AC 2011-1843: INFLUENCES OF S-STEM FUNDING: FINAL OUTCOMES OF FOUR YEAR SCIENTIFIC LEADERSHIP SCHOLARS PROGRAM INCLUDING IMPROVEMENTS TO DEPARTMENT RETENTION PRACTICES

Elizabeth A. Eschenbach, Humboldt State University
Mary E Virnoche, Humboldt State University

Mary Virnoche, Associate Professor and Chair in Sociology, teaches and does research on race, class, gender and inequalities. Much of her recent work focuses more specifically on higher education and STEM persistence.

Tyler J. Evans, Humboldt State University

Tyler J. Evans is an Associate Professor of Mathematics at Humboldt State University in Arcata, California.

Influences of S-STEM Funding: Final Outcomes of Four Year Scientific Leadership Scholars Program Including Improvements to Department Retention Practices

Abstract

The NSF S-STEM sponsored Scientific Leadership Scholars (SLS) program at Humboldt State University (HSU) provides scholarships to a diverse cohort of students in Computing Science, Environmental Resources Engineering (ERE) or Mathematics. The program targeted financially eligible American Indian and first generation students from the HSU region. This paper reports the estimated final retention rates for the fourth and final year of the program and reports how the S-STEM funding has influenced educational practices in the ERE department.

The lessons learned from SLS program have informed the ERE department Diversity and Retention Plan required by the new university accreditation process, whose purpose is to increase retention of diverse students in all majors. One part of the plan that was informed by the SLS project is the implementation of a peer mentoring program for first year engineering (ERE) students. The peer mentoring program was started due to the SLS project outcomes that indicated the importance of peer mentoring. Assessment of the new peer mentoring program is not yet complete. In addition, based on outcomes from the SLS project, the ERE department is encouraging the university to implement Triesman model workshops in introductory STEM courses and to implement targeted recruiting of underrepresented minorities to the engineering program.

The SLS group persisting into year three remained more diverse than earlier corresponding major cohorts: 22 (59%) were either women and/or underrepresented minority (URM) students in STEM. In the 2007-08 academic year, 36 Cohort 1 students entered the program. Of the Cohort 1 freshmen, 23 (66%) persisted into their second year and 12 (33%) persisted into their third year as SLS majors. White and Asian Cohort 1 students were more likely to persist than STEM URM students (47%, n= 8 compared to 21%, n=4). In 2008-09, 15 additional SLS students were added. Of these students, 12 (80%) persisted into their third year as an SLS major. While all white students (6) in Cohort 2 persisted, 67% (6) of the underrepresented students persisted. All 4 women in Cohort 2 persisted. There was no significant difference in the persistence based on gender or first generation status. These earlier results have already been presented.

The SLS program has supported 51 students over the past 4 years. Of these students, 54% where underrepresented minorities and 70% were underrepresented in STEM. In reporting our retention results, we spilt our scholarship recipients into two groups: Group 1-New Diversity and Group 2 –Supporting Diversity.

The Group 1 students were at a higher risk of leaving the university. By their fifth academic year 22% of Group 1 students will either have graduated or continued in their STEM pathway course

taking. Group 1 major persistence rates were similar to what have been reported by others (30-70%).

The Group 2 students were recruited from students already successful in the SLS majors at HSU. Group 2 has a very high persistence rate in their majors. By their fifth academic year 92% of Group 2 students will either have graduated or continued in their STEM pathway course taking.

Keywords: American Indian, Retention, Persistence, Postsecondary Education, Underrepresented Minority

Introduction

The SLS program at Humboldt State University provided scholarships for financially eligible students in Computing Science (CS), Environmental Resources Engineering (ERE) or Mathematics (Math) from Fall 2007-Spring 2011 and was designed to increase the number and diversity of science, technology, engineering and math (STEM) professionals. The program design drew on STEM persistence research, as well as institutional and programmatic self study. STEM recruitment is important as the U.S. faces STEM labor force shortages which may result in declines in competitiveness[1].

