

Institutional Transformation: Establishing a Commitment to Research and Student Success

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Aligning Efforts

San Francisco State University (SFSU)¹ is continuing an institutional transformation begun in 1988, with a focus on increasing scholarly activity. Efforts to create a climate of opportunity on a campus for underrepresented students in the sciences began shortly thereafter. The effect has been synergistic; benefiting the university, its faculty and students, as well as partnering institutions and the graduate programs SFSU students attend.

Stemming the Loss of Talent

Despite the fact that approximately 39% of the students at SFSU are underrepresented minorities (URM),² only a small number graduated with bachelor's degrees – and very few of them completed graduate degrees. The situation was particularly disheartening in the sciences. From 1984 to 2003, 155 bachelor's graduates from SFSU received doctoral degrees in biology or the physical sciences. Only one was issued to a student from an underrepresented minority (URM) group.

From 2004 to 2007, results from over a decade of targeted efforts were realized. SFSU produced ten URM doctorates in these fields, and at least another 35 URM bachelor's graduates from SFSU will complete PhD degree programs in the next five years (2008-2012). Results with master's level students are equally dramatic.

Maintaining Focus and Commitment

Although the transformational activities involve administrators, faculty, and staff across the institution, a small group consisting of the Vice Provost & Graduate Dean (Paul Fonteyn), College Dean (James Kelley) and a professor (Frank Bayliss) ensured that those supporting URMs moved forward. They have played critical leadership and management roles, having the

¹ One of the 24 California State Universities, SFSU is a large, urban comprehensive university with a combined enrollment of approximately 30,000 students. Undergraduate and master's programs are offered.

² Due to recording issues, these numbers only reflect African Americans, Native Americans, and Hispanic Americans; Pacific Islanders were reported alongside Asian Americans and thus were not counted.

vision, patience, dedication, and willingness to tackle the issue from many different directions simultaneously.

The Student Enrichment Opportunities (SEO) Office, with which we are associated, serves as the coordinating point for many of the activities that support the success for targeted students. This office was created with funding from the training grants and grew with the addition of new programs. The focus is on supporting student needs relative to academic preparation, fellowships, travel, housing, purchasing and navigating the university.

Pursuing a Multi-faceted Plan

Our goal was to help students and faculty succeed with a focus on URMs. We began with a firm plan in mind of how we would get there. It involved creating a sustainable continuum of programs that would support students, and their faculty mentors, throughout their academic trajectory.

We borrowed some ideas from other successful programs, came up with others on our own, kept what worked and discarded what didn't until we had a program that aligned with our institutional context, as well as students and faculty needs. We were gratified to have accomplished one of the highest success rates of all the National Institutes of Health (NIH) Minority Opportunities in Research (MORE)-funded programs in the country. The range of activities focused on supporting URMs and the timeframe over which they occurred are shown in Table 1.

Table 1: Timeline of Events

PROGRAMS	ACTIVITIES AND EVENTS
	1991
	First funding for URM graduate students
NIH MS/PhD Bridges to the Future begins	1992
CCSF/SFSU Bridges to the Baccalaureate begins	MOU CSU/UC Systems for Bridge to Doctorate
LS-AMP funding for undergraduates begins	1993
MBRS SO6 begins	First funding for URM undergraduate students
Graduate Assistance in Areas of Nat'l Need	1994
MARC-U STAR begins	1995
Beckman Scholars begins	First wide-scale funding of faculty members
DoD Scholars begins	First funding for majority students
MBRS-SCORE begins	1996
MBRS-RISE Undergraduate and Graduate begin	MOU UCSF, UCB & UCD to increase collaboration
	1997
	1998
	1999
	Supplemental instruction begins
	2000
	Genetics honors course enacted
PREP Post-Bacc with UCSF begins	2001
	2002
NSF MS/PhD Bridge to the Doctorate (2 year)	2003
Graduate Assistance in Areas of Nat'l Need ends	2004
DoD Scholars ends	Funding for majority students essentially ends
	2005
NSF MS/PhD Bridge to the Doctorate (2 year)	2006
	2007
Beckman Scholars ends	Chemistry honors course enacted
PREP ends	2008
	Computing/Math honors course enacted

