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STEM Scholars Engaging in Local Problems

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STEM Scholars Engaging in Local Problems

Abstract

Eastern Mennonite University received a 5-year S-STEM award for their *STEM Scholars Engaging in Local Problems* (SSELP) program. The goal of this place-based, interdisciplinary scholarship program is to increase the number of academically talented, low-income students who graduate in STEM fields and either pursue immediate employment in STEM careers or STEM-related service or continue their STEM education in graduate school.

In 2018 and 2019, two cohorts of seven students were recruited to major in biology, chemistry, engineering, computer science, mathematics, or environmental science. A key part of recruitment involved on-campus interviews, during a February Scholarship Day, between STEM faculty and potential scholars. As the yield rate for the event is high (54-66%), the university has continued this practice, funding additional STEM scholarships.

In order to retain and graduate the scholars in STEM fields, the SSELP faculty designed and carried out various projects and activities to support the students. The SSELP Scholars participated in a first-year STEM Career Practicum class, a one-credit course that connected students with regional STEM practitioners across a variety of fields. The scholars were supported by peer tutors embedded in STEM classes, and now many are tutors themselves. They participated in collaborative projects where the cohorts worked to identify and solve a problem or need in their community. The SSELP scholars were supported by both faculty and peer mentors. Each scholarship recipient was matched with a faculty mentor in addition to an academic advisor. A faculty mentor was in a related STEM field but typically not teaching the student. Each scholar was matched with a peer mentor (junior or senior) in their intended major of study. In addition, community building activities were implemented to provide a significant framework for interaction within the cohort.

To evaluate the progress of the SSELP program, multiple surveys were conducted. HERI/CIRP Freshman Survey was used in the fall of 2018 for the first cohort and 2019 for the second cohort. The survey indicated an upward shift in students' perception of science and in making collaborative effort towards positive change. Preliminary data on the Science Motivation Questionnaire showed that the SSELP scholars began their university studies with lower averages than their non-SSELP STEM peers in almost every area of science motivation.

After over three years of implementation of the NSF-funded STEM Scholars Engaging in Local Problems program, the recruitment effort has grown significantly in STEM fields in the university. Within the two cohorts, the most common majors were environmental science and engineering. While 100% of Cohorts 1 and 2 students were retained into the Fall semester of the second year, two students from Cohort 1 left the program between the third and fourth semesters of their studies. While one student from Cohort 2 had a leave of absence, they have returned to continue their studies. The support system formed among the SSELP scholars and between the

scholars and faculty has benefited the students in both their academic achievement as well as their personal growth.

Introduction

Place-based education is a subset of project-based learning, rooted in the local community, cultures, ecology and environment of the student [1]. Students learn through active participation in the community and often through a community project. Prior research at the K-12 level links place-based activities with increased levels of student motivation [2], [3]. Research on motivation at the undergraduate level links increases in motivation with increased retention and student success [4], [5]. However, there is a gap in the research as place-based studies have not focused much on the postsecondary level.

The Eastern Mennonite University (EMU) Science, Technology, Engineering and Mathematics (STEM) Scholars Engaging in Local Problems (SSELP) program is a place-based, interdisciplinary scholarship program designed to increase the number of academically talented, low-income students who enter into and graduate in STEM fields and pursue employment, service, or continued education in high-need STEM fields regionally and nationwide. This program uses the local community (Harrisonburg, Virginia) and the surrounding region (the Shenandoah Valley) as a rich resource to inspire and teach students STEM concepts in a hands-on, problem-to-solution based manner.

EMU SSELP Scholars have participated in authentic research on real world, place-based issues. In addition, they learned more about the cultures and needs of their community by participating in mentor relationships (as a mentee and mentor), and community building activities culminating in a place-based service project. As the nature of the pandemic changed the landscape of "place" for students, interviews are being conducted to see how the students' perception of place has changed to encompass a virtual place.

