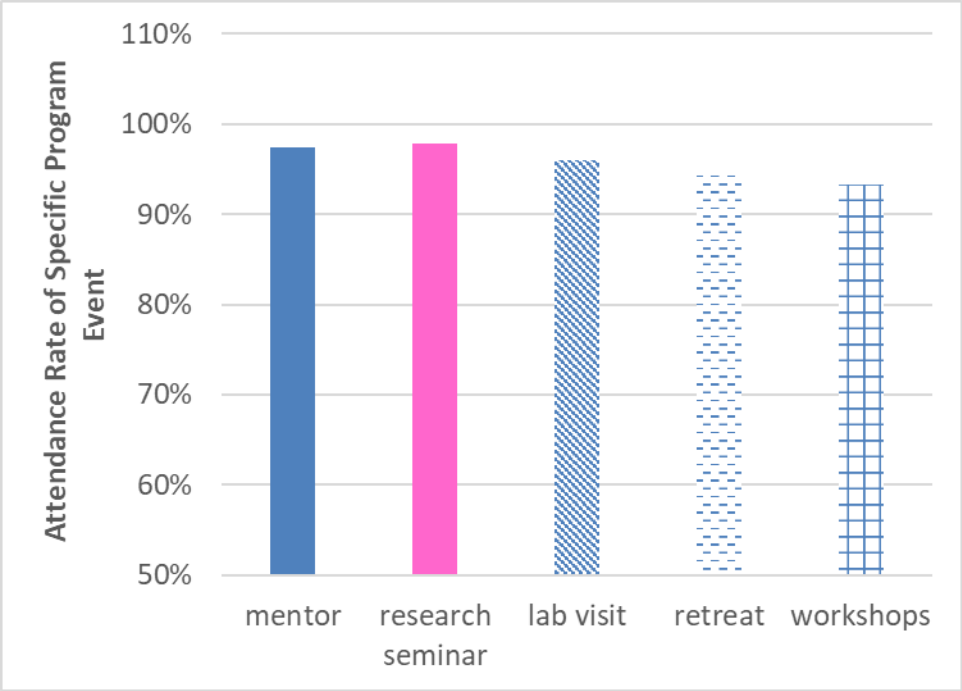

Figure 2. Attendance rate of our scholars attending specific events sponsored by the S-STEM Scholarship Program in the past three years.

Students' satisfaction toward activities sponsored by the S-STEM program was analyzed from annual surveys submitted to our external evaluator. Students were very positive on how mentoring from individual faculty affected their academic performance, with 71% rating mentoring as very good or excellent, and 13% as good; however, 10% rated faculty mentoring as fair or minimally effective. A majority of the scholars rated research related events, such as attending a research seminar and a lab visit, as very good/excellent (64% and 91%, respectively). 22% of the students considered attending a research seminar as good, while only 5% considered attending a lab visit as good. Less than 12% of the scholars rated attending research seminars as minimally effective or fair, none of the students rated attending lab visits as fair. Students' satisfaction rates toward the annual retreat and workshops focused on professional development were similar. More than half of the students (55%) rated the two events as very good or excellent, and more than 30% of the students rated them as good. Only 4.5% of the students rated them as fair. The student satisfaction ratings are summarized in Figure 3.

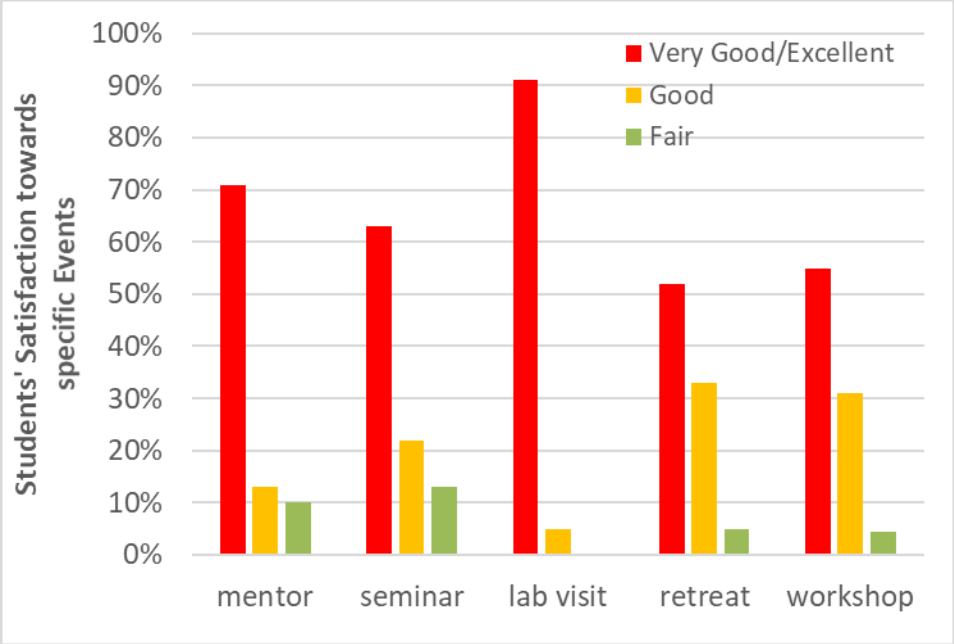

Figure 3: Students' satisfaction rate of individual events sponsored by the program.

