

Alliance for Change: Broadening Participation in Undergraduate Research at California State University

John E. Banks, Carla Fresquez, Heather Haeger, *California State University, Monterey Bay*
Semarhy E. Quinones-Soto, Lisa Hammersley, *California State University, Sacramento*

Abstract

Engagement in high-impact practices such as undergraduate research can dramatically improve academic and developmental outcomes; traditionally underserved students (including underrepresented minorities and first-generation students) often experience outsized benefits from these academic experiences. The California State University Louis Stokes Alliance for Minority Participation (CSU-LSAMP) program provides wide-ranging scaffolding and support to underrepresented students, seeking to increase the participation of individuals who face or have faced social, educational, or economic barriers to careers in science, technology, engineering, and math (STEM). The authors provide a description of the undergraduate research and supplementary programs supported by the CSU-LSAMP program at California State University Monterey Bay and other CSU campuses and present outcome data highlighting the benefits of leveraging undergraduate research engagement to increase participation of underserved groups in STEM.

Keywords: *mentored research, National Science Foundation, professional preparation, student success, underserved students*

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There is now an abundance of evidence suggesting that engagement in high-impact practices such as undergraduate research can dramatically improve academic and developmental outcomes, with traditionally underserved students (including underrepresented minorities and first-generation students) standing to benefit the most (Finley and McNair

2013; Kuh 2008; Waiwaiole, Bohlig, and Massey 2016). The deep engagement that undergraduate research entails coupled with the scaffolding necessary to achieve a level of excellence that will guarantee student success can greatly bolster achievement and retention. Programs and initiatives that center on undergraduate research thus have the potential to transform individual students' trajectories and as well greatly ameliorate institutional outcomes tied to student achievement and degree attainment.

The California State University Louis Stokes Alliance for Minority Participation (CSU-LSAMP) Alliance provides campuses in the 23-campus system with a wide-ranging support structure for underrepresented students in an effort to increase the participation of individuals who face or have faced social, educational, or economic barriers to careers in the fields of science, technology, engineering, and math (STEM). Common majors of CSU-LSAMP participants include engineering (37.5 percent), biological sciences (31.9 percent), physical sciences (> 15 percent), computer science (6.2 percent), mathematics (6.2 percent), natural resources and conservation (< 2 percent), and agricultural sciences (< 1 percent). Data from the past two decades (1994–2016) reveal that 84 percent of the 24,245 student participants served across the alliance identified as underrepresented minorities (URM; Messier and Barker 2016). Individual members of the alliance are requested to tailor their CSU-LSAMP programs to their campus-specific needs through an emphasis on academic preparation and persistence, professional preparation, or a mixture of both. Over the past few years, many campuses in the alliance have shifted their emphasis away from student services and toward providing more professional preparation activities, including undergraduate research. This shift is reflected

in an increase in the proportion of upper-division students served by the program, from 36 percent in 2002–2003 to 80 percent in 2015–2016 (the most recent year for which data are available). It also is reflected in the more than fivefold increase in the number of CSU–LSAMP participants who take part in a research activity, from 185 in 2002–2003 to 990 in 2015–2016. Currently, almost one-third of the 3,000 students who participate in CSU–LSAMP each year take part in research activities.

On the California State University Monterey Bay (CSUMB) campus, the CSU–LSAMP program is one of many in the alliance that emphasizes preparing student participants for STEM careers by providing high-stakes, authentic mentored undergraduate research opportunities. At CSUMB, these undergraduate research opportunities are supplemented by support for students to hone their writing and oral presentation skills in a number of ways, including participation in on-campus workshops and seminars as well as opportunities to attend national conferences and present the products of their research.

The CSU–LSAMP program at CSUMB is administered through the Undergraduate Research Opportunities Center (UROC), a campus resource that facilitates participation in undergraduate research for students of all disciplines. As part of UROC, CSU–LSAMP at CSUMB is geared toward helping students find and participate in undergraduate research (see Figure 1). This is done in the context of a two-year intensive Scholars program. Students apply in the second year and enroll in an ongoing series of seminar courses throughout a two-year period that are taught by UROC staff, aimed at improving oral and written communication as well as uncovering the “hidden curriculum” of academia for the students, many of whom are the first in their families to attend college. The courses are supplemented with workshops focused on other aspects of student success, including tips on finding research opportunities and applying to graduate school, writing support for fellowship and graduate school applications, and career planning. Students in the Scholars program are expected to complete research opportunities—at other institutions or at CSUMB (depending on availability of faculty pursuing research in the students’ areas of interest)—in each of two summer terms. Some students also conduct research during the academic year, again depending on faculty areas of active inquiry. In addition to these mentored academic research experiences, students in the Scholars program are supported by UROC staff and research mentors as they prepare and present their research at regional, national, and international conferences and symposia. All of the activities and courses are calibrated carefully to the experience of the students as they gain proficiency in their research areas; each student also is assigned to a faculty member who serves as a UROC faculty mentor throughout the student’s remaining undergraduate years. Several elements

FIGURE 1. CSU–LSAMP Participant from CSU Monterey Bay Conducting Research in the Laboratory



of the UROC Scholars program are critical to helping a diverse student population gain research experience.