Small colleges and universities will benefit from the knowledge generated about place-based learning and can use this knowledge to enhance the way they prepare and support academically talented, low-income STEM students and all STEM students.

Interventions and Results

Recruitment

One of the program objectives was to recruit 14 academically talented, low-income students majoring in biology, chemistry, biochemistry, engineering, computer science, mathematics, or environmental science.

The SSELP scholarship program (which includes a visit weekend at which prospective students interview for the scholarship and interact with faculty, staff and potential student peers) resulted in the following positive yield outcomes (Figure 1). Yield is calculated as the percentage of students who were admitted to the university that enrolled in the identified semester (e.g., Fall 2018). These outcomes ensured that EMU was able to not only achieve its recruitment targets for

the SSELP program but also observe positive yield rates for students in STEM programs who weren't affiliated with the grant program. These positive yield rates persist even in the years after the grant-funded scholarship program concluded.

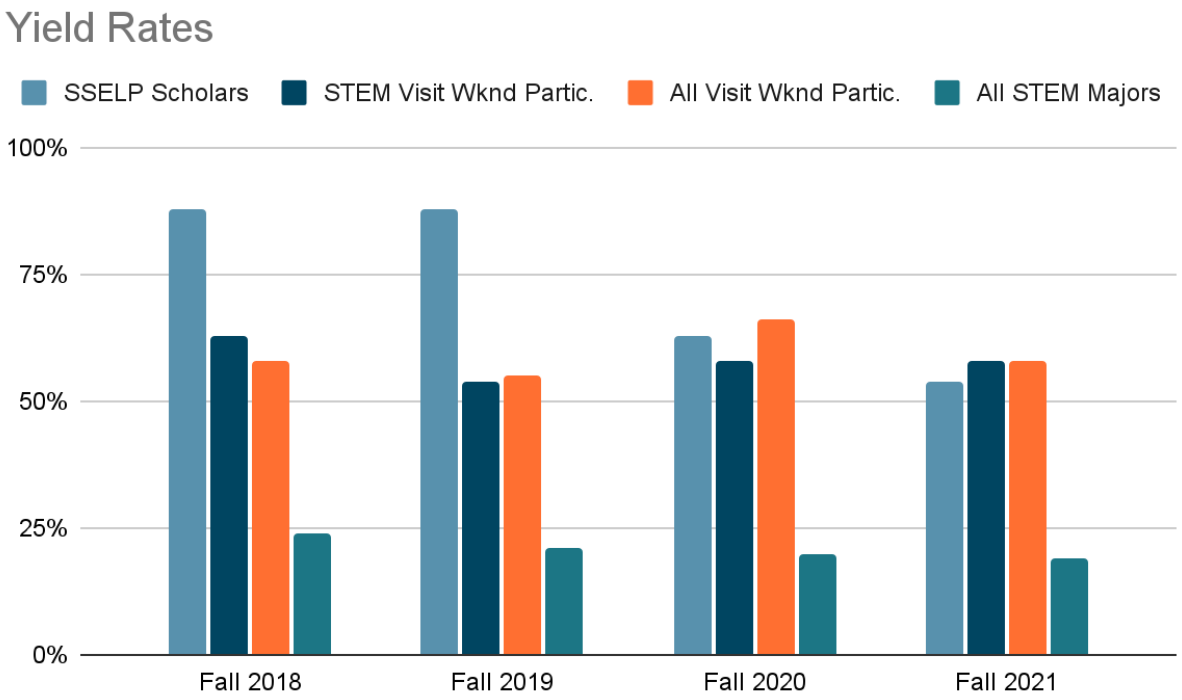

Figure 1. Yield rates for SSELP scholarship awardees, STEM visit weekend participants, Overall visit weekend participants, and STEM majors overall (visit weekend participants and non-participants).