CCSF = City College of San Francisco

CSU = California State University

DoD = Department of Defense
DoE = U.S. Department of Education
LS-AMP = Louis Stokes Alliance for Minority Progress
MARC = Minority Access to Research Careers
MBRS = Minority Biomedical Research Support
MBRS SO6 = Minority Biomedical Research Support S06
MBRS-RISE = MBRS-Research Initiative for Scientific Enhancement Program

MBRS-SCORE = MBRS-Support of Competitive Research Program
MOU = Memorandum of Understanding
NIH = National Institutes of Health
NSF = National Science Foundation
PREP = Post-baccalaureate Research Education Program
UC = University of California
UCSF = University of California, San Francisco

Although funding research experiences for underrepresented students has had a tremendous impact, it is not the only factor contributing to our success in increasing URM PhDs. Analysis of NIH-MORE programs indicates that only a very small number of these programs achieve similar success (National Resource Council, 2005).

Institutional transformation in four major areas has made the difference at SFSU:

- Developing a research environment
- Increasing research opportunities for students
- Instituting academic support programs
- Developing a culture dedicated to the success of URMs

Each of the components is strongly interrelated. Had any been neglected we believe our efforts to increase URM success could not have been successful—or at least not at anywhere near the level we are seeing.

Developing a Research Environment

Just two decades ago, SFSU faculty members were not expected to pursue research grants and did so purely on their own initiative. It was challenging to obtain grants and sustain a research program in this environment, and research projects tended to be isolated.

In 1988, under the leadership of the newly hired President, Dr. Robert Corrigan, SFSU increased its emphasis on faculty scholarly activity at the college level. This has resulted in the coordination and expansion of research activities, increased levels of support, and the formation of internal and external partnerships – all key aspects for meaningful, intensive, and sustainable research.

Building a Critical Mass of Research Faculty

Establishing a research climate required a critical mass of faculty to start and sustain research efforts. Starting in the 1990s, new faculty members were increasingly recruited based on research interests and capability so that, over time, SFSU became known as a place where interesting research was being conducted.

Indirect cost revenue from research grants was used to seed new research by awarding increasing amounts of start-up funds and thereby attracting more competitive faculty. It had the additional benefit of attracting research-active faculty interested in teaching in a diverse institution.

Since Dr. Corrigan was hired, over 50% of the new faculty hires university-wide have been minority or women. Once several URM faculty were hired and became established, additional high quality URM faculty were attracted to SFSU. For example, the biology and chemistry departments now have significant numbers (>20%) of URM faculty.

Providing Faculty Reassigned Time for Research

Pursuing research takes time. Efforts to balance faculty teaching and research responsibilities have been supported by the university. The president's enhanced focus on scholarly activity led to the matching of reassigned time paid for by grants, which has greatly enhanced research possibilities. Additionally, researchers also require funding and time for travel and conference attendance (SFSU provides about 10% of these costs). With these, they can participate in the broader community of scientists.

Coordinating Pursuit of Institutional Grants

Prior to 1995, SFSU did not have a coordinated system of attaining research money for its faculty. This changed with the decision to pursue large-scale institutional research grants such as the MBRS SO6 and its later incarnation, the MBRS-SCORE. The MBRS-SCORE grant provided substantial research money (>\$3M/year) to a number of faculty members on campus over an extended period of time, up to 27 funded projects per year by the end of the grant cycle in 2005.

Obtaining this level of grant activity in a short period of time required the partnered leadership of administrators, faculty members, and research scientists outside the university. One of the most important outcomes of these partnerships was the development of campus-wide research credibility.

Partnerships with other established research facilities, such as Genentech, Inc. and the San Francisco, Berkeley, and Davis campuses of the University of California, have been of great importance to the building of this credibility. The relationships with these outside partners have proven highly valuable in allowing SFSU to quickly build a viable research base.

