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This chapter captures the mission and spirit of the California State University in its efforts to institutionalize undergraduate research and support the success of students traditionally underrepresented in higher education.

Undergraduate Research and Its Impact on Student Success for Underrepresented Students

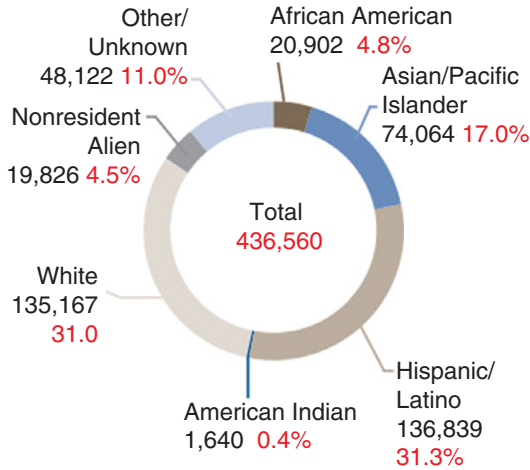
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The California State University System

The California State University (CSU) System is the nation's largest four-year public university system. We educate 437,000 students on our 23 campuses, 87% of whom are undergraduates, with over 76,000 bachelor's degrees conferred annually. The CSU draws students from the top third of the state's high school graduates, placing it between the more selective University of California system and the open-access California Community Colleges. As an access-oriented institution, we are charged with advancing the state's economic growth, civic vitality, and upward mobility.

Many of our students come from groups that are underserved by higher education: economically disadvantaged, first in their families to attend college, and ethnic minorities. In fall 2012, 37% of CSU students were of Hispanic/Latino, African American, or American Indian decent (CSU, 2013; Figure 3.1). We award more than half of all undergraduate degrees granted to students from these groups in California.

The CSU reaffirmed its commitment to enhance student access to active learning, including undergraduate research, in its 2008 management plan, *Access to Excellence* (CSU, 2008). The plan pointed to the capture and replication of best-practice models and applied research infrastructure as important next steps toward this major institutional goal.

Figure 3.1. Fall 2012 Enrollment by Ethnicity

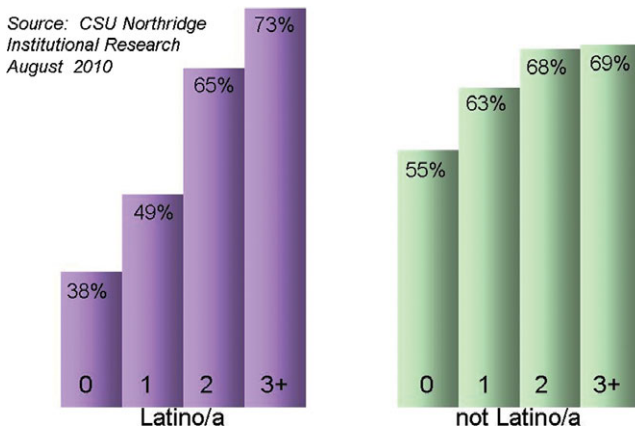
Impact of Undergraduate Research on Underrepresented Student Success

Due to changing demographics, evolving workforce needs, and recognition of the democratizing effect of diverse campuses (Gurin, Nagda, & Lopez, 2004), the success of underrepresented minorities is now a state and national priority. Launched in 2009, the CSU's Graduation Initiative is working to halve the gap in underrepresented student degree attainment by 2015. Nationally, there are calls for increased degree attainment by underrepresented students in the science, technology, engineering, and mathematics (STEM) fields (Malcom, Dowd, & Yu, 2010).

The CSU's investment in "high-impact practices," including service learning, peer mentoring, and undergraduate research, is paying off. At California State University Northridge (CSUN), for example, there is a strong correlation between graduation rates and participation in multiple high-impact practices, particularly for Latino students (Figure 3.2). Service learning has benefited from system-wide coordination and infrastructure support through the CSU Center for Community Engagement. We seek to replicate this systematic approach with undergraduate research to serve our diverse students and close the graduation attainment gap.