Retention

Another objective of the program was to retain 93% (13/14) of scholars from Year 1 to Year 2 and add an additional scholar(s) from the waiting list, if needed, to achieve 100% retention over the term of the grant.

Figure 2 below presents retention across four years of study for the SSELP scholar cohorts as well as for STEM students, and first-year cohorts overall at EMU. The SSELP program achieved (exceeded) the goal of retaining 93% of scholars from Year 1 to Year 2. All scholars (100%; 14/14) returned for a second year of studies. However, during their respective second years three scholars exited the university (two in Cohort 1 and one in Cohort 2). One scholar from the waiting list was added to Cohort 1 and is persisting in enrollment. The Cohort 2 scholar on leave of absence has returned to continue their studies.

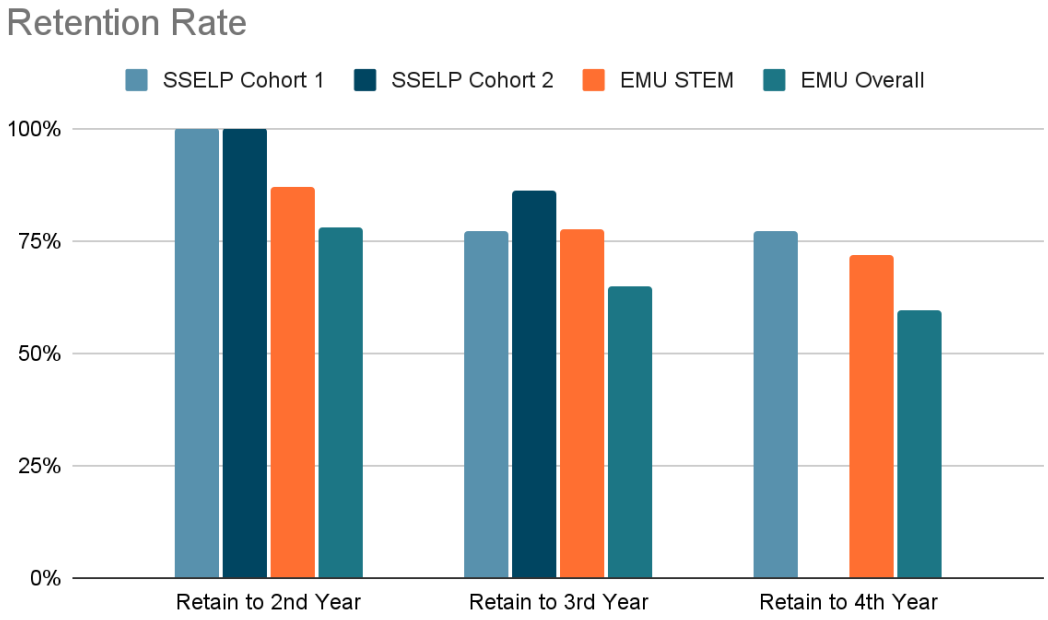

Figure 2. Retention rates for SSELP scholar cohorts, EMU STEM majors, and EMU first-time students overall. Retention rates for Cohort 1 include one scholar who was added to the cohort from the waiting list.

Career Discernment within STEM

The Science and Engineering Practicum (STEM 2019), modeled after another course at EMU, provided opportunities for students to gain healthcare clinical experiences, to reflect upon vocation choice, and to develop a more thorough understanding of professionalism in their chosen field. While this new course met a general education requirement for the students, it was not required for any major. Almost every STEM scholar enrolled in the course, but virtually no others. Because of this lack of student interest, the course was eliminated. The biology program did create something similar for their majors. The goals of the STEM practicum (accomplished) were:

- Connect students with EMU STEM alumni and other STEM professionals,
- Tour / interact with local STEM industries and employers,
- Work with Career Services to develop a resume and cover letter,
- Prepare to apply for summer internships

As a culminating part of the course, all students interviewed an EMU STEM alum who is working in an area related to their current career interests. They created a final project that involved audio or video and a written story.