Upgrading Instrumentation and Facilities

Without state-of-the-art instrumentation and facilities, it is challenging to do the meaningful, competitive research that allows students and faculty members to feel like they are contributing as scientists. The NIH RIMI (Research in Minority Institutions) grant and several other NSF and NIH grants supported the development of core facilities for Nuclear Magnetic Resonance (NMR) spectroscopy, mass spectroscopy, imaging and DNA sequencing.

Even after an initial investment in space and equipment, a lab cannot continue to operate for an indefinite period of time at the same level it did when newly refurbished. Instruments and facilities need to be maintained or upgraded with new models, and people must be supported to do this. These costs are met through competitive grant funds and the university equipment replacement schedule.

Providing and Enhancing Research Opportunities for Students

In the 1980's, research was being conducted by graduate students but occurred at a snail's pace—the average master's student took four to five years to finish the research required for a degree. Undergraduate research was rare and pursued by those who did not need the financial support that stipends or jobs provide. Since then, barriers associated with funding and preparation have been reduced and frameworks for integrating students into the research community have been put in place. Now graduate students, particularly those funded by SEO programs, take much closer to the expected two years to receive a master's degree. Many faculty members have undergraduate students working in their labs, many from SEO programs.

Buying Student Time for Research

Many SFSU students are self-supporting, typically spending 25 hours or more per week at on- or off-campus jobs, which robs time from academics. Our experience indicates that an outside job has a very negative impact on grades, as high as a drop of a letter grade. Before SEO, this had been particularly true for graduate students.

SEO programs buy students' time, which they are expected to spend in the lab doing research or on their academics. The money involved may be modest, but it generally eliminates the need for outside employment or reduces it significantly.

Providing Initial Training

One major concern that many faculty have about taking new students into their lab, particularly undergraduates, is the time commitment required before they are able to be a productive member of the research team.

The respective grant programs provide students with preparatory training before they enter the labs. This includes workshops on lab skills and equipment use, seminars featuring speakers, presentations of work by other students, and discussions of scientific literature. The workshops and seminars have proven to be extremely important, alleviating some of the burden of preparation from the research team and enhancing the students' lab experiences. In some cases, students have been trained on equipment that other members of the lab team are unfamiliar with, resulting in their being able to act as a resource for the rest of the lab.

Integrating Students into Research Teams

The most successful and meaningful research experiences occur when students see themselves as members of a team that incorporates everyone, from the undergraduates to the graduate students, lab technicians, and faculty members. It goes beyond coordinating research activities. The more experienced members of the team also provide mentoring and support to the novices, allowing them to develop and contribute, while providing experiences that stretch their horizons.

The Program Director's familiarity with the research groups on campus allows us to only place students where we believe they will be successfully integrated into research teams. Sometimes these placements are not successful for a variety of personal and situational reasons, and students are moved to other labs to ensure a positive and productive experience.

Enhancing the Diversity and Quantity of Opportunities

For a research experience to have the greatest impact on the students, it must be one that fires their imaginations and speaks to their interests, and it must involve building relationships with people that the students like and respect, and who in turn like and respect them. We feel that the students' choices are important and they need to decide where they want to go.

Without a large enough set of research opportunities, students' choices become limited and the likelihood of not fitting in increases. It also becomes more challenging to find a new lab if a situation is not working and the student needs to be moved.

Maximizing Research Experiences

Recent studies³ have demonstrated that the experiences of students funded by SEO programs are fundamentally different from those of other students doing research at SFSU. They are more involved in the activities of the research team, particularly in directing research questions and disseminating results, and they report that the experience has been more transformative in changing their life course.

This difference seems to result from the fact that SEO supported students spend more time in the research laboratories and, because of the support they receive, are more fully integrated into them. These higher quality research experiences also become a way for students to contextualize their coursework and increase their motivation to understand and succeed.