Between 2007 and 2009, we recruited 51 students who were financially eligible as determined by the Free Application for Federal Student Aid (FAFSA). Students who were American Indian, or from our local 4 county region were given first priority. We also gave priority to first generation students, women and other STEM underrepresented (URM) students. SLS recipients' scholarships covered most of their tuition and fees. The SLS program also provided students with professional development and additional academic counseling.

Our program design leveraged local diversity strengths and needs, as well as accreditation and strategic planning related initiatives linked to HSU diversity and URM retention. Among non-white students, American Indian and Latino students have been most likely to have the best experience at the institution[2]. The HSU Indian Natural Resources, Science and Engineering Program (INRSEP) had been particularly successful in shaping a positive experience for American Indian students and often serves Latino students given links forged through the Society for Advancement of Chicanos and Native Americans in Science (SACNAS). Faculty members and students also had a tradition of working with local tribes in addressing community needs.

This paper presents our final retention data and summarizes how the SLS funding has influenced educational practices in the Environmental Resources Engineering department.

Program Model

The SLS program model was based on practice and theory on general institutional retention[3,4] a growing movement for first-year experiences[5] and retention theory specific to STEM majors[6]. The theoretical foundation and details of the model are reported elsewhere[2], and are summarized below.

The first semester of college calls for successful separation, transition and integration into a campus community[3]. Tinto found that the level and frequency of peer group interactions are significant to successful social integration and related retention outcomes.

Students received significant scholarship monies and assistance securing their full financial aid package. Financial strain and needs to work or incur debt are a drain on student abilities to persist[7,8,9]. Work, particularly work off-campus, not only detracts from students academic focus, but also from opportunities to socially bond on campus[10,11]. So we also worked with students to identify on-campus work opportunities, preferably in their majors.

The SLS program structured social and academic community building through common residence hall living assignments, common course scheduling, a specialized SLS seminar, time management and study skills training[12], supplemental academic advising[10], professional development and social events[5]. Research tells us that formalized mechanisms for structuring this integration are significant for many students of color and those from lower socioeconomic backgrounds whose prior social and academic experiences are less closely aligned with the structure and culture of university life[13].

SLS students were encouraged to enroll each semester in an interdisciplinary service learning seminar focused on professional skills development and collaborative problem solving with local American Indian communities. "Hands-on" experience has been particularly important for STEM women and students of color inviting them to see themselves in the college curriculum[14,15,16]. Most students experienced hands on curriculum in their first semester computer science and engineering courses. All students participating in the SLS seminar began in their second semester a long-term project with tribal collaborators on the development of a community healing center on nearby Tribal land.

Methods

This brief overview of expected SLS retention and persistence outcomes is based on quantitative data aggregated from scholarship applications and institutional sources. Earlier more nuanced analyses have been reported elsewhere [17]and final nuanced outcomes will be reported in future publications.

Quantitative Data Aggregation and Measurement

We compiled a quantitative data set that aggregated data from multiple sources. We extracted demographic data on measures such as ethnicity and parent education from scholarship application materials. When questions arose, Virnoche confirmed data through informal conversations and email correspondence with students and the grant team. We reviewed academic transcripts to gather course and related major progress information and final grades.

Student retention and persistence research and internal institutional reports usually use a "cohort" model for reporting outcomes. This operationalization of persistence and attrition is consistent with both National Center for Education Statistics (NCES) measures, as well as HSU institutional research. In that research, the models look at population data for a group of students entering an institution or program in the fall term of an academic year and communicate the percentage of that cohort that returns for study in each subsequent academic year: these are the "retention" and "persistence" rates. Retention usually reflects stay at the institution regardless of

movement between majors, while persistence relates to particular course taking patterns in major pathways. Most institutions simply track institutional retention. We track and report both.

If a student enrolled in coursework for a given term, but dropped before the term began, his or her status is reflected in our reporting of attrition for a given period. We operationalized "STEM" persistence as course taking consistent with the curriculum of one of the three SLS majors. If a student became ineligible for a scholarship due to a change in financial aid eligibility or poor academics, we counted them as "persisting" if their course taking indicated intention to complete one of the three SLS major. These measures are reasonable given the purpose of the SLS program to graduate students in STEM majors – regardless of their scholarship status.