Embedded tutoring

Research shows that serving as a tutor in the postsecondary environment can result in both personal and academic growth, including increased self-efficacy, content knowledge, problem solving, and communication skills [6], [7]. SSELP Scholars have benefitted from receiving tutoring as well as offering tutoring services themselves. With three academic

semesters remaining in the grant, seven of the Scholars have already served as a tutor for a class within the STEM fields. In some cases, the Scholar was a general tutor in the Academic Success Center, but in most cases, they were embedded within a specific course. Specifically, at the most recent count, they have been embedded in a total of 18 sections of courses including Concepts in Biology, Ecology, Introduction to Engineering and Design, Conservation Biology, Introduction to Programming, Descriptive Statistics, Organic Chemistry I, General Chemistry II, and Physics I.

Embedded tutoring began at EMU in 2016 as part of an NSF-IUSE grant, and has expanded steadily since then (both within STEM and beyond STEM) due to its success. At EMU, an "embedded tutor" is a tutor who is paired with a specific course and professor. The pairing is often initiated by the professor who invites a student who has successfully completed the course. While tutors at EMU had traditionally been some of the top students academically, trial and error revealed that it was effective to expand the range of potential embedded tutors to students who had performed strong, but perhaps not at the top level. Many of these students could relate better with misconceptions that their peers struggled with, and the expanded range also allowed for a pool of tutors from more racially diverse backgrounds. The role of the embedded tutor varies greatly depending on the course, the professor, and the student. In some cases, the embedded tutor attends some of the classes, in order to assist the professor but also to build relationships with students so that they feel more comfortable in seeking help outside of the classroom. Because the embedded tutor is typically in regular contact with the professor, they can serve as a bridge between students and professor and team up to more effectively address the needs of the class. Students attending sessions with an embedded tutor have reported appreciating how well the tutor knows the idiosyncrasies of the specific course, curriculum, and professor.

Team projects

One of the goals of the SSELP program is to bring forth hands-on, real-world learning experiences for our scholars. This goal was achieved through participation in collaborative projects. All of our scholars have participated in team projects through the program. One such project was stream assessment in Parkwoods, a green space with a stream running through it on campus, as part of a restoration project. Eight SSELP scholars worked on the assessment of the physical, chemical, and biological health of the stream, tree identification, and establishment of the stream profile through measuring stream physical parameters such as length, depth, width, and the bank's angle. Another four scholars worked on a wheelchair project where they designed a new wheelchair brake system for a local health center. The scholars met with faculty advisors on a biweekly basis and each had a goal of contributing two hours per week over four semesters. The pandemic interrupted both projects and cut the duration short by one or two semesters for the students depending on when they joined the projects. Even though the projects were scaled down, the scholars appreciated the experiences. One student reflected, "What was most impactful to me though was the last semester of directly working in my local environment. Through the process of determining sediment load and dissolved chemicals, I was able to apply the skills I've learned in my chemistry and biology class directly to a real-life scenario." Another student reflected, "Through the project, I gained practical knowledge about stakeholder

communication and ecosystem restoration. This experience can be applied to my career aspirations of humanitarian aid work and community organizing."

In the process of working on team projects, the scholars built an interdisciplinary community amongst themselves, enjoyed the support from each other, and developed leadership skills. The Parkwoods project team, for example, included students majoring in biology, chemistry, environmental science, computer science, and engineering. In addition, five scholars have been part of the Engineering for a Sustainable World club with two majoring in environmental science, one in computer science, and two in engineering. Beyond the two projects organized by faculty mentors, two SSELP scholars initiated their own projects – one being a super-mileage car project and another a bridge project, where they take on tremendous leadership responsibility. The car project team built a car from scratch and participated in a competition with a team from a local university and the 2021 season Shell Eco-Marathon global virtual competition. The bridge project team is completing Engineering-in-Action's online educational courses and preparing a bridge design, and will help build a bridge for a community in Bolivia in the summer of 2022.