These results do not appear automatically from buying students' time and providing training, however. Students must also feel that they are obligated to spend a substantial amount of time in the lab. Most SEO programs require at least 10-15 hours per week in the lab during the school year (some require more) and a full-time commitment during the summer. Students must also feel that they are responsible for the outcomes of their research. We require them to present results, usually at national meetings, and to do so in a professional and competent manner, which requires the students to know their research well. We provide the support they need to be able to do this successfully through coaching and practice sessions.

Instituting Academic Support Programs

Although some students supported by the SEO Office are academically strong and would achieve high grades no matter what we did, many are not. They may not have taken the rigorous courses they needed in high school or learned necessary study skills. The students may be faced with personal situations that would make it difficult for them to succeed on their own. Whatever the circumstances, their academic achievement is often below what would be expected for acceptance into high-quality graduate programs, and they need assistance developing their talents so that they can be competitive.

Developing the Talent Pool

³ From Fall 2005 to Spring 2007 we surveyed 46 undergraduate students in their 3rd year or beyond who were funded by our SEO programs and 97 who were not, all of whom had been involved in research experiences, allowing us to examine the difference in their responses regarding the activities they participated in and the outcomes of their experience.

Most SEO programs accept students after their first year or two at the university. By this time, most have taken their introductory science and math classes, either at SFSU, a community college or at another school. We have found that the introductory courses at SFSU, particularly Introduction to Biology, are the source of a great deal of student attrition (Peterfreund, Rath, Xenos, Bayliss, 2008; Rath, Peterfreund, Xenos, Bayliss, Carnal, 2007), and the students who do not successfully complete these courses often do not continue within sciences, if they stay at SFSU at all. The attrition rate is particularly harsh among URM students.

To combat this problem and increase the pool of STEM students eligible for participation in SEO programs, we instituted Supplemental Instruction (SI) classes, using the model devised by Triesman (1992). These classes support students in courses with historically low pass rates, providing enrichment activities, training in study skills, and cooperative learning experiences. They are not remedial but, as the name indicates, supplemental, and the students in them perform substantially better in the supported course, despite having lower academic performance indicators such as SAT I scores (Peterfreund *et al*, 2008, and Rath *et al*, 2007). SI classes are open to all students taking the supported courses.

We have also created a learning center. The space is large enough to house some SI classes, contain rooms for cooperative study groups, provide access to computers and printers, and supply office space to SI facilitators who become resources for the students during their office hours. Although originally intended for students in SEO programs, it is used by others as well and has become a source for STEM community development.

Our NIH Bridge to the Baccalaureate program has allowed us to bring students from two-year colleges to SFSU and prepare them for university work, providing them with academic support, a research experience, and funding over the course of a summer. Many of these students eventually transfer to SFSU and provide more talent from which our upper-level programs can draw.

We cannot say that all three of these activities are individually essential for the overall success of SEO programs, but we do feel that it has been necessary to develop a talent pool with the background in content and academic skills to allow them to be successful upon entry to the SEO programs.

Enhancing Student Competitiveness

Students who successfully navigate through their first science courses often still need assistance in their upper-level coursework. By this point, few students' fail and few leave the science field, though some may need to take a course multiple times before passing. More problematic, particularly for those who wish to attend graduate school, is that many earn grades in the C range, which just isn't competitive.

SI classes that support upper division undergraduate courses are very successful at moving grades from the C range to B or even A grade, helping students become academically competitive. Without support across the curriculum (see Table 2), many would not be able to achieve the grades needed to compete for slots in PhD programs.

Table 2: Courses Supported by Supplemental Instruction

Department	Freshman Level	Sophomore Level	Junior Level	Senior Level
Biology	Biology I	Biology II	Genetics	Cell Biology
Chemistry	Chemistry I	Organic I & II	Chem II & Quant Chem Analysis	Biochemistry I & II
Mathematics	Calculus I	Calculus II		
Physics	NA	Physics I	Physics II	

Preparing Students for Graduate-Level Work

We found early on that many SEO students who went to graduate school found themselves unprepared for the primary source-intensive seminar courses; this was one reason behind attrition from graduate school. In response, we developed an honors-level genetics course where students read primary articles and discuss them in a seminar-type environment. Although students from SEO programs are given preference in this class, it is open to other interested students with the necessary prerequisites. Similar courses in other fields⁴ have also been developed. Many of our alumni cite participation as a transformational experience and extremely valuable preparation for graduate school.