The Pursuit of Research Opportunities and Participation in Research

To meet UROC’s goal of connecting students to authentic and calibrated scholarly activities, UROC Scholars are provided both financial and professional development assistance to pursue on-campus research opportunities and also are encouraged to apply to external summer research programs (e.g., REU programs at external institutions). When applying for external programs, students are guided through the process of searching for research opportunities that match their research and career interests and receive instruction on how to develop competitive applications. Due to the competitiveness of external research opportunities, in many cases students are placed into summer research opportunities with CSUMB faculty, or placements are individually brokered with the help of UROC staff and financially supported with UROC funds. In the case of brokered research opportunities, UROC staff rely heavily on the social capital and professional networks of CSUMB faculty serving as UROC faculty mentors, often resulting in strengthened inter-institutional exchanges of ideas and resources for both students and faculty. In the second year, students are encouraged to

develop their networking skills and explore options for continuing on to graduate programs through programming designed to capitalize on the professional, technical, and social skills acquired in the recent summer research experience. Seminar courses and workshops focus on exercises designed to unpack the vocabulary of discipline-specific discourse communities as students reach out to potential graduate program research advisers. Apart from the pedagogical value, this distributed model of research placement—with students sometimes placed on-campus and other times with regional, national, or even international partners—is generally well suited for campuses that may not have faculty engaging in all of the research areas that students seek.

Development of Self-Efficacy and Confidence

Much of the programming provided is centered on empowering students to feel comfortable interacting in research and professional environments. Special emphasis is placed on developing an understanding of the roles played by students as they progress in their careers from REU participants to graduate students and beyond. Students in the program are exposed to the hidden curriculum of academia via active discussions about the nuances of the academic landscape, introducing them to jargon and conventions found in academic settings. In addition, students are encouraged to examine and explore differences among academic disciplines, allowing them to develop a sense of ownership of the topics and conventions in their own research fields. Students are educated about the conventions, institutions, and subtleties of their research disciplines, placing these lessons in the context of preparing to apply to, get into, and succeed in graduate school and beyond. This framework demystifies the academic world and gives students the confidence necessary to develop a true STEM identity and view themselves as a part of their research communities.

Development of Writing Skills

Specialized writing skills are emphasized throughout the Scholars program and are integrated into each stage of the program. Prior to their first research experiences, students work to develop an authentic voice while preparing statements of purpose for research program applications. After participating in research, students work with UROC staff and faculty mentors to develop discipline-specific writing skills, writing for statewide research competitions such as the CSU Research Competition and preparing papers and presentations for conferences in their fields. Throughout the program students become familiar with and accustomed to the process of sharing and receiving feedback on their writing by participating in peer writing groups, facilitated by writing fellows who are more experienced UROC students trained by UROC staff to give productive feedback and reinforce writing strategies introduced in the program. Finally, in their last year, students are able to capitalize on

the writing training they have received over the previous years while preparing statements of purpose and research narratives for graduate school and fellowship applications.

In addition to working with students in the UROC Scholars program, the CSU-LSAMP program at CSUMB provides resources to smooth the transition of younger students into STEM fields. This includes support for orientation programs, academic advising and tutoring (especially for STEM gateway classes), and financial help to offset textbook costs; students also are offered assistance with GRE preparation and graduate school visits. This provides students with a suite of wraparound services aimed at helping them achieve and maintain academic success, complementing their research experiences to create an academic portfolio that will optimize their chances of being accepted into highly competitive graduate programs. In addition to these on-campus elements, the program provides help needed for international research experiences, including a CSU-wide intensive summer research training program conducted each year in Costa Rica, which is administered and led in part by UROC staff (see Figures 2 and 3). The well-built structure provided by the program seeks to help underrepresented students persist and excel in the high-impact practice of undergraduate research. We believe this program is a prime illustration of how a focus on undergraduate research may serve to broaden participation in STEM, both on the CSUMB campus and in the context of the CSU-wide LSAMP Alliance (Malachowski et al. 2015).