Students' level of motivation for their major

Students' level of motivation for their major is assessed primarily via the Science Motivation Questionnaire (SMQ) [8]. The SMQ is a 30-question Likert-scale survey that includes questions related to identity, interest, beliefs, and confidence as they relate to the student's specific STEM discipline. Higher numbers represent higher levels of motivation for the sciences. The two figures (Figure 3 and Figure 4) below present early data on the relationship between the overall motivation levels and student persistence for SSELP scholars and a sample of non-program STEM majors. The figures further present data on key sub-scales of the SMQ (intrinsic motivation & personal relevance, self-efficacy & assessment anxiety, self-determination, career motivation).

The data presented below represent "pre-intervention" data. Figure 3 shows how students who have persisted in the STEM major tended to score higher on certain areas upon beginning their studies. Specifically, they reported higher levels of intrinsic motivation, personal relevance, self-efficacy, and overall science motivation. On the other hand, they scored slightly lower in terms of self-determination and career motivation. These results suggest tentatively that internal motivators may correlate more strongly with retention than external ones. Figure 4 suggests that the SSELP scholars began their university studies with lower science motivation levels, on average, than their peers. Follow-up data will be collected this spring for the first cohort of scholars as they approach their graduation.

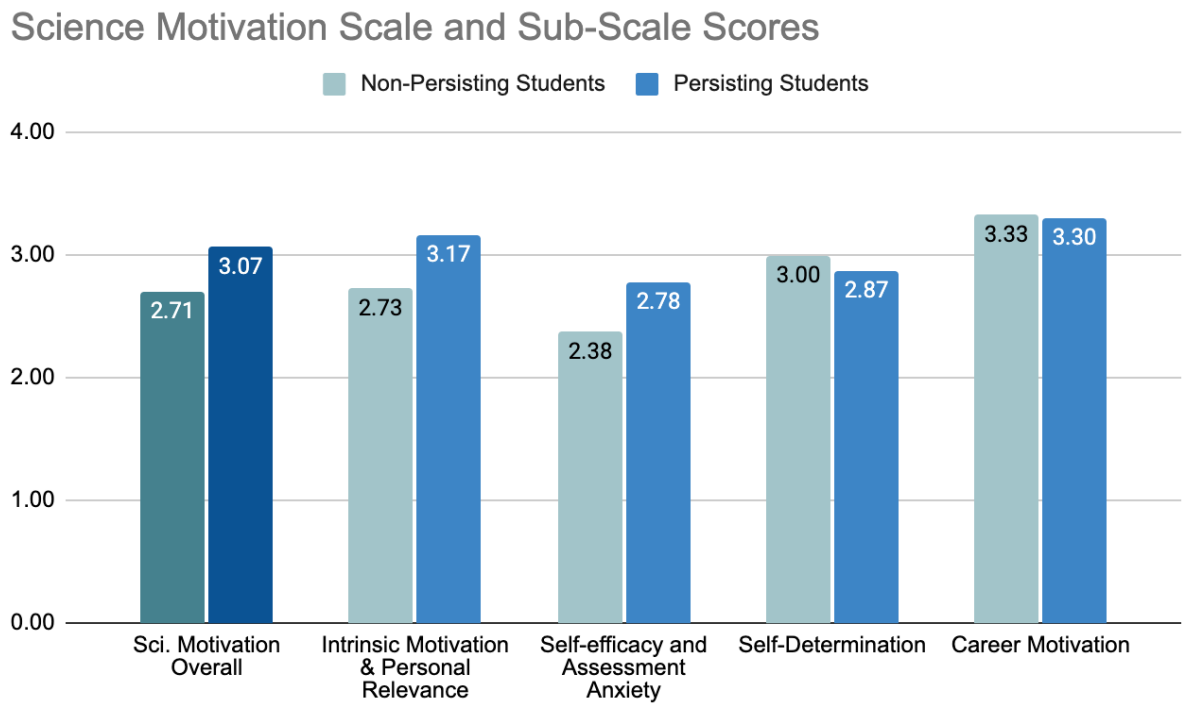

Figure 3. Science motivation scale and subscale scores for students persisting and not-persisting in STEM majors.

