Reflections on Realizing the Promise of the NSF S-STEM Program

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Dr. Davis has a unique combination of education and skills to provide research and evaluation services to STEM education programs. She holds a Ph.D. in Soil Microbiology and after spending over 20 years as a practicing science researcher she spent 12 years engaging in meaningful STEM education research and evaluation. As Director of STEM Education for University of Idaho (UI) since 2012, she developed the STEM Education Strategic Plan and was responsible for evaluating UI STEM education programs against stated objectives, providing feedback that helped bring the university programs into alignment with that strategy. She has served as Principal investigator, researcher, and evaluator on a number of federally

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Introduction

The National Science Foundation (NSF) S-STEM program has a unique combination of goals. As a scholarship program, it has the specific goal of distributing scholarship funds to high achieving students with great financial need. As an NSF program, it is tasked with scientific goals of documenting, assessing, and analyzing the implementation of high impact educational activities within the STEM fields and furthering knowledge through dissemination. Threading the needle towards reaching these targets requires a fine balance of team effort at an institution, so that significant long-term broader impacts remain even after the end of program funding. Meeting this set of goals has been a great challenge; however, students involved in this program have achieved success.

Program Design and Approach

Against the backdrop of the President's Council of Advisors on Science and Technology report calling for one million new STEM graduates,[1] the University of Idaho developed and implemented *Career Launch*, a five-year NSF S-STEM funded program, in 2015. The hypothesis of the program was that reducing the hours students needed to work outside of school through scholarship support would allow them to spend more time participating in activities that would enhance persistence by enriching their academic experience while progressing toward their future career goals.[2-4] The target pool for scholarship recipients had high financial need and were enrolled in STEM fields within the College of Engineering, and these students were identified by coordination with Student Support services and Financial Aid offices. Students who started the program in a given year were considered to be members of a cohort. Beyond a modest number of hours designated for the PI, a clinical, teaching-focused, faculty member was designated as the primary coordinator for student activities to enhance cohort development, academic achievement, and an outcome-oriented evaluation.

To enhance cohort development, activities for the student cohorts included:

- Visiting companies to meet potential employers to see how engineering is conducted in the field,
- Developing and participating in hands-on undergraduate research projects,
- Participating in community service projects,
- Attending guest lectures from world-class engineers,
- Serving as mentors for students in later cohorts, and
- Participating in community outreach with K-12 institutions in the region.

A key objective was to leverage cohort development across cohort years though peer-mentoring. Toward this objective and working within the structure of the NSF S-STEM program, additional stipend funds were designated to support students participating in peer-mentoring, as well as funding for a proposed training retreat to instill best practices in peer-mentoring.

The University of Idaho hosts programs and resources that support students in achieving academic and professional success. A key aspect of Career Launch was to move away from a "self-service" guidance program to proactively introducing cohort students to the variety of resources in the COE and at UI designed to help them succeed in their degree programs and in their careers.

Through the orientation activities, cohort development, faculty and peer mentoring support, seminar series, and research and service activities, students were to develop sustained interactions with other students, faculty, and staff invested in their success. While this approach ensured students had access to programs they may need, we found that most of the high-achieving program participants needed little external support, while students who struggled responded extraordinarily well to personal meetings and interactions.

Outcome-oriented evaluation occurred on two levels. First, the Career Launch scholars were monitored throughout the year and evaluated at the end of each semester. For each student, the evaluation included information about progress towards a degree; GPA; number of hours worked STEM or non-STEM internships/jobs; applied engineering experiences through student clubs, department projects, and undergraduate research; participation in STEM internships; and job placement or application to and acceptance in a graduate degree program for graduating students. Additionally, evaluation was conducted based on the original program criteria, and the impact of the program was quantified.

Results and Evaluation

Student selection was a key component to this program's success. Clear selection criteria were set in the first semester and maintained throughout the life of the program. Criteria included financial need, completion of first year in an Engineering discipline, and cumulative GPA of 3.2 or higher. Financial need and GPA were tracked for each scholar throughout their participation in the program. When the program was initiated, tuition was a total of \$6,524 per year, so scholarships of \$6,000 were awarded in students' first year in Career Launch and \$7,950 budgeted in the second and third years with the goal of eliminating tuition as a student expense. The number of qualified students in the College of Engineering was high and all who were eligible were invited to apply. Final numbers of students invited, applied, and awarded scholarships were as follows:

Cohort 1: (AY 2015-2016): 135 invited in two rounds, 15 applicants, 7 awarded.
Cohort 2: (AY 2016-2017): 120 invited, 18 applied, 9 awarded.
Cohort 3: (AY 2017-2018): 124 invited, 15 applied, 9 awarded.

These numbers show clearly that only a small fraction of the invited students applied. Program faculty noted that this a pattern which had also been seen in other professional society scholarship programs. One potential route to address this issue could be to hold a "Scholarship Bee," where perhaps with food and informal activities, students are encouraged to explore and apply to the numerous financial opportunities at an institutional, national, and even international levels.