Developing a Culture Dedicated to URM Success

The SEO programs have been successful individually and collectively, but to reach our vision, the university needed to embrace the goal of URM success. Without a culture dedicated to URM success, programs can easily become isolated and fade away after the founding individuals leave the institution. Opportunities need to be broad and lasting, rather than isolated programs that abandon students at the end without further support.

Pursuing Opportunities and Celebrating Successes

The pursuit of funds to help URM students was originally prompted by the availability of grants, not by any institutional mission. Their receipt, however, generated enthusiasm for SEO programs. With their increasing success, we were able to demonstrate to those who had not initially bought into the programs' goals that the URM students being served could succeed, go onto graduate school, and earn PhDs, despite academic and social backgrounds that one might have been considered insurmountable.

An important factor in building enthusiasm has been a concerted effort on our part to advertise the programs, to let people, both on campus and off, know what our students are doing and, when they become involved as research advisors, SI instructors, or in other capacities, to make certain they understand that our successes are theirs as well.

Our reputation at this point is such that the graduate school at SFSU will admit students from SFSU and elsewhere accepted by SEO even if they do not meet the normal grade and GRE qualifications. This is based on the school's dedication to URM success and the knowledge that SEO students have historically done very well in the master's program.

⁴ These courses are: Modern Mathematical Biology; Seminar on Modern Mathematical Methods in Molecular Biology; Analyzing DNA Topology with Mathematical and Computational Methods; and Research Trends in Chemistry and Biochemistry

We have also been very careful to develop relationships and share our successes with other graduate schools. We have built a reputation of producing very able students who can succeed and thrive in high-powered programs and help fulfill the graduate schools' missions to enhance their diversity. Our students go to highly ranked graduate programs throughout the country, and many receiving schools have proven highly enthusiastic about accepting more of SEO students.

Supporting Infrastructure

Establishing and maintaining successful programs requires infrastructure. Students need to be recruited, applications and other paperwork need to be processed, and paychecks and other expenses need to be coordinated. On a broader level, students need a place where they can discover opportunities and ask questions about them and their requirements. The programs, all of which have an evaluation requirement, also need someone to collect information about the students and either hand it off to the evaluators or process it in-house. All of these require people, space for them to work, and supplies to use to complete the necessary tasks.

To make our programs work, we combined the administrative funds from the various external grants to support the SEO office. This allows us to hire a number of individuals with specialized skills to take care of all the different tasks that need to be done. The efficiency of scale of programs being administered together and our success at having them renewed have been critical to allowing us to serve students and faculty partners effectively.

Supporting a Continuum of Opportunities

Our best successes come from students who we are able to find and nurture for an extended period of time. Conversely, in several situations students did not have continued funding after an initial year or two and, though they began enthusiastic and seemingly ready to take the long trek to a PhD on their own, found they were not able to overcome the obstacles encountered along the way. In some cases it was money, in others insufficient grades or GRE scores, and in others maturity. From these experiences, it became very clear that students often required extended commitments, often far longer than the one to two years typically allotted by an individual program's funding stipulations.

Having a large number of funding programs has been essential in allowing this continued support for as long as the students need it during the four to six years they take to finish their bachelor's and master's degrees. One might start in one undergraduate program, then be funded by another, and then move into a post-baccalaureate or graduate program before finally being ready to leave SFSU and pursue a PhD. If possible, we keep contact with them throughout their graduate career, providing advice and social support that can make the difference in students' decisions regarding whether to continue or quit.