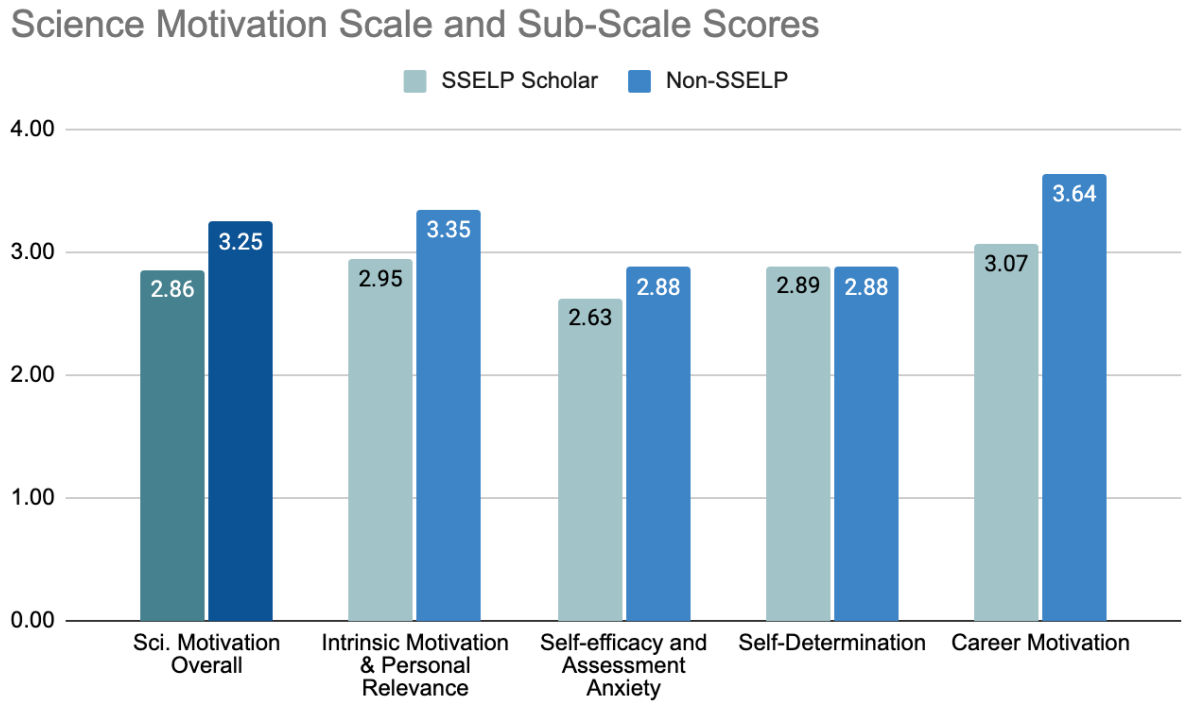

Figure 4. Science motivation scale and subscale pretest scores for SSELP scholars and non-SSELP STEM students.

Conclusions and Future Work

The EMU's STEM Scholars Engaging in Local Problems program has successfully recruited fourteen scholars and twelve students are currently in the program. The Science and Engineering Practicum course helped scholars discern their career choices. The embedded tutoring intervention has benefitted both the scholars and other students in the university. The project-based out-of-the-classroom learning approach has proven to be beneficial for the students in both their intellectual as well as personal growth.

As the first cohort approaching graduation, we plan to provide further career counseling and support for Cohort 1, as well as conduct exit interviews and surveys.

Acknowledgements

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