The benefits of undergraduate research on underrepresented students are well documented. Students who participate in research gain hands-on experience, have more applied learning opportunities (Hunter, Laursen, & Seymour, 2006; Laursen, Seymour, Hunter, Thiry, & Melton, 2010), and are more engaged in their campuses (Kinzie, Gonyea, Shoup, & Kuh, 2008; Kuh, Kinzie, Schuh, Whitt, & Associates, 2010). Participation in

Figure 3.2. CSU Northridge Six-Year Graduation Rates by Student Ethnicity and Self-Reported Number of Participations in High-Impact Practices



undergraduate research is also linked to academic success, retention, and persistence (Finley & McNair, 2013; Jones, Barlow, & Villarejo, 2010; Kinzie et al., 2008; Kuh et al., 2010; Russell, Hancock, & McCullough, 2007; Taraban, 2008), and these benefits are pronounced for traditionally underserved students (Finley & McNair, 2013; Osborn & Karukstis, 2009). Underrepresented minority students, students who enter college with less academic preparation, and first-generation students demonstrate the greatest benefits from undergraduate research (Finley & McNair, 2013; Kinzie et al., 2008; Lopatto, 2007).

Introducing students to research early and over time greatly increases its impact on student retention and academic performance (Jones et al., 2010) and increases the benefits of undergraduate research for all students (Bauer & Bennett, 2003). Schultz et al. (2011) found that minority students who had participated in undergraduate research experiences were more likely to persist in their intentions to pursue a research career.

Enhancing Undergraduate Research for Underrepresented Minorities Within the CSU

The Council on Undergraduate Research’s *Characteristics of Excellence in Undergraduate Research* (Hensel, 2012) outlines 12 essential characteristics that enhance undergraduate research, which take on even greater importance for underrepresented, first-generation, and low-income students. Here we discuss seven characteristics that the CSU is leveraging to benefit these students.

Support Programs. The undergraduate research experience is not limited to the lab, field, library, or studio. It should include robust programming to support communication skills development, cohort and peer network development, and professional skills training (Hensel, 2012).

Hathaway, Nagda, and Gregerman (2002) found that students who participated in structured undergraduate research programs with activities such as career workshops, peer advising, and group meetings were more prepared and more likely to go on to graduate programs. More recently, the CSU Louis Stokes Alliance for Minority Participation (CSU-LSAMP), a system-wide program with the explicit goal of increasing representation of underrepresented students in STEM disciplines, surveyed 191 CSU undergraduate researchers, 70% of whom were underrepresented minorities, finding that students who engaged in support activities such as journal clubs, workshops, and field trips reported greater gains in thinking and working like a scientist. Of those engaged in additional support activities, 68% reported “a lot of gain” in “formulating a research question that could be answered with data,” compared with only 46% of nonparticipants (Messier, Barker, & Nelson, 2013).

Support programs are also essential in making successful research partnerships between students and faculty. Schwartz (2012) illustrates the emotional, professional, and financial costs to faculty participating in undergraduate research, especially faculty of color who are disproportionately called on to mentor students. The most influential factors in mitigating these costs were having adequate support programs for students and institutional support for faculty.

Currently, only four CSU campuses have centralized undergraduate research offices, but there is a growing movement to consolidate support programs, allowing for coordinating services, including workshops and trainings; marketing and communication strategies; and, importantly, evaluation and tracking of undergraduate research. Campuses use innovative funding mechanisms for centralized undergraduate research offices. California State Polytechnic University, Pomona and CSU San Bernardino used CSU Student Success funding to start an office; CSU East Bay tapped into student fees; and CSU Monterey Bay (CSUMB) used a combination of direct institutional support coupled with grants and a growing endowment.

Additionally, one third of CSU campuses are creating STEM Collaboratives with support from the Helmsley Charitable Trust. These programs blend summer immersion programs, first-year experiences, and gateway courses redesigned to include interventions, such as undergraduate research, to develop dispositional learning and to close achievement gaps. STEM Collaboratives will be organized as a learning opportunity for the system, building a case for permanent, publicly funded educational structures—in effect, a new and improved status quo.