In the past three years, 24 of the 44 scholars had at least one internship or research experience, with a participation rate of 55%. Our records showed a total of 26 research experiences and 25 internships obtained by our scholars, resulting in 1.16 research experience/internship per scholar. Students had very positive ratings on how participating in lab research or working in industry as an intern helped them academically. Sixty-two percent (62%) of the students interned in private corporations or industry. Thirty-one percent (31%) interned with government or military agencies, and 15% interned on university campuses. On average, they rated their internship experience 81% as excellent (80%-100%). Among the scholars who had at least one research experience, 50% worked in faculty members' research lab. Twenty-five percent worked in academic labs at other universities and one person worked in an industry lab at the National Institute of Standards and Technology. The average satisfaction rate of the research experiences was between very good and excellent.

Among the 44 S-STEM scholars, six of them were placed on probation because their semester GPAs dropped below our probation threshold of 2.75. Probation triggered academic intervention from the faculty team to those students to help them improve. Among the 6 scholars, the GPAs of 3 improved to exceed our threshold in the subsequent semester, and they thus remained in our scholarship program. Two scholars' scholarships were not renewed because their GPA remained below our required threshold of 2.75 for two sequential semesters. Two scholars transferred to other universities due to personal reasons. Our overall retention rate in the scholarship program is 91% (40/44).

Twenty-one scholars graduated from our undergraduate program in the past three years (since Fall 2018). The average GPA at their graduation was 3.54, ranging from 3.17 to 4.0. There was no statistical difference in the cumulative GPA between the non-transfer students (3.54±0.21, n=12) and students who originally transferred from a local community college (3.51±0.28, n=9). Among the graduated scholars, 29% are enrolled in graduate studies in STEM

fields, and 71% are working either in industry or in government agencies. Based on our previous surveys, the scholars who wanted to work in industry or government agencies expressed their plan to enroll in graduate school part time if their company/agency covers the expenses of their graduate education [12].

The outcomes of the current S-STEM program have suggested positive impacts of the various program activities on the students' retention and graduation [13-15]. S-STEM sponsored activities could be placed into one of four groups: mentoring, academic help, research, and community building. Typically, all mechanical engineering undergraduate students receive advisement by a faculty member in the mechanical engineering department once they are officially admitted into the ME program. Our S-STEM program provides extra faculty mentoring and the scholars are encouraged to meet their faculty mentors when needed to discuss not only their academic progress, but also their future career plan and personal issues. Most of the scholars had talked to their faculty mentors more than three times each semester, suggesting that they felt comfortable to discuss issues they had with the faculty. Peer mentoring is a departmental program open to all undergraduate students. The ME S-STEM scholars are required to join the peer-mentoring program to serve as either a mentor or a mentee. Students in the peer mentoring program meet regularly during semesters. The ME S-STEM program also provides academic help to our students by organizing workshops on time management and tutoring services to our scholars. The faculty in our program actively encourage our scholars to pursue internship opportunities by connecting them to employers in industry and/or resources on campus. Various research related activities are implemented in our program, including providing research opportunities to work in research labs, conducting in-depth lab visits, sponsoring students to attend conferences, and featuring their research on our program website. Since most of the undergraduate students on our campus are commuters, we implemented many community building activities to promote interaction among the scholars and with their faculty mentors, including annual retreats, lunches with faculty, and professional development workshops to create opportunities to promote gathering and interaction. All our scholars are also encouraged to join professional societies to interact with their peers.

As demonstrated by our previous study, the implemented S-STEM activities such as mentoring, research, and internship were viewed favorably by the scholars in helping them establish their scientific efficacy and engineering identity, and understand their expectations and goals [12]. Community building activities were considered helpful and contributed to integrating into campus life and improving their sense of belonging to the campus and program. Previous survey data illustrated that students have identified mentoring, research related activities, internships, and social interaction with faculty and their peers as important factors for their retention and graduation. Results of our study would lead to determination of activities that require minimal resources, but can be easily implemented to improve retention and graduation rates of undergraduate students in mechanical engineering.

To sustain the positive impact of the S-STEM program, it would need support from the university administration. Some of the activities such as tutoring service are costly, and may continue if being merged into existing teaching assistance structures. On the other hand, most of the activities such as research and community building do not require substantial funds. Currently, some of the research activities in our program including lab visits, research seminars, and professional development workshops are not limited to S-STEM scholars; they are open to all ME undergraduate students. However, to sustain it after the end of the grand support, they

would depend on voluntary contributions from the faculty members, in addition to their existing teaching and research duty. It is critical to emphasize the importance of departmental and college recognition of faculty involvement in undergraduate education, especially in institutions favoring graduate research.

Conclusions

In conclusion, based on our aspirational metrics, the ME S-STEM scholarship program has been successful in recruiting applicants, awarding scholarships, and conducting all the planned program activities. Academic records demonstrate that all the proposed benchmarks have been exceeded, especially in the retention rate, diversity of student population, research experience/internship participation, and percentage of our scholars enrolled in graduate school after their graduation. The results suggested that faculty and peer mentoring, proactive research-related activities, engagement in internship, and interaction with faculty and their peers might contribute positively to the success of the scholars in our program. Some of the cost-effective program activities have been implemented in our undergraduate program and could be adapted by engineering programs in other institutions. With continuous commitment by faculty members and department/college recognition, the positive impact of the program could be sustained via merging into existing undergraduate programs.

Acknowledgement

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