In this paper we developed a slightly different operationalization of our study "subgroups" to address validity as we compare, or argue that we cannot compare, our work with other related research. The subpopulation that we identify as "Group 1" (n=32) is most like the cohort groupings of other research. We recruited these students primarily from high schools. A few of those students had taken some classes at community colleges in tandem with other high school classes or had some post-high school community college units. Yet all began Fall 2007 at HSU as "true" first year students with less than 30 units of coursework and were awarded an SLS scholarship in either Fall 2007 or Spring 2008, the first year of scholarship disbursements. As a group, these students represented "new diversity" for the majors that were supported by the SLS program. As new freshmen, let alone other risk factors unique to the group, they faced high risk for attrition.

The subpopulation that we identify as "Group 2" (n=25) is not a cohort and not directly comparable to other research. Students in this subpopulation were enrolled at HSU when we identified them as meeting SLS support criteria. They entered the SLS program having already completed at least 30 units or more of college coursework: They were already success stories having made it past the high attrition first year at a four-year institution, or they were successful transfer students. As a group, these students also represented program goals for "supporting existing diversity" in pathways to STEM majors. While still at some risk for attrition, we expected Group 2 persistence rates to approach 100%.

Scholarship Participant Demographics

More than two thirds (70%) of scholarship recipients identified with statuses underrepresented in STEM fields. One-third of SLS scholars were women and more than half (57%) identified with non-white ethnicities. Most (86%) came from within the state of WWW with 35% from one of the rural local four-county region with documented high need for student educational opportunities and advancement. In addition, 70% (40) students were first generation college students: neither parent held a college degree (Table 1). Table 2 summarizes the new diversity brought to each of the SLS majors in Group 1.

Institutional retention

Group 1 SLS participants were less likely than the average HSU student to return to the university for a second and third year of study (Table 3). At the time of this writing, HSU institutional research had not yet published the 4th and 5th year retention rates for the 2007-08 cohort to which Group 1 SLS students were a part.

Table 1: Demographics of all SLS Participants

	% (N)
Gender	
Women	33% (19)
Men	67% (38)
Ethnicity/Race	
Chinese	2% (1)
Filipino or Thai	7% (4)
Latino	20% (12)
American Indian	25% (14)
White	43% (22)
Geographic Origins	
Local 4-County Region	35% (20)
State of WWW	86% (49)
First in Family	70% (40)
Black	0% (0)
Chinese	0% (0)
White	56% (14)
Filipino and Thai	75% (3)
American Indian	86% (12)
Latino	92% (11)
STEM Underrepresented Minority	54% (31)
Underrepresented in STEM*	70% (40)
Total SLS Participants	100% (51)

* Either women or ethnic minorities underrepresented in STEM

Table 2: Comparison of Group 1 Fall 2007 and Average HSU Major Demographics

	Computing Science		Engineering (ERE)		Mathematics	
	SLS (N)	HSU* (N)	SLS (N)	HSU* (N)	SLS (N)	HSU* (N)
Women	25% (1)	13% (4)	28% (5)	26% (45)	38% (3)	43% (38)
American Indian	50% (2)	--	22% (4)	2% (3)	38% (3)	5% (4)
Ethnic Minority	75% (3)	20% (5)	39% (7)	19% (33)	75% (6)	28% (25)
Underrepresented	75% (3)	--	50% (9)	--	75% (6)	--
First In Family to Attend College	50% (2)	--	38% (6)	--	13% (1)	--
Total	100% (4)	100% (30)	100% (18)	100%(173)	100% (8)	100% (88)

* Based on 2001-2005 Major Enrollment Data

Table 3: Group 1 Institutional Retention

	SLS Students		University Students*	
HSU Retention	%	n	%	n
Year 2 (Fall 2008)	63%	20	73%	758
Year 3 (Fall 2009)	41%	13	61%	629
Year 4 (Fall 2010)**	39%	12	NA	NA
Year 5 (Fall 2011)***	35%	11	NA	NA
Total	100%	32	100%	1038

* 2007 HSU Cohort

** Change reflects one person who graduated

*** Estimate based on enrollment data in January 2011

It is important to remember that the Group 1 SLS students are quite unlike the "average" HSU student. As a group they embodied the intersections of multiple risk factors for attrition at HSU. Group 1 students were more likely than the average HSU student to be lower-income (they all met financial need requirements for the scholarship that were based on FAFSA information). They were also more likely to be first generation and represent an ethnic minority. Given those conditions, we might infer that the SLS program actually played an important role retaining these students at HSU.