Methods

To examine the experiences of students in undergraduate research, including CSU-LSAMP participants at CSUMB, post-research surveys were administered yearly. Administration of the survey was reviewed by the CSUMB

FIGURE 2. Students in the CSU-LSAMP Costa Rica Summer Research Program Gathering Data on Forest Structure



FIGURE 3. Students in the CSU–LSAMP Costa Rica Summer Research Program Measuring Arthropod Diversity and Spider Body-Size Data



Institutional Review Board and determined to be exempt because questions and administration were within the bounds of commonly accepted educational practices and program evaluation. Participants were given electronic informed consents that included an option to opt out of the survey and all future research without any penalty or impact on their participation in CSUMB or LSAMP programs. The survey was developed in 2012 to evaluate students' academic and professional skill development, increases in confidence, satisfaction with the research experience, relationships with peers and faculty, and educational aspirations. Data were tested against other measures of student development, including students' written reflections about their experiences, evaluations from faculty mentors, and measures of academic success (GPA and graduation rates). Here survey results from 2012–2016 ($n = 323$) are described. There was an average response rate of 91 percent; 55 CSU–LSAMP participants at CSUMB responded to the survey. Analysis and results focus on the 55 CSU–LSAMP participants in undergraduate research at CSUMB.

Limitations

This research utilizes self-reported data that illustrate students' perceptions of their learning and cannot be generalized to objective measures (Pike 2011). A subset of students' self-appraisals of their learning and development were compared to faculty mentor evaluations of students' learning and development. Students and mentors were given matched surveys regarding professional development, level of involvement in research, and research-related skills. No significant differences between student and mentor evaluations were found on aggregate measures of research-related skills, professional and academic skills, professionalism, or level of independence in research ($p > 0.05$; data not shown).

Future research should test the effect of participation in programs like CSU–LSAMP using more concrete measures such as academic performance or postgraduation outcomes, including graduate school enrollment and employment. Future research also should include a comparison group of like peers to allow clarification of the impact of this type of program.

Results and Discussion

Survey Data

To date, the CSU–LSAMP program on the CSU Monterey Bay campus has served 524 students; students participating in the program are asked to detail the progress resulting from their experiences via self-report surveys. Overall, undergraduate CSU–LSAMP students at CSUMB who engage in summer research experiences are highly motivated to continue their education, with 92 percent of students recently surveyed ($n = 53$) reporting that they aspired to go on to graduate school (75 percent for a doctorate, 17 percent a master's degree). Some of the factors that may be contributing to this trend include opportunities for students in the program to develop research skills, gain experience in networking, and boost their overall confidence. Nearly all students surveyed over the past three years (2013–2016) indicated high levels of confidence about engaging in rigorous disciplinary research (see Table 1) and working as part of a team (see Table 2). Notably, only 84 percent of student respondents were confident about being able to conduct research independently (see Table 2), suggesting that additional scaffolding may be useful when preparing students to transition to graduate school. Finally, students overwhelmingly (93 percent) reported feeling as though they were an integral part of the research community (see Table 3).

TABLE 1. Student Development

	Percentage with substantial improvement ^a
Ability to read and understand peer-reviewed literature	92.7
Research skills	92.7
Ability to contribute to the body of field research	98.2
Sense of competence as a researcher in the field	94.5
Ability to work in a rigorous research environment	98.2

Note: Please rate how much your knowledge, skills, and abilities improved after your research experience: 1 = not at all, 2 = small, 3 = moderate, 4 = a considerable amount, 5 = a great deal of improvement

^aSubstantial improvement = scores 3–5
 $n = 55$

TABLE 2. Level of Confidence after Research Experience

	Percentage of students who feel confident in these areas ^a
Ability to build professional networks	94.5
Being prepared for graduate school after completing summer research	90.9
Career decision-making skills	96.4
Ability to work independently	83.6
Feeling self-sufficient in academic pursuits (e.g., identifying courses, finding resources and opportunities)	98.2
Ability to work as part of a research team	100.0

Note: Please rate your level of confidence in the following areas after your research experience:

1 = none, 2 = a small degree, 3 = a moderate degree, 4 = a large degree, 5 = a very large degree

^aConfident = scores 3–5

n = 55

TABLE 3. Development as a Result of Research Experience

	Percentage of students who agree ^a
Are more confident about your ability to work effectively in a professional environment	100.0
Were able to interact with a variety of professional contacts in your field	92.5
Feel more competent as a researcher in your field	98.1
Broadened your awareness of academic and career opportunities that are available to you	96.2
Were motivated by your experience this past summer to do more research	98.1
Became more committed to going to graduate school and completing an advanced degree	94.3
Became an integral and active member of a research team	92.5

Note: As a direct result of your research experience, to what extent do you feel you . . . ?