Quality Mentoring and Role Models. Malcom et al. (2010) state “... when students interact with faculty in doing research, they benefit from their apprentice role by becoming familiar with academic and professional networks and norms” (p. 13). The opportunity to deeply engage with role models—be they professors, graduate students, or more advanced peers—allows students to identify similarities in their backgrounds, demystify the path their mentors took to their positions, and, ultimately, view themselves in those roles. Students not only learn technical and research inquiry skills from faculty mentors in their field, but they are also socialized into the profession and build important connections to serve as resources for academic support, professional references, and graduate school preparation and admissions (Hunter et al., 2006; Laursen et al., 2010). Traditionally underrepresented students benefit the most from faculty research mentorship (Finley & McNair, 2013; Kinzie et al., 2008).

CSUMB launched the Monterey Bay Regional Mentorship Alliance with the University of California, Santa Cruz’s Research Mentoring Institute, and Hartnell Community College with the mission to support, sustain, and enhance faculty and graduate student mentorship at regional academic and research institutions.

Funding for Students. The CSU-LSAMP survey (Messier et al., 2013) found that stipends or payment for undergraduate research are critical to our target demographic, with 80% of respondents indicating that a stipend was “very important” or “important” in allowing them to participate. Financial support also trumps academic credit (61% reported that academic credit was “very important” or “important”). Students who participated in summer or summer and academic year research, rather than only academic year research, reported greater gains in “thinking and working like a scientist.” Thiry, Wesson, Laursen, and Hunter (2012) found that multiyear undergraduate research experiences enabled students to develop not only the intellectual skills to advance in science but also the necessary behaviors and temperament. However, they note that most funding structures do not support multiyear research experiences for undergraduates. Because many target demographic students support their own education (Malcom et al., 2010), it is imperative to fund rigorous and multiyear research opportunities.

Currently, the bulk of funding comes from federal grants. For example, CSU-LSAMP and the Department of Education’s Ronald E. McNair Postbaccalaureate Achievement programs fund student research, with a range of academic support services, conference and graduate school travel, and other professional development.

Campuses are also finding creative uses for system-level funding to support students who want to participate in undergraduate research. For example, as an evaluation criterion of its CSU-funded faculty support grants, CSU East Bay includes “the direct involvement of students in the scholarly

or creative process,” effectively using money earmarked for one goal and making it work for two.

Finally, there are system-wide initiatives investing heavily in undergraduate research support. The CSU affinity groups, including the CSU Program for Education and Research in Biotechnology (CSUPERB) and the Council on Ocean Affairs, Science and Technology (COAST), fund student research opportunities, travel, and conference participation. The Chancellor’s Office hosts meetings, subsidizes in-state travel, and supports campus-organized research competitions and conference attendance for students.

Most often, system-level support is made available to campuses by a competitive process through formal requests for proposals with application guidelines, criteria for review, and reporting requirements. A long-time exception to this competitive approach resides in the Center for Community Engagement, which provides direct annual funding to campuses for service learning, an approach that may also work well to support undergraduate research across the CSU.

Authentic Opportunities to Calibrate Knowledge. Bandura (1977) made a strong case for the role of “performance accomplishments” in the development of self-efficacy. Given that our target demographic students perceive themselves as “outside” the academic sphere (Ovink & Veazey, 2011), we must provide authentic opportunities for students to demonstrate and calibrate their knowledge. Martinez (2009) found that when students had more ownership over their research—such as data collection and analysis—they were more enthusiastic about the research, felt a greater association with the research field, and were more likely to pursue a STEM graduate education.

The CSU hosts a system-wide Student Research Competition that celebrates and recognizes faculty–student mentored research across the disciplines. In addition, CSUPERB hosts the annual CSU Biotechnology Symposium that gathers CSU student researchers, faculty, administrators, and biotechnology professionals.

The CSU is also developing an online peer-reviewed journal of undergraduate research, *Journal of the CSU Scholar*, that will give educators and students ongoing access to system innovations. The initial editions of the journal will include submissions of the awardees from the CSU Student Research Competition and affinity group conferences. Next steps include an electronic platform and infrastructure support for the editorial board, such as faculty-assigned time and professional incentives for faculty and students to serve as reviewers.