STEM Major Persistence

There is little national research available on major retention. Major retention is challenging to measure as students declare majors and never begin coursework. Others begin coursework yet only formally declare majors in their second or even third year of study. According to the American Society of Engineering Education, schools collect that information individually, but there have been no recent studies that have looked at the national trends[18]. A 1988 Engineering Deans' Council reported wide variability in institutional data from four-year engineering schools

with overall major retention through graduation ranging from 70 percent to as little as 30 percent[6].

Group 1 participants persisted in their SLS majors at a rate approaching the averages reported elsewhere (Table 4). By year 5 of their academic career at HSU, 22% of those who had not yet graduated remained on a STEM pathway: One student graduated who had come in with college units that were part of high school home schooling.

Table 4: Group 1 STEM Pathway Persistence

	Group 1 SLS		National STEM Final Graduation Rates *
Persistence	%	n	30-70%
Year 2 (Fall 2008)	59%	19	
Year 3 (Fall 2009)	25%	8	
Year 4 (Fall 2010) **	25%	8	
Year 5 (Fall 2011) ***	22%	7	
Total	100%	32	

* Seymour & Hewitt (1997) *Talking About Leaving*

** Includes the student who graduated after year 3

*** Estimate based on enrollment data in January 2011

As expected, almost all of Group 2 students continued their pattern of retention at HSU and their persistence in their STEM major. By their 5th academic year reporting period, 92% (23) of Group 2 students had either graduated or continued their education at HSU. Eighty-four percent (21) had either graduated or continued in their STEM pathway course taking.

One would expect persistence differences between Groups 1 and 2 for several reasons. Primarily, as noted in the methods section, Group 2 was comprised of students who had already persisted prior to selection. Second, we were able to be more selective in awarding scholarships to Group 2 students: these students had exhibited commitment to their majors through successful coursework completion and had been identified by disciplinary faculty members for SLS scholarship consideration. For these reasons, it is important to keep separate our analysis of outcomes for each cohort and the results may indeed inform future award making practices.

Program Impacts

The SLS program has had multiple positive impacts on individual departments, the college and the university itself. In particular, all departments, including the ERE department, are required to develop a Diversity and Retention Plan as part of the Western Association of Schools and Colleges (WASC) accreditation process. Lessons learned from experience with the SLS scholars provided the basis of the plan for the ERE department. The three main components of the ERE department Diversity and Retention Plan are peer mentoring, implementing Uri Triesman model workshops and focused recruiting of URM students.

Peer Mentoring Program

During the first year, we learned that the SLS program would have greatly benefited from the use of peer mentors. We had 30 first year students in the program and each participated in our SLS seminar. Based on journal entries, classroom dynamics, focus groups, student performance and faculty experience, we learned that this particular group of students (first-generation, low-income, URM etc) was not yet receptive to advice from faculty.

Peer mentoring has been shown to be successful in improving retention in first year engineering students[19] and for the success and retention of under-represented engineering students.[20] Peer mentoring has also been shown to improve retention of both the mentors and mentees.[20]

Beginning in the fall of 2009, as part of the Diversity and Retention Plan, the ERE department instituted an informal peer mentoring program. Upper division engineering students were recruited as volunteers and then assigned to new first year and transfer students enrolled in one of two introductory engineering courses. The ratio of new students to mentors is about 5 to 1. The mentors meet at the beginning of the semester and develope a list of advice and a strategy to work with the student mentees. During a lab meeting of the introductory classes, the mentors met with their mentees. They discuss the 3 most import ideas from the advice list and exchange contact information. Over the semester, the mentors and mentees were encouraged to contact each other once a week. In addition, two gatherings (with food) are provided for all mentors and mentees over the course of the semester.