Over the course of the program, a total of 25 students were accepted into the program and three of those were dropped either due to no longer meeting the financial need requirement or inability to maintain the cumulative GPA requirement. In year two of the program, close examination of the first student to drop due to GPA issues revealed that his transfer grades had strongly contributed to his GPA acceptance; however, his University of Idaho course grades were considerably lower. Based on this realization, the team made a change to the selection process to include greater scrutiny of transfer grades compared to UI course grades.

Within this set of students, some were highly self-motivated, and the support from the scholarships allowed them to raise their grade point averages and, in some cases graduate sooner. At the end of the spring semester in 2020, 22 of the original 25 scholars were retained in the program. Of those 22 scholars, 19 graduated in their original degree program in the College of Engineering and 3 remain active in their original degree program and are on schedule to graduate this academic year. This represents an 88% retention rate. It is worth noting however, that the three students that left the Career Launch program all continued in their original field of engineering at UI, two graduated, and the third was continuing in their program. This is essentially a 100% retention rate of the original scholars in College of Engineering. For comparison, the six-year graduation rate for the College of Engineering averaged from 2007–2014 is 59%. For Career Launch scholars, the mean cumulative GPA of active students and graduates at end of 2019/2020 academic year was 3.56 with a range of 3.22 to 4.0.

As shown in Figure **1**, the hours worked per week by Career Launch scholars dropped dramatically over the course of the program. The initial cohort of students entered the program in Spring 2016 reporting, on average, 20 hours per week of work. This was largely due to previous commitments. By spring semester of 2018, all three cohorts had started in the program and there were 20 active students. Allocation of scholarship funds was adjusted (scholarships for continuing students were increased within the limits of the program) to maximize benefit to those in need. The average hours worked per week for those 20 students decreased to under nine hours. Of those 20 scholars, three of them reported not needing to work at all and 10 reported finding internships in their fields of study as their work hours. All reported feeling less financial stress, reduced time working, and increased time to spend on academics and/or other activities. During the 2019/2020 academic year, only five of the nine continuing students reported working at all, and the average hours worked/week dropped to three. Four of those five working scholars worked in STEM related internships.

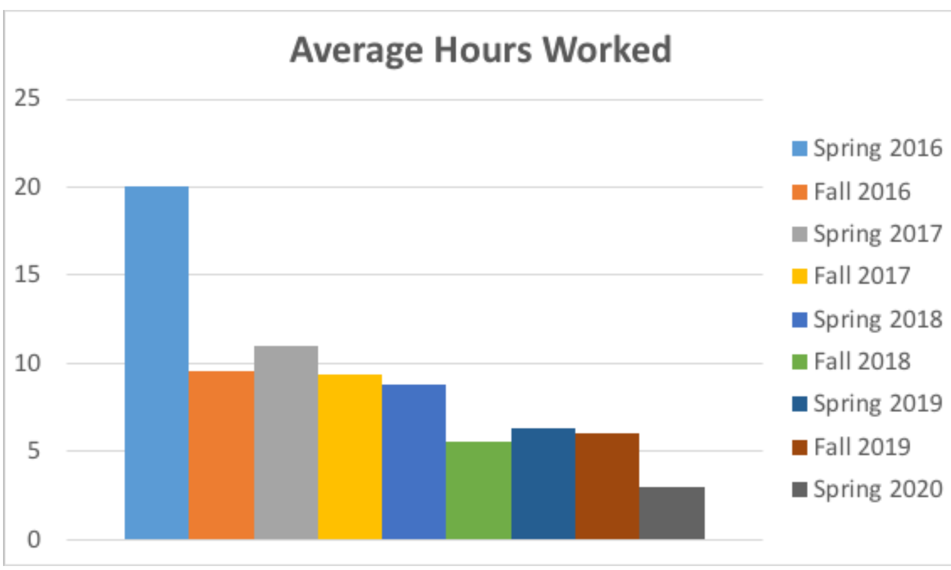

Figure 1. Average hours worked by Career Launch Scholars

All scholars reported spending more time participating in activities that would enrich their academic experience and assist with future career goals, and a relationship between hours worked and participation in other activities is apparent in Figure **1**. In the academic year 2017/2018, when hours worked per week dropped significantly, participation in activities increased. In interviews and discussion groups, students expressed that participation in the activities enhanced their experience and contributed to their successful completion of degrees and post-graduation job and graduate school placement.

The program team made a concerted effort in the third year to provide more mentoring and coaching opportunities to scholars. Program faculty held small group sessions with students and email between faculty mentors and scholars was used to improve communication. Additionally, six seminars were held with follow up discussions and student reflections. While the average number of program activities in which students participated increased somewhat, the program team was concerned that these program-specific activities were having limited reach and impact.

During the grant period, loss of the team's clinical faculty member led to a reevaluation of the program structure, specifically the role of the cohort facilitator. In the academic year 2018/2019 the program team made the decision to hire a graduate student to serve as the coordinator of activities and primary point of contact for students. This was intended to help ensure students received mentoring or assistance when needed. Increased emphasis on mentoring resulted in more faculty engagement in one-on-one mentoring of students needing help and several students reported that the mentoring helped them raise their GPA. Students were also introduced to and encouraged to use support services on campus that were available to them in addition to Career Launch services.