Combining a large number of programs under a single leadership has created a situation where we can find the best options for students, easily move students from one program to another, and develop a student community across programs. Such coordination has prevented the competition for students that could occur if programs had distinct leadership structures, while ensuring continuity of support for students.

Integrating Efforts across Levels

Efforts to improve URM outcomes could not be instituted in isolation and still have a hope of providing significant outcomes. One cannot offer students research experiences and expect dramatic changes in URM success without a research program that provides diverse and meaningful experiences. Similarly, one cannot only provide research opportunities and not support students academically if one hopes to develop competitive candidates for graduate school.

Efforts must reach across every level of education, not just focus on one particular level. This has been one of the most important features of the programs at SFSU, and that continuance of support can be seen clearly on the Unified Plan, which includes both majority and URM participants, as shown on Table 3. This maps out the various programs that support individuals in the sciences at all levels of their academic careers.

Table 3: Unified Plan at SFSU

Program Title	Undergraduate				Graduate	Pd	Fac
	*S 13	*S 14	*S 15	*S 16	*S 17 18		
PROGRAMS FOR UNDERGRADUATES							
Alliance for Minority Participation (LS-AMP)	█	█	█				
Bridges to the Baccalaureate (NIH)	█	█	█				
Minority Engineering Program (MESA)		█	█	█			
Beckman Scholars (Beckman Foundation)			█	█			
MARC-U STAR (NIH)			█	█			
Career Opportunities in Research (NIH NIMH/COR)			█	█			
NCI Cancer Center Collaborative (NIH NCI P20)			█	█	█		
MBRS-RISE (NIH)		█	█	█	█		
LS-AMP (NSF)		█	█	█	█		
PROGRAMS FOR GRADUATE STUDENTS							
PREP Post-Baccalaureate Research Program (NIH)					█	█	
MS/PhD Bridges to the Future (NIH)					█	█	
MS/PhD Bridge to the Doctorate (NSF LS-AMP)					█	█	
Graduate Assistance in Areas of Nat'l Need: Biology					█	█	
Graduate Assistance in Areas of Nat'l Need: Chemistry					█	█	
PROGRAMS FOR POST DOCS							
MORE IRACDA (NIH NIGMS – SFSU/UC Davis)							█
FIPSE (SFSU/UCSF)							█
Research Infrastructure in Minority Institutions (RIMI)							█
PROGRAMS FOR FACULTY							
Minority Research Infrastructure Support Program							█
MBRS-SCORE (NIH)							█
NCI Cancer Center Collaborative (NIH P20)							█
NCI Cancer Center Collaborative (NIH U56)							█
Research Infrastructure in Minority Institutions (RIMI)							█

*S = summer semester, 13 = H.S. + 1st year of college; Pd = Post-doc; Fac = Faculty

This integration of efforts must be university-wide. At SFSU, the faculty and administration are committed to enhancing URM student success and transforming research. Obtaining and maintaining buy-in requires diplomacy, but it also requires advertising of successes and creating

a climate where the faculty members are invested in the students and their own individual successes.

Building an institutional commitment toward and successful strategy for URM student success is a tremendous effort, but as the numbers attest, the efforts are well worth it. By aligning these efforts with the transformation of scholar activity, SFSU now has a reputation as an institution that is conducting research and developing a talented pool of scientists.

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References

- National Resource Council. *Assessment of NIH minority research and training programs: Phase 3*. Washington DC: National Academies Press; 2005.
- Peterfreund AR, Rath KA, Xenos SP, & Bayliss F. The impact of supplemental instruction on students in STEM courses: Results from San Francisco State University. *Journal of College Student Retention*. 2008; 9:487-503.
- Rath KA, Peterfreund AR, Xenos SP, Bayliss F, Carnal N. Supplemental instruction in Introductory Biology I: Enhancing the performance and retention of underrepresented minority students. *Cell Biology Education-Life Sciences Education*. 2007; 6:203-21.
- Treisman U. Studying students studying calculus: A look at the lives of minority mathematics students in college. *The College Mathematics Journal*. 1992; 23:362-372.