We have not yet implemented a formal assessment of this new mentoring program. Informal assessment indicates that the level of mentoring varies depending on the commitment of the mentor and the mentees. The program is entirely voluntary, so it is understandable that this variation would exist.

Possible improvements to the mentoring program for next year include inviting mentees to provide a weekly reminders for mentees to report online any contact with their mentees.

Academic Mentoring via the Treisman Model to First Year Gateway Courses

As part of the Diversity and Retention Plan, the XXX department is encouraging the university to develop a compensated peer mentoring program that builds on our existing tutoring program. The model for the peer mentor/tutoring program would be based on the successful Triesman's Model [21] that has been implemented at multiple institutions across the country. The Triesman model has upper division students facilitate groups of lower division students solve problems in "workshops" that are affiliated with introductory STEM courses. This model has been extremely successful in retaining URM students over the past three decades[22].

In the early years of the SLS program, some of the students from Group 1 that left their majors in the SLS would have benefitted from academic mentoring. These students needed more academic and social support as they were at high risk of leaving the major based on their URM, first generation, lower socioeconomic status. The Triesman model workshops have a structure that help combat issues related with these types of students, including stereotype threat.[22]

Our campus has not yet been ready to institute the Triesman model, as it has been undergoing structural changes in campus academic support services in response to extreme budgetary challenges. However, the reorganization seems to be complete, and there is now a focused effort

to increase campus diversity and retention rates. The new Office of Diversity and Inclusion plans to invite an Triesman model expert to the (now) annual *Diversity in Learning and Teaching Workshop.* The Office of Diversity and Inclusion, along with the administration of the College of ZZZ are supportive of implementing the Treisman model.

Focused Recruiting

A third component of the XXX department's Diversity and Retention Plan is to "target recruiting to identify high school and community college students from diverse backgrounds that are interested and able to succeed in the ERE program". The SLS program's recruiting efforts developed a large set of contacts for recruiting American Indian students. In developing this database, we learned that our local high school has more American Indian students than any high school in the state of WWW. So, recruiting efforts that increase diversity can focus in our own region. This contact database for American Indians has not yet been well utilized for STEM recruiting. Currently, the ERE program is over-enrolled and the administration is not interested in increasing enrollment. However, recruiting focused on increasing diversity across all majors is currently in place.

Summary and Conclusions

The SLS program has supported 51 students over the past 4 years. Of these students, 54% where underrepresented minorities and 70% were underrepresented in STEM. In reporting our retention results, we spilt our scholarship recipients into two groups: Group 1-New Diversity and Group 2 –Supporting Diversity.

The Group 1 students were recruited to bring new diversity to the CS, Engineering and Math programs. These students were at a higher risk of leaving the university because they were first year students from a high risk group. In fact, Group 1 students were retained at a lower rate than the average student at Humboldt State University. This retention rate is reasonable, as Group 1 students have multiple risk factors for attrition, unlike the "average" HSU student. By their fifth academic year 22% of Group 1 students will either have graduated or continued in their STEM pathway course taking. Group 1 major persistence rates were similar to what have been reported by others (30-70%).

The Group 2 students were recruited from students already successful in the CS, Engineering and Math majors at HSU. These students are not a true cohort as they were recruited at different levels of progress in their respective majors and they were recruited from transfer students as well as students that started at HSU. Thus, it is difficult to compare yearly retention rates of Group 2 to HSU retention rates. However, as might be expected, Group 2 has a very high persistence rate in their majors. By their fifth academic year 92% of Group 2 students will either have graduated or continued in their STEM pathway course taking.

The lessons learned from the SLS program have greatly influenced the Diversity and Retention Plan of the Environmental Resources Engineering department. The plan includes peer mentoring, instituting Treisman Model Workshops in introductory STEM courses and targeted recruiting. The volunteer peer mentoring program has been implemented, has not yet been assessed. The Treisman workshops are becoming more attractive to the HSU administration as an URM retention tool. Targeted recruiting for the ERE department has not yet been

implemented, as the department is currently over enrolled. However, targeted recruitment of URM is in place for all majors at HSU.

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