For some students, direct intervention was particularly effective to help them achieve success. In fall of 2018, there were four students that were struggling academically as indicated by their GPA. Those students received targeted, individual mentoring in the form of an in-person meeting with a Career Launch faculty member and the graduate student assistant, with subsequent email follow-up. Of those four students, three were able to raise their GPA sufficiently to remain eligible for the program scholarship. One student also went on to become heavily involved in the Grand Challenges Scholars Program, participating in international events. The one student that was dropped due to low GPA reported that the mentoring helped him raise his GPA and he did remain in his degree program within the College of Engineering. This simple intervention made an outsized impact on student outcomes.

Simultaneously, it was found that cohort students were extensively involved in multiple on-campus activities, including professional societies, limiting their ability and interest to take on additional program-specific activities and responsibilities. However, feedback from students suggested that opportunities to engage in research are important to their decisions regarding future plans. In year 3, a tour and follow-on discussion introduced the scholars to undergraduate research opportunities. The following year, students participated in activities that included industry internships, attending and presenting at research conferences, engaging in faculty research projects, and participating in professional societies. Of the 17 scholars active in spring of 2019, nine reported participating in a research activity of some kind, the highest frequency of any enrichment activities offered.

Discussion

While this program has been effective, it has identified key questions for future proposals:

1. Within the constraints of the NSF S-STEM program, what is the appropriate balance of near-peer, graduate student, staff, and faculty advisors?

In the experience documented here, the introduction of a near peer, graduate student assistant was a significant positive development. Due to the unexpected loss of the clinical faculty intended to coordinate student activities, the graduate student assistant played a critical role in the program by serving as the primary program-student interface. This relieved program faculty from lower-level communication and follow-up tasks and gave students a single point of contact. The utility of this approach did raise questions regarding the distribution of responsibilities in future proposals. Faculty hours, in particular, are significant budgetary constraints, strongly limiting the possibility for day-to-day responsibility. The funding of a full-time staff member associated solely with the S-STEM program does not seem sustainable unless the institution guarantees to take on the salary burden once program funds are expended. Moreover, lower paid staff positions are also susceptible to significant turnover as staff seek career advancement opportunities. In contrast, for a limited term program of five years, a suitably selected and mentored Ph.D. student, or students, could very likely use graduate student assistantship funding to support dissertation research concerning S-STEM program goals, giving the program another broader impact.

2. Is it reasonable for an NSF S-STEM program to operate independently of existing host University academic staffing and structures?

The experiences here indicate that in order to meet the goals of the NSF S-STEM program, namely long-term institutional impact integration into existing structures and leveraging interactions with existing long-standing institution structures is highly desirable. In this way, the limited term funding can be used to boot-strap new educational opportunities on-campus and give them a permanent home. Another potential opportunity is the development of new laboratory classes that could be justified long-term by increased tuition revenue that could be allocated to supporting teaching assistants. The teaching assistant is important to prevent additional responsibilities falling to faculty who could otherwise allocate their support to the program in other ways.

3. Given a desire for intra-cohort activities, are low cohort numbers spread across multiple disciplines problematic given the multiple external commitments observed in driven students?

One point of feedback that was received, and confirmed by experience, is that these driven, high-achieving students do not need more on their plates, so to speak. As one student stated plainly, they "just need the money." So, in terms of developing new educational interventions, are S-STEM eligible students the target audience? ***Our experience shows that these students seek out challenges when they have the freedom to do so.*** Perhaps S-STEM activities should be targeted at the general STEM student population, allowing scholarship recipients to engage on their own prerogative. To wit, do *already high-achieving,* low-income students need new interventions? Clearly, they possess drive and many tools for success; perhaps they truly only need limited or no intervention, just the financial breathing room offered by a scholarship. In contrast, the funding of interventions targeting low-achieving STEM students could be truly transformative.

4. If an S-STEM program is focused on a specific discipline or disciplines, is it critical to have previously identified specific external funding entities to sustain the program's existence beyond the grant period?

Certainly, scholarships require funding, so once NSF funding ends, further scholarships require new funding sources. Perhaps ideally, this funding would be picked up by local or regional STEM companies who have benefited by employing former scholarship recipients. Such a mechanism could certainly create a "virtuous circle." On the other hand, institutional enhancements demonstrating increased student demand present a straight-forward argument for long-term institutional funding.

Conclusion

While our NSF S-STEM program has succeeded in assisting STEM students with high financial need to graduate and obtain STEM employment; several questions have arisen for future efforts, and additional long-term support has not been forthcoming from within or without the investigator's university. In particular, key challenges to sustain this valuable program are identifying stable staffing and coordination structures, some perhaps already present within our institution, and external funding avenues for long-term support. As these issues are unlikely to be unique to our institution, working towards their resolution will further broaden efforts in STEM education.

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