Societal Relevance and Community Engagement. Much as Martinez (2009) saw with ownership factoring into student learning, CUR’s and CSU’s research has shown that students, particularly those from underrepresented groups, also benefit from taking ownership of their learning when they connect their research to the greater good satisfying a deep-seated need to give back to their families, communities, and society.

For example, at San Diego State University students apply techniques of social science research to investigate food security and health issues in three San Diego neighborhoods. At CSU Los Angeles, film students use the documentary form to “put a face on critical issues impacting our nation’s youth.” At CSU Fresno, students work with community partners on water quality and habitat restoration, as well as teaching aquatic ecology modules in local classrooms.

Links From Community College. The CSU system is the largest baccalaureate degree granting institution in the United States; however, over 63% of all California high school graduates admitted as freshmen in California higher education enroll at a community college, including 75% of Hispanic students. A high percentage of students who transfer to the CSU are underrepresented, but they are often unable to find timely campus resources (Moore & Shulock, 2010) and miss out on high-impact experiences (Malcom et al., 2010). CSU Fullerton (CSUF) and three local community colleges—Citrus College, Cypress College, and Santiago Canyon College—are tackling this issue head-on with funding from the Department of Education. CSUF students mentor community college students in career workshops and individually, and recruit for CSUF’s Summer Research Experience program. Over two years, 57 community college students were paired with CSUF faculty for an eight-week paid summer research experience. CSUF peer advisors met with them weekly to discuss the struggles and triumphs of research. The program has had phenomenal success: 23 of the 25 first cohort participants transferred to four-year universities.

Curricular Enhancements. Injecting research opportunities into the core curriculum engages all students in applied active learning (Malcom et al., 2010), but is particularly important for underrepresented students, who participate in such activities at lower rates than their peers. Fecheimer, Webber, and Kleiber (2011) compared students who took courses with an undergraduate research component to other students at the same institution. Even when controlling for academic preparation (SAT score), taking courses with an authentic research component was positively correlated with academic performance across classes (cumulative GPA). This relationship was strongest for students who had taken multiple courses with a research emphasis, findings that were consistent across disciplines.

CSU Channel Island’s innovative Stepladder Program for Interdisciplinary Research and Learning (SPIRaL; funded by the W.M. Keck Foundation) introduces common research methods and develops analytical tools and skills in new lower division courses with increasingly sophisticated research projects integrated into middle and upper division courses. As reported on the project’s website, “By introducing interdisciplinary research at the lower-division in a way that demonstrates the university’s commitment to community engagement and service learning, SPIRaL will systematically develop intellectual depth and breadth in a broad spectrum of the student population and will encourage students to develop career and life

goals marked by engaged curiosity, sustained passion, and civic responsibility. At the same time, the stepladder structure will cultivate expertise in the students continuing on to senior-level.”

Fechheimer et al. (2011) also suggest that funding and incentives for faculty to incorporate undergraduate research in their courses would benefit students. However, the system-wide provision of faculty “seed mini-grants,” while promising, does not represent a sustainable model.

Leveraging the System to Institutionalize Undergraduate Research Across the CSU

The above examples from CSU campuses dovetail with current literature and the *Characteristics of Excellence* that the Council for Undergraduate Research has identified as essential to support undergraduate research. Accelerating and spreading their adoption is one of the key roles of a system office.

Although charged formally with the implementation of law and policy, public university systems often find that their deeper influence lies in convening, communicating, and connecting. Several formal structures, including the “affinity groups” discussed above, were developed to regularly bring together faculty around topics of interest, pooling best practices and new ideas more efficiently than if the Chancellor’s Office tried a more centralized hub-and-spoke approach.