1 = not at all, 2 = small amount, 3 = moderately, 4 = considerably, 5 = a great deal

^aAgree = scores 3–5

n = 53

Persistence and Graduation Rates

Participating in undergraduate research increases a student's connection to a discipline and retention in STEM fields (Finley and McNair 2013; Hurtado et al. 2009). At CSUMB, the LSAMP program with an emphasis on undergraduate research experiences clearly fosters a sense of belonging in discipline-based communities both on- and off-campus. Positive benefits from these types of initiatives include boosted retention and completion rates as well as enhanced career trajectories (Gregerman et al. 1998). Across the alliance, persistence and graduation rates for URM CSU–LSAMP participants are almost twice

as high as those for URM students who do not participate in the program. The proportion of CSU–LSAMP participants who progress to graduate programs also is very high: 42 percent of CSU–LSAMP graduates have either earned a postbaccalaureate degree or are currently enrolled in a graduate program (Messier and Barker 2016). At CSUMB, CSU–LSAMP participants and other students who have participated in undergraduate research graduate with higher grade point averages than similar peers who have not participated in research; research participants also benefit from stronger connections to faculty mentors in their fields of study (Haeger and Fresquez 2016).

Overall, the benefits of providing high-impact practices such as undergraduate research opportunities are well established. For underserved students, these types of engagement are especially meaningful (Kinzie et al. 2008). The increased emphasis on mentored undergraduate research experiences is being accompanied by calls to boost inquiry-based instruction (Gentile, Brenner, and Stephens 2017; Schneider 2018); the development of course-based research is a further means of broadening participation in high-impact practices (Kuh 2008). Programs like those offered by the CSU–LSAMP Alliance afford a diverse student population at a large public university system the chance to engage in research during the undergraduate years. The experience and skill sets students gain from participating in high-stakes authentic research prepare them for postgraduate employment and graduate studies and at the same time bolster their confidence, self-efficacy, and cultural capital. We anticipate that campuses nationwide will continue to create and implement transformative research-intensive programs to complement initiatives aimed at better recruiting, retaining, and serving diverse student populations.

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John E. Banks

California State University, Monterey Bay,
jebanks@csumb.edu

John E. Banks is director of the Undergraduate Research Opportunities Center at California State University, Monterey Bay (CSUMB). He is also campus co-coordinator and serves on the Program Oversight Committee for the CSU–Louis Stokes Alliance for Minority Participation (LSAMP) Alliance. He earned an MS in applied mathematics at the University of Southern California and a PhD in zoology at the University of Washington, Seattle. He spent 16 years as a faculty member and administrator at the Tacoma campus of the University of Washington, where he was a professor of environmental science and served as director of international programs and director of undergraduate education. Trained as a quantitative ecologist, Banks has published more than 75 scientific articles, book chapters, and technical reports—several with undergraduate coauthors—exploring biological control and predator-prey population dynamics in agroecosystems, ecotoxicology, and the conservation of biological diversity in natural and managed systems in both temperate and tropical environments.

Carla Fresquez is the research associate at the Undergraduate Research Opportunity Center at CSUMB. She received her graduate degree in ecology and evolutionary biology from the University of California, Santa Cruz. Her research interests include examinations of the

factors shaping communities of sensitive intertidal marsh species and identification of mentoring strategies effective for supporting students in undergraduate research. She is co-coordinator of the Louis Stokes Alliance for Minority Participation (LSAMP) and is an UndocuAlly at CSUMB.

Heather Haeger is the educational research associate in the Undergraduate Research Opportunity Center at CSUMB. She conducts research on educational equity in high-impact practices and the transition to graduate education. Her research is used to inform programmatic interventions aimed at engaging traditionally underserved populations. Haeger also serves as the assessment and research coordinator for the Council on Undergraduate Research. She surveys current literature on undergraduate research, develops tools for CUR members to use in conducting their own research and assessment, and studies the role of faculty mentoring of undergraduate research in tenure and promotion. Haeger received her PhD in education policy, studies, and practices from the University of Arizona. From 2011 to 2014, she was assistant research faculty in the Center for Postsecondary Research at Indiana University. She worked on designing, testing, and administering surveys on student engagement, including

the National Survey of Student Engagement (NSSE) and the Law School Survey of Student Engagement (LSSSE).

Semarhy Quinones-Soto is the associate project director of the CSU-LSAMP Alliance. She is the director of the Student Research Center, a lecturer in biological sciences, and the research coordinator of the Science Educational Equity Program at California State University, Sacramento (Sac State). She also created Sac State's first Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) student chapter and serves as its faculty adviser. She earned a BS in microbiology from the University of Puerto Rico, Humacao, and a PhD in microbiology from the University of California, Davis.

Lisa Hammersley is a professor of geology and associate dean of the College of Natural Sciences and Mathematics at Sac State. She also is the lead project director of CSU-LSAMP. Originally from the United Kingdom, Hammersley earned her PhD from the University of California, Berkeley. Her academic interests include the influence of magma chamber processes on the size and intensity of volcanic eruptions and increasing diversity in STEM disciplines. Hammersley is an author of Physical Geology, a popular introductory-level geology textbook.

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