In the shorter term, grant-funded activity can also spur the cross-campus collaboration that epitomizes well-functioning state systems. At times the very impermanence of these projects is a strength, drawing those who may avoid long-term commitments, and lending a sense of urgency and purpose to routine interaction. When campuses are allowed to opt in, the external impetus for activity can be remarkably valuable. For example, one third of the CSU campuses applied to join a series of workshops organized by the Council for Undergraduate Research (Malachowski, Ambos, Karukstis, & Osborn, 2010) to strategically devise ways to provide more comprehensive support for undergraduate research. The system-wide project entailed the appointment of delegates to a CSU council and participation in regularly scheduled conference calls and webinars. The opportunity to meet, trade ideas, and learn from others in a similar context was routinely cited at the top of the project evaluations. Furthermore, the ideas are more than academic: some innovations have spread to other campuses, including, most visibly, the creation of central undergraduate research offices.

Future Directions

Looking forward, the CSU system must: (a) deepen its understanding of undergraduate research’s impact on retention, graduation, and career

success; (b) stabilize faculty and undergraduate research funding; (c) provide reliable, consistent, and strong system-level leadership to develop and promote undergraduate research initiatives; (d) develop community college–CSU–University of California undergraduate research linkages; and (e) broaden the engagement of faculty and students in undergraduate research (e.g., more disciplines and curriculum/scaffolding).

Body of Evidence. While CSU takes pride in the availability of undergraduate research experiences for its traditionally underserved students, with the exception of LSAMP data, we have little quantitative evidence on how this intervention is impacting persistence and graduation. Much of the effort to strengthen the quantitative case for undergraduate research and its benefits for underserved student success is centrally coordinated and externally supported.

The CSU's recently developed Student Success Dashboard (Dashboard) will help us close the data gap on how high-impact practices affect student achievement as it compiles data already collected from campuses and repackages it for their decision makers. The Dashboard will also store records of student participation in high-impact practices, consistently and explicitly defined, to add detail and reliability to the gains suggested by the Northridge study (Figure 3.2). The CSU is developing more precise definitions and scales of intensity for some of the engaging pedagogies most commonly used around the system, including service learning, summer bridge programs, peer mentoring, and undergraduate research. The Dashboard will analyze if and how particular subgroups (such as majors, ethnicity groups, and community college transfers) are benefiting from these high-impact practices. To maximize the Dashboard's potential, the CSU must also include longitudinal data regarding alumni graduate studies and career paths.

Developing a Sustainable Model to Support Undergraduate Research Systematically. An unusual and sustained degree of central support has strengthened service learning across the CSU, and this provides a model for undergraduate research development. Four characteristics have made service learning work well in the CSU: (a) the Board of Trustees and system-wide Academic Senate issued formal resolutions supporting universal opportunities for service learning and community service, including the requirements for dedicated office and staff, and annual reports to the board; (b) presidents and the chancellor are aware of the support and its significance; (c) a system-wide Center for Community Engagement is charged with oversight and administration of the dedicated resources; and (d) within the requirements for commitment and reporting, campuses tailor their interventions to fit local mission, culture, and administrative structures.

Funding Faculty Engagement in Undergraduate Research. We must also address the funding model for faculty engagement in undergraduate research, putting a premium on undergraduate research within

departmental policies of retention, promotion, and tenure; calculations of classroom and laboratory allocation; faculty workload; and student credit hours and degree requirements. This work won't be easy but should be facilitated by the research now underway with the Council on Undergraduate Research (Malachowski et al., 2010), Keck, Helmsley, BHEF, AAC&U, and others. The projects emphasize rigorous documentation of the benefits of undergraduate research, not only in student learning but also in cost effectiveness in the state's efforts to support more college-educated individuals.

Until we can strengthen the business case, undergraduate research—like other high-impact practices—will be relegated to the margins of the overall enterprise, relying on the goodwill of committed faculty members and enlightened administrators for essentially unpaid extra workload.

Leadership at the System Level. As service learning was a decade or so ago, undergraduate research in the CSU is poised for a more systematic approach. The faculty-led, grant-funded, and affinity-group-supported activities around the state are reaching critical mass, the kind that strikes us at the system level as primed for—in the words of this volume title—“a systems approach.” CSU faculty and campus academic affairs administrators report that reliable, consistent support—both in money and high-level attention—is critical to their success. As we document and promote the case for undergraduate research as a high-impact, gap-closing practice, we advocate for a permanent undergraduate research center in the Chancellor's Office, on the same model as the Center for Community Engagement created in 1998.

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